THE GORDIAN GROUP®

THE STANDARD FOR JOB ORDER CONTRACTING™

NEW YORK CITY DEPARTMENT OF DESIGN + CONSTRUCTION

JOB ORDER CONTRACT

Technical Specifications

VOLUME I of V
CSI SECTIONS 01000 - 05000

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SECTION 01352 - NO SPECIFICATION REQUIRED

1.1 GENERAL

A. A separate specification is not required for this item. The description given in the line item of the Construction Task Catalog completely defines the item.

1.2 PRODUCTS - (Not Used)

1.3 EXECUTION - (Not Used)

END OF SECTION 01352

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SECTION 01510 - CONSTRUCTION WASTE MANAGEMENT

1.1 GENERAL

A. Summary
1. This Section includes administrative and procedural requirements for the following:
   a. Salvaging nonhazardous demolition and construction waste.
   b. Recycling nonhazardous demolition and construction waste.
   c. Disposing of nonhazardous demolition and construction waste.

B. Definitions
1. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
2. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.
3. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.
4. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.
5. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.
6. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

C. Performance Goals **OR** Requirements, **as directed**
1. General: Develop waste management plan that results in end-of-Project rates for salvage/recycling of 50 **OR** 75, **as directed**, percent by weight of total waste generated by the Work.
2. Salvage/Recycle Goals **OR** Requirements, **as directed**: Owner's goal is to salvage and recycle as much nonhazardous demolition and construction waste as possible including the following materials:

   OR

   Salvage/Recycle Goals **OR** Requirements, **as directed**: Owner's goal is to salvage and recycle as much nonhazardous demolition and construction waste as possible. Owner has established minimum goals for the following materials:
   a. Demolition Waste:
      1) Asphaltic concrete paving.
      2) Concrete.
      3) Concrete reinforcing steel.
      4) Brick.
      5) Concrete masonry units.
      6) Wood studs.
      7) Wood joists.
      8) Plywood and oriented strand board.
      9) Wood paneling.
      10) Wood trim.
      11) Structural and miscellaneous steel.
      12) Rough hardware.
      13) Roofing.
      14) Insulation.
      15) Doors and frames.
      16) Door hardware.
      17) Windows.

18) Glazing.
19) Metal studs.
20) Gypsum board.
21) Acoustical tile and panels.
22) Carpet.
23) Carpet pad.
24) Demountable partitions.
25) Equipment.
26) Cabinets.
27) Plumbing fixtures.
28) Piping.
29) Supports and hangers.
30) Valves.
31) Sprinklers.
32) Mechanical equipment.
33) Refrigerants.
34) Electrical conduit.
35) Copper wiring.
36) Lighting fixtures.
37) Lamps.
38) Ballasts.
39) Electrical devices.
40) Switchgear and panelboards.
41) Transformers.

b. Construction Waste:
1) Site-clearing waste.
2) Masonry and CMU.
3) Lumber.
4) Wood sheet materials.
5) Wood trim.
6) Metals.
7) Roofing.
8) Insulation.
9) Carpet and pad.
10) Gypsum board.
11) Piping.
12) Electrical conduit.
13) Packaging: Regardless of salvage/recycle goal indicated above, salvage or recycle 100 percent of the following uncontaminated packaging materials:
a) Paper.
b) Cardboard.
c) Boxes.
d) Plastic sheet and film.
e) Polystyrene packaging.
f) Wood crates.
g) Plastic pails.

D. Submittals
1. Waste Management Plan: Submit 3 copies of plan within 7 **OR** 30, **as directed**, days of date established for commencement of the Work **OR** the Notice to Proceed **OR** the Notice of Award, **as directed**.
2. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit three copies of report. Include separate reports for demolition and construction waste, **as directed**. Include the following information:
a. Material category.

b. Generation point of waste.
c. Total quantity of waste in tons (tonnes).
d. Quantity of waste salvaged, both estimated and actual in tons (tonnes).
e. Quantity of waste recycled, both estimated and actual in tons (tonnes).
f. Total quantity of waste recovered (salvaged plus recycled) in tons (tonnes).
g. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.

3. Waste Reduction Calculations: Before request for Substantial Completion, submit three copies of calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.
4. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.
5. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.
6. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
7. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
8. LEED Submittal: LEED letter template for Credit MR 2.1 and 2.2, **as directed**, signed by Contractor, tabulating total waste material, quantities diverted and means by which it is diverted, and statement that requirements for the credit have been met.
9. Qualification Data: For Waste Management Coordinator and refrigerant recovery technician.
10. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

E. Quality Assurance
1. Waste Management Coordinator Qualifications: LEED Accredited Professional by U.S. Green Building Council. Waste management coordinator may also serve as LEED coordinator.
2. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.
3. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.
4. Waste Management Conference: Conduct conference at Project site. Review methods and procedures related to waste management including, but not limited to, the following:
   a. Review and discuss waste management plan including responsibilities of Waste Management Coordinator.
   b. Review requirements for documenting quantities of each type of waste and its disposition.
   c. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
   d. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
   e. Review waste management requirements for each trade.

F. Waste Management Plan
1. General: Develop plan consisting of waste identification, waste reduction work plan, and cost/revenue analysis. Include separate sections in plan for demolition and construction waste if Project requires selective demolition or building demolition. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.
2. Waste Identification: Indicate anticipated types and quantities of demolition, site-clearing, and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.
3. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.

a. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work.
b. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.
c. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
d. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
e. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
f. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location on Project site where materials separation will be located.

4. Cost/Revenue Analysis: Indicate total cost of waste disposal as if there was no waste management plan and net additional cost or net savings resulting from implementing waste management plan. Include the following:
a. Total quantity of waste.
b. Estimated cost of disposal (cost per unit). Include hauling and tipping fees and cost of collection containers for each type of waste.
c. Total cost of disposal (with no waste management).
d. Revenue from salvaged materials.
e. Revenue from recycled materials.
f. Savings in hauling and tipping fees by donating materials.
g. Savings in hauling and tipping fees that are avoided.
h. Handling and transportation costs. Include cost of collection containers for each type of waste.
i. Net additional cost or net savings from waste management plan.

1.2 PRODUCTS (Not Used)

1.3 EXECUTION

A. Plan Implementation
1. General: Implement waste management plan as approved by the Owner. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
a. Comply with Division 01 Section "Temporary Facilities And Controls" for operation, termination, and removal requirements.
2. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan. Coordinator shall be present at Project site full time for duration of Project.
3. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work occurring at Project site.
a. Distribute waste management plan to everyone concerned within three days of submittal return.
b. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.
4. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
a. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.

b. Comply with Division 01 Section "Temporary Facilities And Controls" for controlling dust and dirt, environmental protection, and noise control.

B. Salvaging Demolition Waste
1. Salvaged Items for Reuse in the Work:
a. Clean salvaged items.
b. Pack or crate items after cleaning. Identify contents of containers.
c. Store items in a secure area until installation.
d. Protect items from damage during transport and storage.
e. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.
2. Salvaged Items for Sale and Donation: Permitted **OR** Not permitted, **as directed**, on Project site.
3. Salvaged Items for Owner's Use:
a. Clean salvaged items.
b. Pack or crate items after cleaning. Identify contents of containers.
c. Store items in a secure area until delivery to Owner.
d. Transport items to Owner's storage area on-site **OR** off-site **OR** designated by Owner, **as directed**.
e. Protect items from damage during transport and storage.
4. Doors and Hardware: Brace open end of door frames. Except for removing door closers, leave door hardware attached to doors.

C. Recycling Demolition And Construction Waste, General
1. General: Recycle paper and beverage containers used by on-site workers.
2. Recycling Receivers and Processors: Refer to the Owner for available recycling receivers and processors.
3. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Owner **OR** accrue to Contractor **OR** be shared equally by Owner and Contractor, **as directed**.
4. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical.
a. Provide appropriately marked containers or bins for controlling recyclable waste until they are removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
1) Inspect containers and bins for contamination and remove contaminated materials if found.
b. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
c. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
d. Store components off the ground and protect from the weather.
e. Remove recyclable waste off Owner's property and transport to recycling receiver or processor.

D. Recycling Demolition Waste
1. Asphaltic Concrete Paving: Grind asphalt to maximum 1-1/2-inch (38-mm) **OR** 4-inch (100-mm), **as directed**, size.
a. Crush asphaltic concrete paving and screen to comply with requirements in Division 02 Section "Earthwork" for use as general fill.
2. Asphaltic Concrete Paving: Break up and transport paving to asphalt-recycling facility.
3. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.
a. Pulverize concrete to maximum 1-1/2-inch (38-mm) **OR** 4-inch (100-mm), **as directed**, size.
b. Crush concrete and screen to comply with requirements in Division 02 Section "Earthwork" for use as satisfactory soil for fill or subbase.

4. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.
   a. Pulverize masonry to maximum 3/4-inch (19-mm) **OR** 1-inch (25-mm) **OR** 1-1/2-inch (38-mm) **OR** 4-inch (100-mm), **as directed**, size.
      1) Crush masonry and screen to comply with requirements in Division 02 Section "Earthwork" for use as general fill **OR** satisfactory soil for fill or subbase, **as directed**.
      2) Crush masonry and screen to comply with requirements in Division 02 Section "Exterior Plants" for use as mineral mulch.
   b. Clean and stack undamaged, whole masonry units on wood pallets.
5. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.
6. Metals: Separate metals by type.
   a. Structural Steel: Stack members according to size, type of member, and length.
   b. Remove and dispose of bolts, nuts, washers, and other rough hardware.
7. Asphalt Shingle Roofing: Separate organic and glass-fiber asphalt shingles and felts. Remove and dispose of nails, staples, and accessories.
8. Gypsum Board: Stack large clean pieces on wood pallets and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners.
9. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in a dry location.
   a. Separate suspension system, trim, and other metals from panels and tile and sort with other metals.
10. Carpet and Pad: Roll large pieces tightly after removing debris, trash, adhesive, and tack strips.
    a. Store clean, dry carpet and pad in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.
11. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.
12. Plumbing Fixtures: Separate by type and size.
13. Piping: Reduce piping to straight lengths and store by type and size. Separate supports, hangers, valves, sprinklers, and other components by type and size.
14. Lighting Fixtures: Separate lamps by type and protect from breakage.
15. Electrical Devices: Separate switches, receptacles, switchgear, transformers, meters, panelboards, circuit breakers, and other devices by type.
16. Conduit: Reduce conduit to straight lengths and store by type and size.

E. Recycling Construction Waste
   1. Packaging:
      a. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
      b. Polystyrene Packaging: Separate and bag materials.
      c. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
      d. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.
   2. Site-Clearing Wastes: Chip brush, branches, and trees on-site **OR** at landfill facility, **as directed**.
      a. Comply with requirements in Division 02 Section "Exterior Plants" for use of chipped organic waste as organic mulch.
   3. Wood Materials:
      a. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
      b. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.
         1) Comply with requirements in Division 02 Section "Exterior Plants" for use of clean sawdust as organic mulch.
   4. Gypsum Board: Stack large clean pieces on wood pallets and store in a dry location.

a. Clean Gypsum Board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.
   1) Comply with requirements in Division 02 Section "Exterior Plants" for use of clean ground gypsum board as inorganic soil amendment.

F. Disposal Of Waste
1. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
   a. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
   b. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
2. Burning: Do not burn waste materials.
   OR
   Burning: Burning of waste materials is permitted only at designated areas on Owner's property, provided required permits are obtained. Provide full-time monitoring for burning materials until fires are extinguished.
3. Disposal: Transport waste materials and dispose of at designated spoil areas on Owner's property.
   OR
   Disposal: Transport waste materials off Owner's property and legally dispose of them.

END OF SECTION 01510

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SECTION 01520 - TEMPORARY FACILITIES AND CONTROLS

1.1 GENERAL

A. Summary
1. This Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

B. Definitions
1. Permanent Enclosure: As determined by the Owner, permanent or temporary roofing is complete, insulated, and weathertight; exterior walls are insulated and weathertight; and all openings are closed with permanent construction or substantial temporary closures.

C. Use Charges
1. General: Cost or use charges for temporary facilities shall be included in the Contract Sum. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Owner's construction forces, the Owner, occupants of Project, testing agencies, and authorities having jurisdiction.
2. Water Service: Water from Owner's existing water system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.
3. Electric Power Service: Electric power from Owner's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

D. Submittals
1. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.

E. Quality Assurance
1. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
2. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

F. Project Conditions
1. Temporary Use of Permanent Facilities: Installer of each permanent service shall assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

1.2 PRODUCTS

A. Materials
1. Pavement: Comply with Division 02 Section(s) "Asphalt Paving" OR "Cement Concrete Pavement", **as directed**.
2. Chain-Link Fencing: Minimum 2-inch (50-mm), 0.148-inch- (3.76-mm-) thick, galvanized steel, chain-link fabric fencing; minimum 6 feet (1.8 m) high with galvanized steel pipe posts; minimum 2-3/8-inch- (60-mm-) OD line posts and 2-7/8-inch- (73-mm-) OD corner and pull posts, with 1-5/8-inch- (42-mm-) OD top rails **OR** with galvanized barbed-wire top strand, **as directed**.
3. Portable Chain-Link Fencing: Minimum 2-inch (50-mm), 9-gage, galvanized steel, chain-link fabric fencing; minimum 6 feet (1.8 m) high with galvanized steel pipe posts; minimum 2-3/8-inch- (60-mm-) OD line posts and 2-7/8-inch- (73-mm-) OD corner and pull posts, with 1-5/8-inch- (42-

mm-) OD top and bottom rails. Provide concrete **OR** galvanized steel, **as directed**, bases for supporting posts.

4. Wood Enclosure Fence: Plywood, 6 feet (1.8 m) **OR** 8 feet (2.4 m), **as directed**, high, framed with four 2-by-4-inch (50-by-100-mm) rails, with preservative-treated wood posts spaced not more than 8 feet (2.4 m) apart.
5. Lumber and Plywood: Comply with requirements in Division 06 Section(s) "Rough Carpentry" OR "Miscellaneous Carpentry", **as directed**.
6. Gypsum Board: Minimum 1/2 inch (12.7 mm) thick by 48 inches (1219 mm) wide by maximum available lengths; regular-type panels with tapered edges. Comply with ASTM C 36/C 36M.
7. Insulation: Unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.
8. Paint: Comply with requirements in Division 09.

B. Temporary Facilities
1. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.
2. Common-Use Field Office: Of sufficient size to accommodate needs of construction personnel. Keep office clean and orderly. Furnish and equip offices as follows:
   a. Furniture required for Project-site documents including file cabinets, plan tables, plan racks, and bookcases.
   b. Conference room of sufficient size to accommodate meetings of 10 individuals. Provide electrical power service and 120-V ac duplex receptacles, with not less than 1 receptacle on each wall. Furnish room with conference table, chairs, and 4-foot- (1.2-m-) square tack board.
   c. Drinking water and private toilet.
   d. Coffee machine and supplies.
   e. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F (20 to 22 deg C).
   f. Lighting fixtures capable of maintaining average illumination of 20 fc (215 lx) at desk height.
3. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.
   a. Store combustible materials apart from building.

C. Equipment
1. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
2. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
   a. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
   b. Heating Units: Listed and labeled for type of fuel being consumed, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   c. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return air grille in system and remove at end of construction.

1.3 EXECUTION

A. Installation, General
1. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
   a. For greenfield sites if reduced site disturbance is required for LEED-NC Credit SS 5.1: Locate facilities to limit site disturbance as specified in General Requirements.

2. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

B. Temporary Utility Installation
   1. General: Install temporary service or connect to existing service.
      a. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
   2. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.
      a. Connect temporary sewers to municipal system **OR** private system indicated, **as directed**, as directed by authorities having jurisdiction.
   3. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.

      OR

      Water Service: Use of Owner's existing water service facilities will be permitted, as long as facilities are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.
      a. Where installations below an outlet might be damaged by spillage or leakage, provide a drip pan of suitable size to minimize water damage. Drain accumulated water promptly from pans.
   4. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
      a. Toilets: Use of Owner's existing toilet facilities will be permitted, as long as facilities are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.
   5. Heating **OR** Heating and Cooling, **as directed**: Provide temporary heating **OR** heating and cooling, **as directed**, required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.
   6. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.
   7. Electric Power Service: Use of Owner's existing electric power service will be permitted, as long as equipment is maintained in a condition acceptable to Owner.

      OR

      Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.
      a. Install electric power service overhead **OR** underground, **as directed**, unless otherwise indicated.
      b. Connect temporary service to Owner's existing power source, as directed by Owner.
   8. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
      a. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
      b. Install lighting for Project identification sign.
   9. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel. Install one telephone line for each field office.
      a. Provide additional telephone lines for the following:
         1) Provide a dedicated telephone line for each facsimile machine and computer in each field office.
      b. At each telephone, post a list of important telephone numbers.
         1) Police and fire departments.
         2) Ambulance service.

3) Contractor's home office.
4) the Owner's office.
5) Owner's office.
6) Principal subcontractors' field and home offices.

c. Provide superintendent with cellular telephone or portable two-way radio for use when away from field office.

10. Electronic Communication Service: Provide temporary electronic communication service, including electronic mail, in common-use facilities.
    a. Provide DSL **OR** T-1 line, **as directed**, in primary field office.

C. Support Facilities Installation
1. General: Comply with the following:
    a. Provide incombustible construction for offices, shops, and sheds located within construction area or within 30 feet (9 m) of building lines. Comply with NFPA 241.
    b. Maintain support facilities until near Substantial Completion. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.
2. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas as indicated **OR** within construction limits indicated, **as directed**, on Drawings.
    a. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.

OR

3. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas in same location as permanent roads and paved areas. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.
    a. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
    b. Prepare subgrade and install subbase and base for temporary roads and paved areas according to Division 02 Section "Earthwork".
    c. Recondition base after temporary use, including removing contaminated material, regrading, proofrolling, compacting, and testing.
    d. Delay installation of final course of permanent hot-mix asphalt pavement until immediately before Substantial Completion. Repair hot-mix asphalt base-course pavement before installation of final course according to Division 02 Section "Asphalt Paving".
4. Traffic Controls: Comply with requirements of authorities having jurisdiction.
    a. Protect existing site improvements to remain including curbs, pavement, and utilities.
    b. Maintain access for fire-fighting equipment and access to fire hydrants.
5. Parking: Provide temporary **OR** Use designated areas of Owner's existing, **as directed**, parking areas for construction personnel.
6. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.
    a. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties nor endanger permanent Work or temporary facilities.
    b. Remove snow and ice as required to minimize accumulations.
7. Project Identification and Temporary Signs: Provide Project identification and other signs as indicated on Drawings, **OR as directed**. Install signs where indicated to inform public and individuals seeking entrance to Project. Unauthorized signs are not permitted.
    a. Provide temporary, directional signs for construction personnel and visitors.
    b. Maintain and touchup signs so they are legible at all times.
8. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with General Requirements for progress cleaning requirements.
9. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.

a. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

10. Temporary Elevator Use: Refer to Division 14 for temporary use of new elevators.
11. Existing Elevator Use: Use of Owner's existing elevators will be permitted, as long as elevators are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore elevators to condition existing before initial use, including replacing worn cables, guide shoes, and similar items of limited life.
    a. Do not load elevators beyond their rated weight capacity.
    b. Provide protective coverings, barriers, devices, signs, or other procedures to protect elevator car and entrance doors and frame. If, despite such protection, elevators become damaged, engage elevator Installer to restore damaged work so no evidence remains of correction work. Return items that cannot be refinished in field to the shop, make required repairs and refinish entire unit, or provide new units as required.
12. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.
13. Existing Stair Usage: Use of Owner's existing stairs will be permitted, as long as stairs are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore stairs to condition existing before initial use.
    a. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If, despite such protection, stairs become damaged, restore damaged areas so no evidence remains of correction work.
14. Temporary Use of Permanent Stairs: Cover finished, permanent stairs with protective covering of plywood or similar material so finishes will be undamaged at time of acceptance.

D. Security And Protection Facilities Installation
1. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
2. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.
    a. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
3. Stormwater Control: Comply with authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.
4. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.
5. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Obtain extended warranty for Owner. Perform control operations lawfully, using environmentally safe materials.
6. Site Enclosure Fence: Before construction operations begin **OR** When excavation begins, **as directed**, furnish and install site enclosure fence in a manner that will prevent people and animals from easily entering site except by entrance gates.
    a. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations **OR** As indicated on Drawings, **as directed**.
    b. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Provide Owner with one set of keys, **as directed**.
7. Security Enclosure and Lockup: Install substantial temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security.

8. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
9. Covered Walkway: Erect structurally adequate, protective, covered walkway for passage of individuals along adjacent public street(s). Coordinate with entrance gates, other facilities, and obstructions. Comply with regulations of authorities having jurisdiction and requirements indicated on Drawings, **OR as directed**.
    a. Construct covered walkways using scaffold or shoring framing.
    b. Provide wood-plank overhead decking, protective plywood enclosure walls, handrails, barricades, warning signs, lights, safe and well-drained walkways, and similar provisions for protection and safe passage.
    c. Extend back wall beyond the structure to complete enclosure fence.
    d. Paint and maintain in a manner approved by Owner and the Owner.
10. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
    a. Where heating or cooling is needed and permanent enclosure is not complete, insulate temporary enclosures.
11. Temporary Partitions: Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by Owner and tenants from fumes and noise.
    a. Construct dustproof partitions with gypsum wallboard with joints taped on occupied side, and fire-retardant plywood on construction operations side.
    b. If containment of airborne particles and dust generated by construction activities is critical to occupants of other spaces in building, e.g., occupied healthcare facilities: Construct dustproof partitions with 2 layers of 3-mil (0.07-mm) polyethylene sheet on each side. Cover floor with 2 layers of 3-mil (0.07-mm) polyethylene sheet, extending sheets 18 inches (460 mm) up the sidewalls. Overlap and tape full length of joints. Cover floor with fire-retardant plywood.
        1) Construct vestibule and airlock at each entrance through temporary partition with not less than 48 inches (1219 mm) between doors. Maintain water-dampened foot mats in vestibule.
    c. Insulate partitions to provide noise protection to occupied areas.
    d. Seal joints and perimeter. Equip partitions with dustproof doors and security locks.
    e. Protect air-handling equipment.
    f. Weather strip openings.
    g. Provide walk-off mats at each entrance through temporary partition.
12. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241.
    a. Prohibit smoking in hazardous fire-exposure **OR** construction, **as directed**, areas.
    b. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
    c. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
    d. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

E. Operation, Termination, And Removal
1. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
2. Maintenance: Maintain facilities in good operating condition until removal.
    a. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.

3. Operate Project-identification-sign lighting daily from dusk until 12:00 midnight.
4. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
5. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
    a. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
    b. Remove temporary paving not intended for or acceptable for integration into permanent paving. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
    c. At Substantial Completion, clean and renovate permanent facilities used during construction period. Comply with final cleaning requirements specified in General Requirements

END OF SECTION 01520

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Task	Specification	Specification Description
01520	01352	No Specification Required
01540	01352	No Specification Required
01550	01352	No Specification Required
01560	01352	No Specification Required
01580	01352	No Specification Required
01590	01352	No Specification Required
01660	01352	No Specification Required

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SECTION 01720 - CUTTING AND PATCHING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for cutting and patching. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes procedural requirements for cutting and patching.

C. Definitions
1. Cutting: Removal of in-place construction necessary to permit installation or performance of other Work.
2. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

D. Submittals
1. Cutting and Patching Proposal: Submit a proposal describing procedures at least 10 days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:
   a. Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.
   b. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.
   c. Products: List products to be used and firms or entities that will perform the Work.
   d. Dates: Indicate when cutting and patching will be performed.
   e. Utility Services and Mechanical/Electrical Systems: List services/systems that cutting and patching procedures will disturb or affect. List services/systems that will be relocated and those that will be temporarily out of service. Indicate how long services/systems will be disrupted.
   f. Structural Elements: Where cutting and patching involve adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with original structure.
   g. the Owner's Approval: Obtain approval of cutting and patching proposal before cutting and patching. Approval does not waive right to later require removal and replacement of unsatisfactory work.

E. Quality Assurance
1. LEED Requirements for Building Reuse:
   a. Credit MR 1.1 and 1.2, **as directed**: Maintain existing building structure (including structural floor and roof decking) and envelope (exterior skin and framing, excluding window assemblies and nonstructural roofing material) not indicated to be removed; do not cut such existing construction beyond indicated limits.
   b. Credit MR 1.3: Maintain existing interior nonstructural elements (interior walls, doors, floor coverings, and ceiling systems) not indicated to be removed; do not cut such existing construction beyond indicated limits.
   c. Credit MR 1.2 and 1.3, **as directed**: Maintain existing nonshell, nonstructural components (walls, flooring, and ceilings) not indicated to be removed; do not cut such existing construction beyond indicated limits.

2. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.
   a. **Refer to the Owner for list of elements that might otherwise be overlooked as structural elements and that require Architect's or Construction Manager's approval of a cutting and patching proposal**.
3. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. Operating elements include the following:
   a. Primary operational systems and equipment.
   b. Air or smoke barriers.
   c. Fire-suppression systems.
   d. Mechanical systems piping and ducts.
   e. Control systems.
   f. Communication systems.
   g. Conveying systems.
   h. Electrical wiring systems.
   i. Operating systems of special construction in Division 13.
4. Miscellaneous Elements: Do not cut and patch miscellaneous elements or related components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Miscellaneous elements include the following:
   a. Water, moisture, or vapor barriers.
   b. Membranes and flashings.
   c. Exterior curtain-wall construction.
   d. Equipment supports.
   e. Piping, ductwork, vessels, and equipment.
   f. Noise- and vibration-control elements and systems.
5. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
6. Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

F. Warranty
1. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, by methods and with materials so as not to void existing warranties.

1.2 PRODUCTS

A. Materials
1. General: Comply with requirements specified in other Sections.
2. In-Place Materials: Use materials identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
   a. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of in-place materials.

1.3 EXECUTION

A. Preparation
1. Temporary Support: Provide temporary support of Work to be cut.
2. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
3. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
4. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to minimize **OR** prevent, **as directed**, interruption to occupied areas.

B. Performance
1. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
   a. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
2. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
   a. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
   b. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
   c. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
   d. Excavating and Backfilling: Comply with requirements in applicable Division 02 where required by cutting and patching operations.
   e. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
   f. Proceed with patching after construction operations requiring cutting are complete.
3. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections.
   a. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
   b. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
      1) Clean piping, conduit, and similar features before applying paint or other finishing materials.
      2) Restore damaged pipe covering to its original condition.
   c. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
      1) Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.

d. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
e. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.

4. Cleaning: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.

END OF SECTION 01720

SECTION 02011 - SUBSURFACE DRILLING, SAMPLING, AND TESTING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing of labor and equipment for drilling, sampling and testing for subsurface investigation of soils.

B. System Description: The purpose of the work specified herein is to determine the type, nature, and characteristics of subsurface materials and the extent and conditions of the various materials as they exist to the depths and at the locations specified. This is to be accomplished by means of auger borings, drive sample borings, undisturbed sample borings, core drilling, pressure testing, or test pits.
1. Auger Borings and Sampling: An auger boring is any boring made in unconsolidated soils with a conventional manually or power-driven earth auger for the purpose of obtaining samples of subsurface materials. Auger boring and sampling shall be performed in accordance with ASTM D 1452.
2. Drive Sample Borings and Sampling: A drive sample boring is a boring made through unconsolidated or partly consolidated sediments or decomposed rock by means of a mechanically driven sampler. The purpose of these borings is to obtain knowledge of the composition, the thickness, the depth, the sequence, the structure, and the pertinent physical properties of foundation or borrow materials. Drive sample boring and sampling shall be performed in accordance with ASTM D 1587. Standard Penetration Tests (SPT) shall be performed in accordance with ASTM D 1586.
3. Undisturbed Sample Borings and Sampling: An undisturbed sample boring is a boring made to obtain soil samples which, when tested, will show properties as close to the in situ (in place) properties as any sample which can be obtained. All undisturbed sampling shall be accomplished in accordance with ASTM D 1587.
4. Core Drilling: Drilling of cores shall be performed as per ASTM D 2113. The method used shall provide equally good recovery of cores from both hard and soft rocks.
5. Pressure Testing (Hydraulic): Hydraulic pressure testing is the process of forcing water under pressure into subsurface rock formations through pre-drilled holes for the purpose of determining the subsurface leakage conditions and possible grouting requirements.
6. Test Pit Excavation and Sampling: A test pit is any excavation in soil, hardpan, decomposed rock, or other unconsolidated or partially consolidated overburden materials which has an open cross-sectional area large enough to permit efficient excavation and shoring/lining, engineering and geological inspection and photographing of the subsurface soils and manual undisturbed sampling from within the test pit. All test pits shall be excavated, dewatered (if necessary), shored/lined and protected from surface water drainage in accordance with all applicable Federal, State, local, and OSHA safety regulations.
7. Bearing Capacity: ASTM D 1149.
8. Soils Classification: ASTM D 2487, ASTM D 2488, MIL-STD 619.

C. Submittals
1. Permits, Certifications, and Licenses: Comply with all Federal, State and local laws, regulations and ordinances relating to the performance of this work. The Contractor shall, at his own expense, procure all required permits, certifications and licenses required of him by Federal, State, and local law for the execution of this work. Furnish copies of all such documents to the Owner prior to starting work.
2. Drilling, Sampling, and Testing Plan: Prior to starting work, submit a plan for drilling, sampling, testing, and safety. The plan shall include, but not be limited to, the proposed method of drilling and sampling including a description of the equipment and sampling tools that will be used, a listing of any subcontractors to include a description of how the subcontractors will be used and a description of all methods and procedures that will be utilized to ensure a safe operation and to protect the environment. This submittal shall also include a statement of the prior experience, in

the type of work described in these specifications, of the person or persons designated to perform the work specified herein. No work shall be performed until this plan has been approved and no deviation from the approved plan will be permitted without prior approval by the Owner.

3. Drilling Log: Submit complete, legible copies of drilling log and records to the Owner within 5 days after a hole or test pit is completed.

D. Care And Delivery Of Samples

1. General: The Contractor shall be solely responsible for preserving all samples in good condition. Keep samples from freezing and from undue exposure to the weather, and shall keep all descriptive labels and designations on sample jars, tubes, and boxes clean and legible until final delivery of samples to, and acceptance by, the Owner. Except as otherwise specified, deliver samples to the Owner. Deliver samples within the time limits specified for each type of investigation or in accordance with schedules prepared by the Owner.
2. Undisturbed Samples: Take every precaution to avoid damage to samples as a result of careless handling and undue delay in shipping. Ship samples in containers approved by the Owner, of sufficient durability to protect the samples from any damage during shipment. Pack sample tubes in vermiculite or other equal material approved by the Owner to protect the samples against vibration. Avoid exposing sealed and crated samples to precipitation, direct sunlight, freezing and temperatures in excess of 100 degrees F (38 degrees C). Samples permitted to freeze, even partially, shall be replaced by the Contractor at his expense. In general, no undisturbed samples shall remain on the site of sampling for more than one week before shipment. Store and ship samples with the tube in a horizontal **OR** vertical, **as directed**, position in order to prevent consolidation and segregation or change of water content.

E. Project/Site Conditions

1. Environmental Requirements
   a. In order to prevent and to provide for abatement and control of any environmental pollution arising from Contractor activities in the performance of this contract, the Contractor and his subcontractors shall comply with all applicable Federal, State, and local laws, regulations, and ordinances concerning environmental pollution control and abatement.
      1) The Contractor shall be responsible for keeping informed of all updates and changes in all applicable laws, regulations, and ordinances.
      2) The Contractor shall not pollute lakes, ditches, rivers, springs, canals, waterways, groundwaters, or reservoirs with drill fluids, fuels, oils, bitumens, calcium chloride, insecticides, herbicides, or other materials that may be harmful to the environment or a detriment to outdoor recreation.
2. Field Measurements: The approximate locations of drill holes or test pits shall be as directed. The actual locations will be established in the field by the Owner prior to the start of work. The elevations of the established locations will also be provided by the Owner prior to the start of work. The Contractor will provide access to the locations as he deems necessary for the prosecution of the work. Since no separate payment will be made for access construction, all costs associated with this shall be included in the cost of drilling or excavating.

F. Sequencing And Scheduling

1. Schedule of Drilling, Sampling and Testing: The schedule of Drilling, Sampling, and Testing is listed in the following schedule:

SCHEDULE OF DRILLING, SAMPLING AND TESTING

HOLE NO. or PIT NO.	METHOD	DEPTH FT(M)	VERTICAL or INCLINED	SPECIAL INSTRUCTIONS

2. Order of Work: The order in which the work is to be accomplished will be determined in the field by the Owner.

1.2 PRODUCTS

A. Containers: Furnish jars, tubes, and boxes that meet the following requirements. All such containers will become the property of the Owner and the cost thereof shall be included in the contract price for the applicable item for which payment is provided.

1. Sample Jars: Sample jars shall be 1 pint (0.5 L) **OR** 1 quart (1.0 L), **as directed**, capacity, wide-mouth over 2-1/4 inches (57 mm) in diameter, glass **OR** plastic, **as directed**, jars with moisture-tight screw tops.
2. Shipping Boxes: Boxes for shipping sample jars shall be corrugated cardboard **OR** wooden, **as directed**, boxes that have the capacity to hold no more than 12 sample jars and the strength to contain and protect the jars and their contents under ordinary handling and environmental conditions.
3. Tubes and Crates: Undisturbed samples shall be shipped in thin walled Shelby tubes packed in crates.
4. Core Boxes: Longitudinally partitioned, hinged top, wooden core boxes constructed of plywood and dressed lumber or other approved materials shall be used for all rock cores. As many core boxes as may be required shall be used to box all core. Core boxes shall be completely equipped with all necessary partitions, hinges, and a hasp for holding down the cover. In addition, the Contractor shall provide wood spacers made of surfaced lumber (not plywood) and having dimensions that are 1/8 inch (3 mm) less than the inside dimensions of the individual core box troughs and no less than 3/4 inch (19 mm) thick for blocking the core in the boxes and for providing a marking space to identify core runs and pull depths/elevations. The quantities of these blocks that are required are: ten blocks per core box for 3-inch (75-mm) or smaller core, five blocks per core box for 4-inch (100-mm) and PQ core, and three blocks per core box for 6-inch (150-mm) core. The box should have the following capacities:

6-inch (150-mm) core	single row of core
4-inch (100-mm) or PQ core	2 rows of core
3-inch (75-mm) or smaller core	3 or 4 rows of core

The maximum length of a core box shall be 4 feet (1.2 m) for 3-inch (75 mm) or smaller core and shall be dimensioned so that a box will hold 12 to 16 feet (3.6 to 4.9 m) of core. The maximum length of a core box for core that is larger than 3 inches (75 mm) shall be 5 feet (1.5 m).

B. Labels

1. Sample Jar Labels: A printed or type-written, fade resistant and waterproof label shall be affixed to the outside of each jar and shall contain the following information:
   PROJECT_____LOCATION_____
   (Such as Table Rock Dam) (Such as Borrow Area B)
   HOLE NO. _____ STATION_____
   JAR NO. _____ of _____ JARS
   TOP ELEV. OF HOLE_____ DEPTH OF SAMPLE _____
   DESCRIPTION OF MATERIAL_____
   (Such as moist, silty, medium sand)
2. Shipping Box Labels: Each box of jar samples shall be identified with weatherproof and wear-proof labels indicating the following:
   PROJECT: [_____]
   LOCATION: [_____]
   JAR SAMPLES FROM HOLE OR HOLES: [_____]
3. Core Box Labels: Core boxes shall be identified with stenciled labels. The information on this label shall contain the following:
   PROJECT: [_____]
   HOLE NO. [_____]
   BOX NO. [_____]
   TOTAL NUMBER OF BOXES FOR THE HOLE: [_____]

1.3 EXECUTION

A. Mobilization and Demobilization
   1. Mobilization: Mobilization shall consist of the delivery to the site of all plant, equipment, materials and supplies to be furnished by the Contractor, the complete assembly in satisfactory working order of all such plant and equipment at the jobsite and the satisfactory storage at the site of all such materials and supplies.
   2. Demobilization: Demobilization shall consist of the removal from the site of all plant, equipment, materials and supplies after completion of the work and also includes, at the direction of the Owner, the cleanup and removal of all scrap, waste backfill material, waste drilling fluid, soil contaminated with engine/hydraulic oil, backfilling all sumps or excavations resulting from the operations and, in general, returning the site as close to its original condition as possible.

B. Equipment and Supplies
   1. Auger Boring and Sampling: The equipment to be furnished by the Contractor for making auger borings shall include, but not be limited to, standard continuous flight augers and/or standard cup-type earth augers, similar or equal to the Iwan Auger and not less than 4 inches (100 mm) in diameter unless otherwise approved. The augers shall be completely equipped with all the accessories necessary for boring and sampling of overburden materials to the depths and diameters specified or shown on the drawings.
   2. Drive Sample Boring and Sampling: Equipment to be furnished by the Contractor for making drive sample borings shall include, but not be limited to, standard 2-inch (50 mm) split barrel **OR** solid barrel, **as directed**, drive samplers and power-driven drilling machinery of a type or types approved by the Owner, complete with a drive-hammer of the weight as required to meet project requirements, and all other accessories for taking samples of all types of soils or decomposed rock at the locations and to the depths indicated in the schedule in paragraph SCHEDULE OF DRILLING, SAMPLING, AND TESTING. The drive shoe for the split barrel samplers shall be of hardened steel and shall be replaced or repaired when it becomes dented or distorted. Supplies shall include, but not be limited to, all casing, drill stem, drill bits, drill fluid and additives, pumps, and power necessary to accomplish the required boring and sampling.
   3. Undisturbed Sample Boring and Sampling: Equipment to be furnished by the Contractor for making undisturbed sample borings shall include, but not be limited to, power-driven drilling machinery of an approved type or types complete with the special devices and accessories enumerated and described hereinafter. Drilling machinery shall be of the hydraulic feed type. Supplies shall include, but not be limited to, all samplers, casing, drill stem, drill bits, drill fluid and additives, pumps, and power necessary to accomplish the required boring and sampling. Drill casing, if used, shall be of such minimum inside diameter as to allow use of the selected sampler.
      a. Sands and Cohesive Soils: The sampling device used to sample fine to medium grain sands and cohesive soils shall be a fixed or stationary piston type that uses a 3-inch (75-mm) **OR** 5-inch (125-mm), **as directed**, diameter thin wall Shelby tube. Subject to the approval of the Owner, floating or free piston and non-piston type samplers may be used provided adequate means, such as check valve or vacuum system, are provided to prevent loss of samples.
      b. Stiff and Dense Soils: The sampling device for obtaining samples of stiff and dense soils shall be similar or equal to a Denison double tube, swivel head core barrel, or a Pitcher sampler and must be approved by the Owner prior to use.
   4. Core Drilling - Size BX and NX Core: Equipment to be furnished by the Contractor for core drilling shall include core-drilling machinery of a type or types approved by the Owner complete with all the accessories needed to take continuous rock cores of a diameter consistent with bit size to the depths specified. The Contractor shall use, as a minimum, a standard ball-bearing, swivel-head, double-tube core barrel, or equivalent. The capacity of the core barrel shall not exceed 10.5 feet (3.2 m) of core. Supplies for core drilling to be furnished by the Contractor shall include, but not be limited to, all casing, drill rods, core barrels, coring bits, piping, pumps, water, tools, and power required for drilling and all boxes and containers required for core samples. Selection of the type of bit shall be at the Contractor's discretion provided that the selected bit produces high quality rock core. (see paragraph SUPPLEMENTAL BORINGS or PITS). The

Contractor's drilling equipment shall be capable of drilling inclined as well as vertical core holes as specified.

5. Pressure Testing (Hydraulic): Pressure testing equipment to be furnished by the Contractor shall include, but not be limited to, a water pump with a minimum capacity of 50 gallons per minute (3.15 liters per second) that is capable of delivering a constant discharge pressure with double expander packers with rubber expansion elements set 5 feet (1.5 m) **OR** 10 feet (3 m), **as directed**, apart with piping so arranged that water may be admitted either below the bottom packer element or between the two packer elements, a pressure relief valve, a pressure gage capable of measuring water pressures to the nearest 10 psi (1.45 kPa) and water meter capable of measuring flows to the nearest 1.6 gallon(s) per minute (0.1 liter(s) per second). Supplies shall include, but not be limited to, all accessory valves, gages, surge tanks, stopcocks, plugs, expanders, potable water for testing, standby pumps, fuels, pipes, pressure hose, and tools necessary for maintaining uninterrupted tests for each boring to be tested. The pressure test equipment shall be configured so that the pressure gage is located at the top of the hole, a by-pass water line and valve are located between the pump and the gage, a flow meter is located between the by-pass and the pressure gage, and a valve is located in the line between the flow meter and the pressure gage. All equipment and supplies used for pressure testing shall be approved by the Owner prior to use.
6. Test Pit Excavation and Sampling: Selection of the test pit excavation, shoring/lining and dewatering (if necessary) methods and equipment shall be at the Contractor's discretion but must be approved by the Owner. When the number of test pits to be excavated is large, and when adaptable mechanical trenching equipment is available, the Owner may require that such mechanical excavating equipment be used to expedite completion of the pits. Supplies which the Contractor shall furnish for obtaining undisturbed samples shall include, but not be limited to, split metal cylinders and/or metal or wooden boxes of acceptable sizes and types. Accessories to be supplied by the Contractor shall include, but not be limited to, a small sample trimming shovel or spade, hatchet, trimming knife, wax and facilities for melting and brushing same, trowels, labels, and boxes for shipping samples. The Contractor shall also furnish all materials required for shoring/lining to comply with all applicable safety regulations. The Owner may require the Contractor to salvage and re-use this shoring/lining material in successive test pits.

C. Identifying Samples: Sample jars, shipping boxes, and labels shall comply with paragraphs SAMPLE JARS, SHIPPING BOXES, and LABELS, respectively. The Contractor shall take all precautions required to insure that the shipping boxes are not subjected to rough handling or damaging environmental conditions, and complies with paragraph CARE AND DELIVERY OF SAMPLES. A copy of the boring log for the portion of the boring that the samples came from shall be enclosed in the shipping box.

D. Auger Boring and Sampling: Samples shall be labeled in accordance with paragraph IDENTIFYING SAMPLES. Samples shall be obtained for each change of overburden material and at maximum vertical intervals as directed by the Owner. In order to retain the natural moisture content of the material to the fullest extent possible, all samples shall be of sufficient volume to completely fill the sample jars and the samples shall be placed in the sample jars as soon as possible after they are taken from the hole. All sample jars shall be labeled. In general, no sample shall remain on the site of boring for more than 1 week after being taken from the boring and placed in a jar.

E. Drive Sample Boring and Sampling: Samples shall be labeled in accordance with paragraph IDENTIFYING SAMPLES. Drive sample borings drilled through overburden materials shall be suitably cased to permit obtaining drive samples of the size or sizes specified or as directed. Samples shall be taken either continuously or at a change in materials in accordance with instructions contained in the SCHEDULE OF DRILLING, SAMPLING, AND TESTING or as otherwise directed by the Owner. To minimize the compacting effect of casing driving when casing is used to stabilize a boring, the bottom of the casing shall be kept as high above the soil sampling zone as conditions permit. If hollow stem auger is used as a casing and/or to advance the boring, a plug assembly must be used to keep soil from entering the inside of the auger. Above the water table, samples shall be obtained from a dry hole. Below the water table, water shall be maintained within the hole at or above the groundwater level.

Where information on the natural water content of soils above the water table is not needed and when approved by the Owner, boreholes may be drilled without casing by using a suitable drilling fluid to prevent collapse of sidewalls. When a drilling fluid is used, soil sampling shall be done by such means that will prevent inclusion of drilling fluid in the samples. The samples shall be placed in sample jars as soon as possible after they are taken from the hole and, when possible, the volume of the sample shall be large enough to completely fill the sample jar in order that the natural moisture content of the material may be retained to the fullest extent possible. All samples shall be labeled. No sample shall remain at the site of boring for more than one week after being taken from the hole.

F. Undisturbed Sample Boring And Sampling: In general, labeling of undisturbed samples shall conform to paragraph IDENTIFYING SAMPLES. Particular care shall be taken to indicate the top and bottom of each sample tube. Tubes and crates for undisturbed samples shall be labeled "DO NOT JAR OR VIBRATE" and "HANDLE, HAUL, AND SHIP IN A HORIZONTAL **OR** VERTICAL POSITION," **as directed**.

1. Procedure: The procedure for Undisturbed Sample Boring and Sampling shall be the same as outlined in paragraph DRIVE SAMPLE BORING AND SAMPLING, except that the sampling device shall be advanced downward by one continuous, smooth drive using the drill rig's hydraulic feed system. The hydraulic down pressure shall be read and recorded at 6 inch (150 mm) intervals during each sample drive. The sampling device for stiff and dense soils shall be advanced by continuous rotation of the outer cutting barrel in conjunction with use of drill fluid circulation. Driving of any undisturbed sampling device by means such as a drop hammer will not be permitted.
2. Sealing
   a. Alternate 1: The soil sample obtained in a thin wall Shelby tube shall be retained in the tube and sealed on both ends with a mechanically expandable O-ring sealing disk of the appropriate size.
   b. Alternate 2: The soil sample obtained in a thin wall Shelby tube shall be extruded from the tube in the field as soon as the tube is removed from the boring by a method approved by the Owner. The extruded soil sample shall immediately be wrapped in aluminum foil or thin plastic wrap and placed in the center of a metal bottomed, waxed cardboard or plastic tube that has a diameter of at least 1 inch (25 mm) larger than the diameter of the soil sample, is at least 1-inch (25 mm) longer than the length of the soil sample, and has at least 1/2-inch (13 mm) of congealed 50/50 mixture of paraffin and microcrystalline wax in the bottom. The annular space between the soil sample and the tube shall be filled with a 50/50 mixture of paraffin and microcrystalline wax to a distance of at least 1/2-inch (13 mm) above the top of the soil sample.
   c. Alternate 3: Both ends of the soil sample tube/liner obtained with a Denison barrel, or its equivalent, shall be cleaned out to remove all drill fluid contaminated and/or disturbed soil or to a minimum distance of 2 inches (50 mm) from the ends of the tube/liner. Any material removed that is not contaminated with drill fluid shall be placed in a sample jar and labeled in accordance with paragraph IDENTIFYING SAMPLES. The cleaned out ends of the sample liner tube shall then be sealed with a 50/50 mixture of paraffin and microcrystalline wax. A metal or wooden disk, having a diameter just slightly smaller than the inside diameter of the liner tube shall be inserted into the wax to a distance of 1/4-inch (6 mm) from the end of the soil sample. The wax plugs shall be flush with the ends of the tube and a final seal consisting of a metal cap or tape shall be placed over the ends of the tube.

G. Core Hole Overburden Drilling: Where samples of overburden materials are required in connection with core drilling, the soil overburden shall be drilled and sampled in accordance with the applicable provisions for the type of samples required. Where sampling of the overburden materials is not required, the Contractor may utilize any method and equipment for drilling and, if required, casing through the overburden that will not affect the quality of the core drilling from the rock surface downward in accordance with these specifications. The method chosen must be approved by the Owner prior to starting any overburden drilling.

H. Core Drilling - Size BX and NX core.

1. Procedure: All holes shall be drilled vertically **OR** at the inclined angles listed in paragraph SCHEDULE OF DRILLING, SAMPLING, AND TESTING, **as directed**, to the bottom elevations or depths specified unless indicated in the schedule of borings or directed to be drilled otherwise. Off-setting of borings from the locations specified in the Plan of Borings or as shown on the drawings, will not be permitted without prior approval. Casing through the overburden may be required. This casing shall be sealed in the rock at the elevation where rock is encountered prior to commencement of rock coring. The Contractor shall operate his drills at such speeds and with such down pressures and shall control drill fluid pressures and quantities to insure maximum core quality and recovery in whatever kind of rock is encountered. Where soft or broken rock is encountered, the Contractor shall reduce the length of runs to 5 feet (1.5 m) or less in order to reduce and/or keep core loss and core disturbance to the minimum. Failure to comply with the foregoing procedures shall constitute justification for the Owner to require redrilling, at the Contractor's expense, of any boring from which the core recovery is unsatisfactory. The Contractor shall exercise particular care in recording zones of water loss, cavities, rod jerks, rough drilling and other unusual and non-ordinary coring experiences that, supplementing the core record, will throw light on the nature and the extent of any fracturing or abnormalities.
2. Arrangement of Core: Core boxes shall comply with paragraph CORE BOXES. All cores shall be arranged neatly in the partitioned boxes in the same sequence in which they occurred before removal from the hole. Facing the open box with the hinged cover above and the open box below, cores shall be arranged in descending sequence beginning at the left end of the trough nearest the hinges and continuing in the other troughs from left to right. The highest part of the core shall be placed in box 1, and the lower portions of the core shall be placed in the other boxes in consecutive order.
3. Preservation of Core: Representative samples of core shall be wrapped in aluminum foil or thin plastic wrap or cheese cloth and then sealed by applying paraffin wax to the outside of the wrapping material prior to placing the core in the core box. This sealing process shall be accomplished as soon as possible after the core is removed from the core barrel. The minimum length of core that is preserved from each boring shall be no less than 2.5 times the core diameter. Spacer blocks shall be marked and placed in the core box to show where samples have been removed.
4. Labeling, Marking and Packing Core: Stenciled labels for core boxes complying with paragraph CORE BOX LABELS shall be placed on the inside and outside of the top cover in addition to each end. In addition, the depths (or elevations) of each core run/pull shall be marked with a black waterproof pen on the spacer blocks that are placed between core pulls. When a box is full, the space between the core and the trough sides shall be filled with finely ground vermiculite or other packing material approved by the Owner.
5. Disposition of Core: While on site, the Contractor shall protect the filled core boxes from direct sunlight, precipitation, and freezing by some form of the Owner approved shelter that allows ventilation to the boxes. Upon completion of core drilling and sampling operations, core boxes containing cores shall be stored in an area provided by the Owner near the site of drilling **OR** shipped or delivered to address provided by the Owner, **as directed**.

I. Pressure Testing (Hydraulic): The Contractor shall pressure-test each hole commencing at the top of bedrock and progressing downward to the bottom of the hole or to such depths as determined by the Owner below which testing of the hole is not necessary. Where core data from the test holes indicate only isolated zones that are open or fractured, pressure testing may be limited by the Owner to these zones only. Water pressure employed for each lift shall be determined in the field by the Owner and shall not exceed of depth one pound per square inch per foot (22.6 kPa per meter) of depth to the upper expander. The pressure test will be divided into two phases; the first phase will be a flow test which shall then be followed by the second phase which is a duration test. In performing the first phase, water is pumped slowly at first, and the flow then gradually increased to the point where the predetermined maximum pressure is maintained, by adjusting the valve on the by-pass line. The allowable pressure shall be held for 1 minute before any readings are taken. The volume of flow into the test section shall be measured for a period of 5 minutes during which time the pressure shall not vary by more than 5 psi (34.5 kPa). After this 5-minute test, the second phase shall be started by closing the valve located

between the flow meter and the pressure gage. The drop in pressure is then read for a period of 5 minutes at 15 to 30-second intervals. In some situations, such as in a very tight formation, the Owner may eliminate phase one of the test. The Contractor may be required to make check tests at his own expense if the testing equipment or its assembly and arrangement are found to be faulty during or after the testing of any holes. The Contractor shall record all gage and meter readings made during a pressure test on a suitable form approved by the Owner.

J. Test Pit Excavation And Sampling

1. Excavation: The test pits shall be excavated in the order scheduled in paragraph SCHEDULE OF DRILLING, SAMPLING, AND TESTING, and shall be excavated to depths and dimensions indicated in paragraph SCHEDULE OF DRILLING, SAMPLING, AND TESTING. Before excavating pits, the Contractor shall thoroughly familiarize himself with work site and with all available subsurface data, particularly groundwater conditions. Regardless of the method of excavation employed, the pits shall be excavated, dewatered and shored/lined in conformance with all applicable safety regulations.
2. Sampling: Soil samples shall be obtained from each pit at the depths/elevations indicated in paragraph SCHEDULE OF DRILLING, SAMPLING, AND TESTING **OR** at depths determined by the Owner, **as directed**. In obtaining samples from test pits, the undisturbed in situ (in place) natural physical and structural characteristics of the sampled materials shall be preserved insofar as possible both while samples are being taken and during shipment to the point of testing. In cohesive and partially cohesive soils this may be accomplished by isolating the soil column or cube to be sampled by gently trenching around it and knife-trimming it to the required dimensions of the split cylinder or box. A thin coating of melted 50/50 mixture of paraffin and microcrystalline wax shall then be applied quickly but gently to the sample with a paint brush to seal it against loss of moisture. The metal or wooden sample container, with the top and bottom removed shall then be placed over the wax coated sample such that the sample is centered within the container and the top of the container sides are at least 1 inch (25 mm) above the top of the sample. The spaces between the sample and the side walls of the container shall then be filled with melted wax. After this wax has congealed, the space between the top of the sample container sides and the top of the sample shall be filled with wax. After this wax has congealed, it shall be trimmed so that when the top of the sample container is installed there is no void between the container top and the wax. After the container top is installed, the soil column or cube shall then be cut off a few hundred inches (millimeters) below the container, the sample and container inverted and removed from the pit and the sample trimmed at the base so that the bottom of the sample is at least 1 inch (25 mm) below the bottom of the container. This space shall be filled with wax and, after the wax has congealed, it shall be trimmed so that when the bottom of the container is installed, there shall be no void between the wax and the bottom of the container. Where overburden materials to be sampled are only partially cohesive, it is best not to expose the entire soil column before waxing. By exposing and waxing small sections at a time, the sample will be subjected to less disturbance. Where natural moisture content is an important factor, delay shall be avoided in taking the sample in order that the natural moisture content of the material may be retained to the fullest extent.
3. Disposition of Samples: Samples shall be packed in vermiculite or a packing material approved by the Owner and shipped in sturdy wooden boxes of strength and construction sufficient to guarantee against damage during shipment. Boxes should be no larger than is required for shipping two such samples. All sample boxes shall be marked FRAGILE-HANDLE WITH CARE and shall be identified by labels, similar to those as specified in paragraph IDENTIFYING SAMPLES, attached to the outside of each box. Extreme care shall be taken to indicate the top and bottom of each sample. The Contractor shall avoid exposing sealed and crated samples to precipitation and extremes of temperature. Undisturbed samples permitted to freeze, even partially, shall be replaced by the Contractor at his expense. The Contractor shall not hold these samples at the site of sampling for a period in excess of one week. Prior to shipment, each sealed and boxed sample shall be checked for correct labeling.

K. Supplemental Borings or Pits: Borings or Pits that are abandoned or from which unsatisfactory samples or cores are obtained will be supplemented by other borings or pits adjacent to the original in order that satisfactory samples or the required information will be obtained. Actual locations of any supplemental borings or pits will be established by the Owner. Penetration to the depth where the original was abandoned or to the depths where unsatisfactory samples were obtained may be made by any method selected by the Contractor that in the opinion of the Owner will permit satisfactory completion and sampling below the elevation where the last satisfactory sample was obtained in the abandoned or satisfactory sampling in the reaches where satisfactory samples were not obtained in the original borings or pits. No payment will be made for supplemental borings or pits that are required to be drilled or excavated to replace borings or pits that were abandoned or from which satisfactory samples were not obtained because of mechanical failure of drilling and sampling equipment, negligence on the part of the Contractor, or other preventable cause for which the Contractor is responsible except that payment will be made for acceptable portions of these supplementary borings or pits below the depths or outside the reaches for which payment was made for the original borings or pits.

L. Backfilling

1. Drill Holes: Unless otherwise noted in these specifications or directed by the Owner, all drill holes shall be backfilled and abandoned in accordance with all Federal, State, and local laws, regulations and ordinances. The Contractor shall preserve all holes in good condition until final measurement and until the records and samples have been accepted. As a minimum, all holes shall be grouted from the bottom of the hole to within 2 feet (600 mm) of the ground. All grout shall be pumped through a tremie pipe that is inserted to the bottom of the boring to ensure that the grout fills the full extent of the hole. The remaining ungrouted portion of the hole shall be backfilled with local soil and tamped. All backfilling operations shall be performed in the presence of the Owner and, if required by regulation, Federal, State, and local officials. No separate payment will be made for backfilling drill holes. The cost of this work shall be included in the drilling costs.
2. Test Pits: The Contractor shall backfill all test pits with local soil compacted to original densities as directed by the Owner. No separate payment will be made for backfilling test pits. The cost of this work shall be included in the test pit excavation costs.

M. Records: The Contractor shall keep accurate driller's logs and records of all work accomplished under this contract and shall deliver complete, legible copies of these logs and records to the Owner upon completion of the work or at such other time or times as he may be directed. All such records shall be recorded during the actual performance of the work and shall be preserved in good condition and order by the Contractor until they are delivered and accepted. The Owner shall have the right to examine and review all such records at any time prior to their delivery to him and shall have the right to request changes to the record keeping procedure. The following information shall be included on the logs or in the records for each hole or test pit:

1. Hole or Test Pit number or designation and elevation of top of hole or test pit.
2. Driller's name and Geologist's name.
3. Make, size, and manufacturer's model designation of drilling, sampling, pressure testing, and test-pit excavating equipment.
4. Type of drilling, sampling, and pressure testing operation by depth.
5. Hole diameter.
6. Dates and time by depths when test-pit excavation, drilling, sampling, and pressure testing operations were performed.
7. Time required for drilling each run and pressure testing each interval tested.
8. Drill action, rotation speed, hydraulic pressure, water pressure, tool drops, and any other unusual and non-ordinary experience which could indicate the subsurface conditions encountered.
9. Depths at which samples or cores were recovered or attempts made to sample or core including top and bottom depth of each run and of each interval pressure tested.
10. Classification or description by depths of the materials sampled, cored, or penetrated using the Unified Soil Classification System (ASTM D 2487) and including a description of moisture conditions, consistency and other appropriate descriptive information described in paragraph

SUPPLEMENTAL BORINGS or PITS of ASTM D 2488. This classification or description shall be made immediately after the samples or cores are retrieved.

11. Classification and description by depths of rock materials sampled or cored including rock type, composition, texture, presence and orientation of bedding, floiation, or fractures, presence of vugs or other interstices, and the RQD for each cored interval.
12. Indication of penetration resistance such as drive-hammer blows given in blows per foot for driving sample spoons and casing and the pressure in applied to push thin-wall or piston-type samplers.
13. Weight (Force) of drive hammer.
14. Percentage of sample or core recovered per run.
15. Depth at which groundwater is encountered initially and when stabilized.
16. Depths at which drill water is lost and regained and amounts.
17. Depths at which the color of the drill water return changes.
18. Type and weight of drill fluid.
19. Depth of bottom of hole.
20. Pressures employed in pressure testing.

TABLE 1 - COMMON CORE DIAMETERS

	CORE DIAMETER		HOLE DIAMETER	
	in.	(mm)	in.	(mm)
Conventional Core Barrels				
AWG	1.185	(30.1)	1.890	(48.0)
BWG	1.655	(42.0)	2.360	(60.0)
NWG	2.155	(54.7)	2.980	(75.7)
HWG	3.000	(76.2)	3.907	(99.2)
Wireline Core Barrels*				
A	1.064	(27.0)	1.890	(48.0)
B	1.432	(36.5)	2.360	(60.0)
N	1.875	(47.6)	2.980	(75.7)
H	2.450	(62.2)	3.716	(94.4)
	3.345	(85.0)	4.827	(122.6)
Large Diameter Series				
2-3/4" X 3-7/8"	2.690	(68.3	3.875	(98.4)
4" X 5-1/2"	3.970	(100.8)	5.495	(139.6)
6" X 7-3/4"	5.970	(151.6)	7.750	(196.9)

*No Industry Standard for Wireline Sizes. Diameters shown for wireline core barrels are nominal and vary between manufacturers.

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SECTION 02111 - BUILDING DEMOLITION

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for building demolition. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Demolition and removal of buildings and site improvements.
b. Abandoning in place **OR** Removing, **as directed**, below-grade construction.
c. Disconnecting, capping or sealing, and abandoning in-place **OR** removing, **as directed**, site utilities.
d. Salvaging items for reuse by Owner.

C. Definitions
1. Demolish: Completely remove and legally dispose of off-site.
2. Recycle: Recovery of demolition waste for subsequent processing in preparation for reuse.
3. Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse. Include fasteners or brackets needed for reattachment elsewhere.

D. Materials Ownership
1. Unless otherwise indicated, demolition waste becomes property of Contractor.
2. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
a. Carefully salvage in a manner to prevent damage and promptly return to Owner.

E. Submittals
1. Qualification Data: For refrigerant recovery technician.
2. Proposed Protection Measures: Submit informational report, including drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and, for noise control, **as directed**. Indicate proposed locations and construction of barriers.
a. Adjacent Buildings: Detail special measures proposed to protect adjacent buildings to remain.
3. Schedule of Building Demolition Activities: Indicate the following:
a. Detailed sequence of demolition work, with starting and ending dates for each activity.
b. Temporary interruption of utility services.
c. Shutoff and capping or re-routing of utility services.
4. Building Demolition Plans: Drawings indicating the following:
a. Locations of temporary protection and means of egress for adjacent occupied buildings.
5. Inventory: Submit a list of items to be removed and salvaged and deliver to Owner prior to start of demolition.
6. Predemolition Photographs **OR** Video, **as directed**: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by building demolition operations. Submit before the Work begins.
7. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.
8. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that

recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

F. Quality Assurance
1. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.
2. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
3. Standards: Comply with ANSI A10.6 and NFPA 241.
4. Predemolition Conference: Conduct conference at Project site.

OR

Predemolition Conference: Conduct conference at Project site to comply with requirements. Review methods and procedures related to building demolition including, but not limited to, the following:
   a. Inspect and discuss condition of construction to be demolished.
   b. Review structural load limitations of existing structures.
   c. Review and finalize building demolition schedule and verify availability of demolition personnel, equipment, and facilities needed to make progress and avoid delays.
   d. Review and finalize protection requirements.
   e. Review procedures for noise control and dust control.
   f. Review procedures for protection of adjacent buildings.
   g. Review items to be salvaged and returned to Owner.

G. Project Conditions
1. Buildings to be demolished will be vacated and their use discontinued before start of the Work.
2. Buildings immediately adjacent to demolition area will be occupied. Conduct building demolition so operations of occupied buildings will not be disrupted.
   a. Provide not less than 72 hours' notice of activities that will affect operations of adjacent occupied buildings.
   b. Maintain access to existing walkways, exits, and other facilities used by occupants of adjacent buildings.
      1) Do not close or obstruct walkways, exits, or other facilities used by occupants of adjacent buildings without written permission from authorities having jurisdiction.
3. Owner assumes no responsibility for buildings and structures to be demolished.
   a. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
   b. Before building demolition, Owner will remove certain items, as directed by the Owner.
4. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
   a. Hazardous materials will be removed by Owner before start of the Work.
   b. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.

   OR

   Hazardous Materials: Hazardous materials are present in buildings and structures to be demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.
   a. Hazardous material remediation is specified elsewhere in the Contract Documents.
   b. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.
   c. Owner will provide material safety data sheets for materials that are known to be present in buildings and structures to be demolished because of building operations or processes performed there.
5. On-site storage or sale of removed items or materials is not permitted.

H. Coordination

1. Arrange demolition schedule so as not to interfere with Owner's on-site operations **OR** operations of adjacent occupied buildings, **as directed**.

1.2 PRODUCTS

A. Soil Materials
1. Satisfactory Soils: Satisfactory Soils: For soils which is to be used for backfilling voids that result from demolition operations in below-grade areas, comply with requirements in Division 02 Section "Earthwork".

1.3 EXECUTION

A. Examination
1. Verify that utilities have been disconnected and capped before starting demolition operations.
2. Review Project Record Documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
3. Inventory and record the condition of items to be removed and salvaged. Provide photographs **OR** video, **as directed**, of conditions that might be misconstrued as damage caused by salvage operations.
4. Perform **OR** Engage a professional engineer to perform, **as directed**, an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during building demolition operations.
   a. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.
5. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

B. Preparation
1. Refrigerant: Remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction before starting demolition.
2. Existing Utilities: Locate, identify, disconnect, and seal or cap off indicated utilities serving buildings and structures to be demolished.
   a. Owner will arrange to shut off indicated utilities when requested by Contractor.
      OR
      Arrange to shut off indicated utilities with utility companies, **as directed**.
   b. If removal, relocation, or abandonment of utility services will affect adjacent occupied buildings, then provide temporary utilities that bypass buildings and structures to be demolished and that maintain continuity of service to other buildings and structures.
   c. Cut off pipe or conduit a minimum of 24 inches (610 mm) below grade. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing according to requirements of authorities having jurisdiction.

   OR

   Existing Utilities: Refer to Division 15 AND Division 16 for shutting off, disconnecting, removing, and sealing or capping utilities. Do not start demolition work until utility disconnecting and sealing have been completed and verified in writing, **as directed**.
3. Temporary Shoring: Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent unexpected movement or collapse of construction being demolished.
   a. Strengthen or add new supports when required during progress of demolition.
4. Salvaged Items: Comply with the following:
   a. Clean salvaged items of dirt and demolition debris.
   b. Pack or crate items after cleaning. Identify contents of containers.
   c. Store items in a secure area until delivery to Owner.

d. Transport items to storage area designated by Owner **OR** indicated on Drawings, **as directed**.
e. Protect items from damage during transport and storage.

C. Protection
1. Existing Facilities: Protect adjacent walkways, loading docks, building entries, and other building facilities during demolition operations. Maintain exits from existing buildings.
2. Existing Utilities: Maintain utility services to remain and protect from damage during demolition operations.
   a. Do not interrupt existing utilities serving adjacent occupied or operating facilities unless authorized in writing by Owner and authorities having jurisdiction.
   b. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and authorities having jurisdiction.
      1) Provide at least 72 hours' notice to occupants of affected buildings if shutdown of service is required during changeover.
3. Temporary Protection: Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction, and as indicated. Comply with requirements in Division 01 Section "Temporary Facilities And Controls".
   a. Protect adjacent buildings and facilities from damage due to demolition activities.
   b. Protect existing site improvements, appurtenances, and landscaping to remain.
   c. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.
   d. Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
   e. Provide protection to ensure safe passage of people around building demolition area and to and from occupied portions of adjacent buildings and structures.
   f. Protect walls, windows, roofs, and other adjacent exterior construction that are to remain and that are exposed to building demolition operations.
   g. Erect and maintain dustproof partitions and temporary enclosures to limit dust, noise, and dirt migration to occupied portions of adjacent buildings.
4. Remove temporary barriers and protections where hazards no longer exist. Where open excavations or other hazardous conditions remain, leave temporary barriers and protections in place.

D. Demolition, General
1. General: Demolish indicated existing buildings and site improvements completely. Use methods required to complete the Work within limitations of governing regulations and as follows:
   a. Do not use cutting torches until work area is cleared of flammable materials. Maintain portable fire-suppression devices during flame-cutting operations.
   b. Maintain fire watch during and for a specified time after flame cutting operations as directed by the Owner.
   c. Maintain adequate ventilation when using cutting torches.
   d. Locate building demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
2. Engineering Surveys: During demolition, perform surveys to detect hazards that may result from building demolition activities.
3. Site Access and Temporary Controls: Conduct building demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
   a. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
   b. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations. Do not use water when it may damage

adjacent construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.

4. Explosives: Use of explosives is not permitted, **unless directed otherwise**.

E. Demolition By Mechanical Means

1. Proceed with demolition of structural framing members systematically, from higher to lower level. Complete building demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. Remove debris from elevated portions of the building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
   a. Remove structural framing members and lower to ground by method suitable to minimize ground impact and dust generation.
3. Salvage: Items to be salvaged are indicated on Drawings **OR** below, **as directed**:
   a. Doors and door hardware.
   b. Windows.
   c. Cabinets.
   d. Mirrors.
   e. Chalkboards.
   f. Tackboards.
   g. Marker boards.
   h. Plumbing fixtures.
   i. Other items as directed.
4. Below-Grade Construction: Abandon foundation walls and other below-grade construction. Cut below-grade construction flush with grade.

   OR

   Below-Grade Construction: Demolish foundation walls and other below-grade construction that are within footprint of new construction and extending 5 feet (1.5 m) outside footprint indicated for new construction. Abandon below-grade construction outside this area.
   a. Remove below-grade construction, including basements, foundation walls, and footings, completely **OR** to at least 6 inches (150 mm) below grade **OR** to at least 12 inches (300 mm) below grade **OR** to depths indicated, **as directed**.

   OR

   Below-Grade Construction: Demolish foundation walls and other below-grade construction.
   b. Remove below-grade construction, including basements, foundation walls, and footings, completely **OR** to at least 6 inches (150 mm) below grade **OR** to at least 12 inches (300 mm) below grade **OR** to depths indicated, **as directed**.
5. Existing Utilities: Abandon existing utilities and below-grade utility structures. Cut utilities flush with grade.

   OR

   Existing Utilities: Demolish existing utilities and below-grade utility structures that are within 5 feet (1.5 m) outside footprint indicated for new construction. Abandon utilities outside this area.
   a. Fill abandoned utility structures with satisfactory soil materials **OR** recycled pulverized concrete, **as directed**, according to backfill requirements in Division 02 Section "Earthwork".
   b. Piping: Disconnect piping at unions, flanges, valves, or fittings.
   c. Wiring Ducts: Disassemble into unit lengths and remove plug-in and disconnecting devices.

   OR

   Existing Utilities: Demolish and remove existing utilities and below-grade utility structures.
   a. Piping: Disconnect piping at unions, flanges, valves, or fittings.
   b. Wiring Ducts: Disassemble into unit lengths and remove plug-in and disconnecting devices.

F. Demolition By Explosives – ONLY IF APPROVED BY OWNER

1. Explosives: Perform explosive demolition according to governing regulations.

a. Obtain written permission from authorities having jurisdiction before bringing explosives to, or using explosives on, Project site.
b. Do not damage adjacent structures, property, or site improvements when using explosives.

2. Comply with recommendation in Explosives Consultant's report.

G. Site Restoration
1. Below-Grade Areas: Rough grade below-grade areas ready for further excavation or new construction.
OR
Below-Grade Areas: Completely fill below-grade areas and voids resulting from building demolition operations with satisfactory soil materials **OR** recycled pulverized concrete **OR** recycled pulverized masonry, **as directed**, according to backfill requirements in Division 02 Section "Earthwork".
2. Site Grading: Uniformly rough grade area of demolished construction to a smooth surface, free from irregular surface changes. Provide a smooth transition between adjacent existing grades and new grades.

H. Repairs
1. Promptly repair damage to adjacent buildings caused by demolition operations.

I. Disposal Of Demolished Materials
1. Remove demolition waste materials from Project site. See Division 01 Section "Construction Waste Management" for recycling and disposal of demolition waste.
OR
Remove demolition waste materials from Project site and legally dispose of them in an EPA-approved landfill acceptable to authorities having jurisdiction.
a. Do not allow demolished materials to accumulate on-site.
b. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
2. Do not burn demolished materials.

J. Cleaning
1. Clean adjacent structures and improvements of dust, dirt, and debris caused by building demolition operations. Return adjacent areas to condition existing before building demolition operations began.

END OF SECTION 02111

SECTION 02111a - PORTLAND CEMENT CONCRETE REMOVAL

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for portland cement concrete removal. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Section Includes:
1. Provide all labor, materials and equipment required for the removal work and disposal of existing Portland Cement Concrete indicated on the drawings and specified, including but not limited to the following:
   a. Saw cutting existing concrete pavements, sidewalks, driveways, curbs and gutters noted on drawings to be removed.
   b. Saw cutting existing concrete sidewalks for new tree pit openings (refer to drawings for locations).
   c. Saw cutting existing bituminous paving noted on drawings to be removed.
   d. Removal and disposal of demolished concrete sidewalks, driveways, curbs and gutters, including concrete removed for new tree pit openings.
   e. Removal and disposal of demolished bituminous paving.
   f. All excavating, rough grading and compacting as required to establish subgrade for new sidewalks, and Subgrade and Sub-Base for driveways.
   g. Providing, placing and grading sand fill under new sidewalks. Top of compacted subgrades shall allow for the placement of sidewalks plus thickness of sand fill.
   h. Removal and disposal of excavated material.

C. Special Requirements:
1. Protection: Provide protection barricades, maintain all lights and signals and other measures as required by federal, state, and municipal laws, for the full period of demolition operations and remove same when directed. In removing work, perform all work required to protect and maintain adjacent property, streets, alleys, sidewalks, curbs, and other structures remaining in place.

1.2 PRODUCTS

A. Backfilling Material:
1. Sand: Natural sand, with the following gradation: 100% passing the 1 sieve-, 65-100% passing the No. 4 sieve; 40-90% passing the No. 10 sieve- 30-80% passing the No. 16 sieve- 10-50% passing the No. 50 sieve; 0-30% passing the No. 100 sieve, and 0-10% passing the No. 200 sieve.
2. Crushed Stone: Crushed stone having a #57 crusher run gradation.

1.3 EXECUTION

A. Demolition:
1. The contractor shall accept the site as he finds it and shall inform himself as to the character and types of work to be removed. The Owner assumes no responsibility for the condition of the existing construction to be removed or demolished.
2. No demolition shall be commenced until a program of operations has been coordinated with the Owner, except that preparatory work may be started if specifically approved by the Owner.

3. Operations shall be done in such manner as to avoid hazards to persons and property and interference with use of adjacent areas or interruption of free passage to and from such areas. Maintain Pedestrian access to all private entrances where construction of new sidewalks is in progress. Provide temporary walk ways or other means as required to maintain entry into the private properties, complying with all laws and ordinances and as approved by the Owner. Care shall be taken to prevent the spread of dust and flying particles.
4. Demolition and removal work shall be executed in a careful and orderly manner. Accumulation of rubbish will not be permitted.
5. After work is started, it shall be continued to completion at a rate that will allow the balance of the work to be completed within the time specified. If extra shifts are necessary beyond regular working hours, the work shall proceed with a minimum of nuisance to surrounding properties.
6. Contractor shall determine the nature and extent of demolition that will be necessary by comparing the drawings with the existing field conditions. It is expressly understood that this contract includes all work of a demolition nature that may be required or necessary for a full and complete execution of the work, whether particularly referred to herein or not.

B. Removal And Excavation:
1. When removing existing sidewalks, driveways, curbs and gutters provisions shall be made for satisfactory transition between replacements and the portion remaining in place. The contractor shall saw cut to a minimum depth of 1-1/2 inches with a concrete sawing machine to prevent the surface from spilling when the concrete is broken out. This work shall be done in such a manner that a straight joint will be secured.
2. It shall be the responsibility of the contractor to determine the thickness of the existing sidewalk to be removed. No additional compensation will be allowed because of variations from the assumed thickness or from the thickness shown on the plans.
3. After existing concrete sidewalks and driveways have been removed, excavate to depth required for sand fill.
4. The bottoms of all excavations shall be properly leveled off and all loose materials shall be removed from excavations. All wood, timber and organic materials, that are exposed at the bottom of all excavations, shall be removed and the area backfilled with sand and compacted.
5. Any excess or unauthorized excavation shall be backfilled with sand and compacted, at no additional cost to the Owner.
6. No backfill shall be placed in standing water, on frozen ground or on surfaces which have not been approved by the Commissioner.
7. Backfilling for all areas shall be approved material. Backfill shall be compacted to 95% maximum density in accordance with ASTM D 1557.
8. Contractor shall determine the nature and extent of excavation work that will be necessary by comparing the drawings with the existing areas to be excavated. It is expressly understood that this contract includes all work of an excavation nature that may be required or necessary for a complete execution of all excavation work, whether particularly referred to herein or not.

C. Disposal Of Materials:
1. All demolished and unsuitable materials, including excavated earth removed to establish required grade elevations shall be disposed of legally in such a manner that public or private property will not be damaged or endangered.

D. Clean-Up:
1. On completion of the demolition work, excavation work and before acceptance by the Owner, clean the areas affected, including areas outside the limits of the contractor's work area where permission to work has been granted. Remove surplus construction material or debris resulting from the demolition work and excavation work, and dispose of legally off the site.
2. Access routes to and from the site shall be kept clean of debris resulting from the work.

END OF SECTION 02111a

Task	Specification	Specification Description
02112	01720	Cutting and Patching
02112	02111	Building Demolition
02112	02111a	Portland Cement Concrete Removal

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SECTION 02115 - SELECTIVE DEMOLITION

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for selective demolition. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Demolition and removal of selected portions of building or structure.
b. Demolition and removal of selected site elements.
c. Salvage of existing items to be reused or recycled.

C. Definitions
1. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and reinstalled.
2. Remove and Salvage: Detach items from existing construction and deliver them to Owner ready for reuse, **as directed**.
3. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.
4. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

D. Materials Ownership
1. Historic items, relics, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, antiques, and other items of interest or value to Owner that may be encountered during selective demolition remain Owner's property. Carefully remove and salvage each item or object in a manner to prevent damage and deliver promptly to Owner.
a. Coordinate with Owner's archaeologist **OR** historical adviser, **as directed**, who will establish special procedures for removal and salvage.

E. Submittals
1. Qualification Data: For demolition firm, professional engineer, refrigerant recovery technician, **as directed**.
2. Schedule of Selective Demolition Activities: Indicate the following:
a. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's building manager's and other tenants' on-site operations are uninterrupted.
b. Interruption of utility services. Indicate how long utility services will be interrupted.
c. Coordination for shutoff, capping, and continuation of utility services.
d. Use of elevator and stairs.
e. Locations of proposed dust- and noise-control temporary partitions and means of egress, including for other tenants affected by selective demolition operations.
f. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
g. Means of protection for items to remain and items in path of waste removal from building.
3. Inventory: After selective demolition is complete, submit a list of items that have been removed and salvaged.

4. Predemolition Photographs or Videotapes: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by selective demolition operations. Submit before Work begins.
5. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.
   a. Comply with submittal requirements in Division 01 Section "Construction Waste Management".

F. Quality Assurance
1. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project.
2. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.
3. LEED Requirements for Building Reuse:
   a. Credit MR 1.1 and 1.2, **as directed**: Maintain existing building structure (including structural floor and roof decking) and envelope (exterior skin and framing, excluding window assemblies and nonstructural roofing material) not indicated to be demolished; do not demolish such existing construction beyond indicated limits.
   b. Credit MR 1.3: Maintain existing interior nonstructural elements (interior walls, doors, floor coverings, and ceiling systems) not indicated to be demolished; do not demolish such existing construction beyond indicated limits.
   c. Credit MR 1.2 and 1.3, **as directed**: Maintain existing nonshell, nonstructural components (walls, flooring, and ceilings) not indicated to be demolished; do not demolish such existing construction beyond indicated limits.
4. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
5. Standards: Comply with ANSI A10.6 and NFPA 241.
6. Predemolition Conference: Conduct conference at Project site. Review methods and procedures related to selective demolition including, but not limited to, the following:
   a. Inspect and discuss condition of construction to be selectively demolished.
   b. Review structural load limitations of existing structure.
   c. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
   d. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
   e. Review areas where existing construction is to remain and requires protection.

G. Project Conditions
1. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
2. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
   a. Before selective demolition, items will be removed as directed by the Owner.
3. Notify the Owner of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
4. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
   a. Hazardous materials will be removed by Owner before start of the Work **OR** have been removed by Owner under a separate contract, **as directed**.
   b. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify the Owner and Owner. Owner will remove hazardous materials under a separate contract.

   OR

5. Hazardous Materials: It is unknown whether hazardous materials will be encountered in the Work.
   a. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify the Owner and Owner. Owner will remove hazardous materials under a separate contract.
6. Hazardous Materials (if asbestos abatement is part of Work of this Contract): Hazardous materials are present in construction to be selectively demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.
   a. Hazardous material remediation is specified elsewhere in the Contract Documents.
   b. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.
7. Storage or sale of removed items or materials on-site is not permitted.
8. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
   a. Maintain fire-protection facilities in service during selective demolition operations.

H. Warranty
1. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

1.2 PRODUCTS (Not Used)

1.3 EXECUTION

A. Utility Services And Mechanical/Electrical Systems
1. Existing Services/Systems: Maintain services/systems indicated to remain and protect them against damage during selective demolition operations.
2. Service/System Requirements: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.
   a. the Owner will arrange to shut off indicated services/systems when requested by Contractor.
   b. Arrange to shut off indicated utilities with utility companies.
   c. If services/systems are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
   d. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.
      1) Where entire wall is to be removed, existing services/systems may be removed with removal of the wall.

B. Preparation
1. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
2. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
   a. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
   b. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.

c. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
d. Cover and protect furniture, furnishings, and equipment that have not been removed.
e. Comply with requirements for temporary enclosures, dust control, heating, and cooling.

3. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
   a. Strengthen or add new supports when required during progress of selective demolition.

C. Selective Demolition, General
1. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
   a. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
   b. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
   c. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
   d. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.
   e. Maintain adequate ventilation when using cutting torches.
   f. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
   g. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
   h. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
   i. Dispose of demolished items and materials promptly. Comply with requirements in Division 01 Section "Construction Waste Management".
2. Reuse of Building Elements: Project has been designed to result in end-of-Project rates for reuse of building elements as follows. Do not demolish building elements beyond what is indicated on Drawings without the Owner's approval.
   a. Building Structure and Shell: 75 **OR** 100, **as directed**, percent.
   b. Nonshell Elements: 50 percent.
3. Removed and Salvaged Items:
   a. Clean salvaged items.
   b. Pack or crate items after cleaning. Identify contents of containers.
   c. Store items in a secure area until delivery to Owner.
   d. Transport items to Owner's storage area on-site **OR** off-site **OR** designated by Owner **OR** indicated on Drawings, **as directed**.
   e. Protect items from damage during transport and storage.
4. Removed and Reinstalled Items:
   a. Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.
   b. Pack or crate items after cleaning and repairing. Identify contents of containers.
   c. Protect items from damage during transport and storage.

d. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

5. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by the Owner, items may be removed to a suitable, protected storage location during selective demolition and cleaned, **as directed**, and reinstalled in their original locations after selective demolition operations are complete.

D. Selective Demolition Procedures For Specific Materials

1. Concrete: Demolish in small sections. Cut concrete to a depth of at least 3/4 inch (19 mm) at junctures with construction to remain, using power-driven saw. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete indicated for selective demolition. Neatly trim openings to dimensions indicated.

   OR

   Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals, using power-driven saw, then remove concrete between saw cuts.
2. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between saw cuts.
3. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.
4. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI-WP and its Addendum.
   a. Remove residual adhesive and prepare substrate for new floor coverings by one of the methods recommended by RFCI.
5. Roofing: Remove no more existing roofing than can be covered in one day by new roofing and so that building interior remains watertight and weathertight. Refer to Division 07 for new roofing requirements.
   a. Remove existing roof membrane, flashings, copings, and roof accessories.
   b. Remove existing roofing system down to substrate.
6. Air-Conditioning Equipment: Remove equipment without releasing refrigerants.

E. Disposal Of Demolished Materials

1. General: Except for items or materials indicated to be recycled, **as directed**, reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.
   a. Do not allow demolished materials to accumulate on-site.
   b. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
   c. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
   d. Comply with requirements specified in Division 01 Section "Construction Waste Management".
2. Burning: Do not burn demolished materials.

   OR

   Burning: Burning of demolished materials will be permitted only at designated areas on Owner's property, **as directed**, provided required permits are obtained. Provide full-time monitoring for burning materials until fires are extinguished.
3. Disposal: Transport demolished materials and dispose of at designated spoil areas on Owner's property.

   OR

   Disposal: Transport demolished materials off Owner's property and legally dispose of them.

F. Cleaning

1. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

G. Selective Demolition Schedule
1. Existing Items **OR** Construction, **as directed**, to Be Removed, as directed by the Owner.
2. Existing Items to Be Removed and Salvaged, as directed by the Owner.
3. Existing Items to Be Removed and Reinstalled, as directed by the Owner.
4. Existing Items to Remain, as directed by the Owner.

END OF SECTION 02115

SECTION 02115a - EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for excavation and handling of contaminated material. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Shop Drawings: Separate cross-sections of each area before and after excavation and after backfilling.
2. Product Data: Work Plan within 30 calendar days after notice to proceed. No work at the site, with the exception of site inspections and surveys, shall be performed until the Work Plan is approved. The Contractor shall allow 30 calendar days in the schedule for the Owner's review. No adjustment for time or money will be made if resubmittals of the Work Plan are required due to deficiencies in the plan. At a minimum, the Work Plan shall include:
   a. Schedule of activities.
   b. Method of excavation and equipment to be used.
   c. Shoring or side-wall slopes proposed.
   d. Dewatering plan.
   e. Storage methods and locations for liquid and solid contaminated material.
   f. Borrow sources and haul routes.
   g. Decontamination procedures.
   h. Spill contingency plan.
3. Closure Report: Three (3) copies of the Closure Report within 14 calendar days of work completion at the site.
4. Test Reports
   a. Backfill
   b. Surveys
   c. Confirmation Sampling and Analysis
   d. Sampling of Stored Material
   e. Sampling Liquid
   f. Compaction
   g. Test results.

C. Surveys
1. Surveys shall be performed immediately prior to and after excavation of contaminated material to determine the volume of contaminated material removed. Surveys shall also be performed immediately after backfill of each excavation. The Contractor shall provide cross-sections on 25 foot (7.6 meter) intervals and at break points for all excavated areas. Locations of confirmation samples shall also be surveyed and shown on the drawings.

D. Regulatory Requirements
1. Permits and Licenses: The Contractor shall obtain required federal, state, and local permits for excavation and storage of contaminated material. Permits shall be obtained at no additional cost to the Owner.
2. Air Emissions: Air emissions shall be monitored and controlled in accordance with Owner’s Environmental Requirements.

E. Chemical Testing
1. Required sampling and chemical analysis shall be conducted in accordance with local requirements and the Owner’s requirements.

F. Scheduling
1. The Contractor shall notify the Owner five (5) calendar days prior to the start of excavation of contaminated material. The Owner will **OR** The Contractor shall, **as directed**, be responsible for contacting regulatory agencies in accordance with the applicable reporting requirements.

1.2 PRODUCTS

A. Backfill
1. Backfill material shall be obtained from the location indicated on the drawings **OR** offsite sources approved by the Owner, **as directed**. Backfill shall be classified in accordance with ASTM D 2487 as GW, GP, GM, GC, SW, SP, SM, SC, ML, MH, CL, or CH and shall be free from roots and other organic matter, trash, debris, snow, ice or frozen materials. Backfill material shall be tested for the parameters listed below at a frequency of once per 3000 cubic yards (cubic meters). A minimum of one set of classification tests shall be performed per borrow source. One backfill sample per borrow source shall also be collected and tested for the chemical parameters listed below.

Physical Parameter	Test Method
Grain Size	ASTM D 422
Compaction	ASTM D 698

Backfill shall not be used until borrow source chemical and physical test results have been submitted and approved.

B. Spill Response Materials
1. The Contractor shall provide appropriate spill response materials including, but not limited to the following: containers, adsorbents, shovels, and personal protective equipment. Spill response materials shall be available at all times when contaminated materials/wastes are being handled or transported. Spill response materials shall be compatible with the type of materials and contaminants being handled.

1.3 EXECUTION

A. Existing Structures And Utilities
1. No excavation shall be performed until site utilities have been field located. The Contractor shall take the necessary precautions to ensure no damage occurs to existing structures and utilities. Damage to existing structures and utilities resulting from the Contractor's operations shall be repaired at no additional cost to the Owner. Utilities encountered that were not previously shown or otherwise located shall not be disturbed without approval from the Owner.

B. Clearing
1. Clearing shall be performed to the limits shown on the drawings in accordance with Division 2 Section “Site Clearing.”

C. Contaminated Material Removal
1. Excavation: Areas of contamination shall be excavated to the depth and extent shown on the drawings and not more than 0.2 feet (60 mm) beyond the depth and extent shown on the drawings unless directed by the Owner. Excavation shall be performed in a manner that will limit spills and the potential for contaminated material to be mixed with uncontaminated material. An excavation log describing visible signs of contamination encountered shall be maintained for each area of excavation. Excavation logs shall be prepared in accordance with ASTM D 5434.
2. Shoring: If workers must enter the excavation, it shall be evaluated, shored, sloped or braced as required by U.S. Army Corps of Engineers (USACE) EM 385-1-1 and U.S. National Archives and Records Administration (NARA) 29 CFR 1926 section 650.

3. Dewatering: Surface water shall be diverted to prevent entry into the excavation. Dewatering shall be limited to that necessary to assure adequate access, a safe excavation, prevent the spread of contamination, and to ensure that compaction requirements can be met. No dewatering shall be performed without prior approval of the Owner.

D. Confirmation Sampling And Analysis

1. The Owner shall be present to inspect the removal of contaminated material from each site. After all material suspected of being contaminated has been removed, the excavation shall be examined for evidence of contamination. If the excavation appears to be free of contamination, field analysis shall be used to determine the presence of contamination using a real time vapor monitoring instrument **OR** immunoassay field kits, **as directed**. Excavation of additional material shall be as directed by the Owner. After all suspected contaminated material is removed, confirmation samples shall be collected and analyzed.
2. Samples shall be collected at a frequency as directed by the Owner. A minimum of one sample shall be collected from the bottom and each side wall of the excavation. Based on test results, the Contractor shall propose any additional excavation which may be required to remove material which is contaminated above action levels. Additional excavation shall be subject to approval by the Owner. Locations of samples shall be marked in the field and documented on the as-built drawings.

E. Contaminated Material Storage

1. Material shall be placed in temporary storage immediately after excavation **OR** after treatment while awaiting test results, **as directed**. The following paragraphs describe acceptable methods of material storage. Storage units shall be in good condition and constructed of materials that are compatible with the material or liquid to be stored. If multiple storage units are required, each unit shall be clearly labeled with an identification number and a written log shall be kept to track the source of contaminated material in each temporary storage unit.
2. Stockpiles
   a. Stockpiles shall be constructed to isolate stored contaminated material from the environment. The maximum stockpile size shall be as directed by the Owner. Stockpiles shall be constructed to include:
      1) A chemically resistant geomembrane liner free of holes and other damage. Non-reinforced geomembrane liners shall have a minimum thickness of 20 mils (0.5 mm). Scrim reinforced geomembrane liners shall have a minimum weight of 40 lbs. per 1000 square feet (20 kg/100 square meters). The ground surface on which the geomembrane is to be placed shall be free of rocks greater than 0.5 inches (12 mm) in diameter and any other object which could damage the membrane.
      2) Geomembrane cover free of holes or other damage to prevent precipitation from entering the stockpile. Non-reinforced geomembrane covers shall have a minimum thickness of 10 mils (0.25 mm). Scrim reinforced geomembrane covers shall have a minimum weight of 26 lbs. per 1000 square feet (13 kg/100 square meters). The cover material shall be extended over the berms and anchored or ballasted to prevent it from being removed or damaged by wind.
      3) Berms surrounding the stockpile, a minimum of 12 inches (300 mm) in height. Vehicle access points shall also be bermed.
      4) The liner system shall be sloped to allow collection of leachate. Storage and removal of liquid which collects in the stockpile, in accordance with paragraph Liquid Storage.
3. Roll-Off Units: Roll-off units used to temporarily store contaminated material shall be water tight. A cover shall be placed over the units to prevent precipitation from contacting the stored material. The units shall be located as shown on the drawings. Liquid which collects inside the units shall be removed and stored in accordance with paragraph Liquid Storage.
4. Liquid Storage: Liquid collected from excavations and stockpiles shall be temporarily stored in 55 gallon barrels (220 L barrels) **OR** 500 gallon tanks (2000 L tanks), **as directed**. Liquid storage containers shall be water-tight and shall be located as shown on the drawings.

F. Sampling

1. Sampling of Stored Material
   a. Samples of stored material shall be collected at a frequency as directed by the Owner.
   b. Stored material with contaminant levels that exceed the action levels shall be treated offsite. Analyses for contaminated material to be taken to an offsite treatment facility shall conform to local, state, and federal criteria as well as to the requirements of the treatment facility. Documentation of all analyses performed shall be furnished to the Owner. Additional sampling and analyses to the extent required by the approved offsite treatment, storage or disposal (TSD) facility shall be the responsibility of the Contractor and shall be performed at no additional cost to the Owner **OR** subject to approval by the Owner, **as directed**.

      OR

      Stored material with contaminant levels that exceed the action levels shall be treated onsite.
2. Sampling Liquid
   a. Liquid collected from excavations **OR** storage areas **OR** decontamination facilities, **as directed**, shall be sampled at a frequency of once for every 500 gallons (2,000 L) of liquid collected.
   b. Liquid with contaminant levels that exceed action levels shall be treated offsite. Analyses for contaminated liquid to be taken to an offsite treatment facility shall conform to local, state, and federal criteria as well as to the requirements of the treatment facility. Documentation of all analyses performed shall be furnished to the Owner. Additional sampling and analysis to the extent required by the approved offsite treatment, storage or disposal (TSD) facility receiving the material shall be the responsibility of the Contractor and shall be performed at no additional cost to the Owner **OR** subject to approval by the Owner.

      OR

      Liquid with contaminant levels that exceed action levels shall be treated onsite.
3. Sampling Beneath Storage Units
   a. Samples from beneath each storage unit shall be collected prior to construction of and after removal of the storage unit. Samples shall be collected at a frequency as directed by the Owner from a depth interval of 0 to 0.5 feet (0 to 0.15 m).
   b. Based on test results, soil which has become contaminated above action levels shall be removed at no additional cost to the Owner. Contaminated material which is removed from beneath the storage unit shall be handled in accordance with paragraph Sampling of Stored Material. as directed by the Owner and at no additional cost to the Owner, additional sampling and testing shall be performed to verify areas of contamination found beneath stockpiles have been cleaned up to below action levels.

G. Spills

1. In the event of a spill or release of a hazardous substance (as designated in NARA 40 CFR 302), pollutant, contaminant, or oil (as governed by the Oil Pollution Act [OPA], 33 U.S.C. 2701 et seq.), the Contractor shall notify the Owner immediately. If the spill exceeds the reporting threshold, the Contractor shall follow the pre-established procedures as described in the Contingency Plan for immediate reporting and containment. Immediate containment actions shall be taken to minimize the effect of any spill or leak. Cleanup shall be in accordance with applicable federal, state, and local regulations. as directed by the Owner, additional sampling and testing shall be performed to verify spills have been cleaned up. Spill cleanup and testing shall be done at no additional cost to the Owner.

H. Backfilling

1. Confirmation Test Results: Excavations shall be backfilled immediately after all contaminated materials have been removed and confirmation test results have been approved. Backfill shall be placed and compacted to the lines and grades shown on the drawings.

2. Compaction: Approved backfill shall be placed in lifts with a maximum loose thickness of 8 inches (200 mm). Soil shall be compacted to 90 percent of ASTM D 698 **OR** ASTM D 1557, **as directed**, maximum dry density. Density tests shall be performed at a frequency of once per 10,000 square feet (930 square meters) per lift. A minimum of one density test shall be performed on each lift of backfill placed. Field in-place dry density shall be determined in accordance with ASTM D 1556, ASTM D 2167, or ASTM D 2922. If ASTM D 2922 is used, a minimum of one in ten tests shall be checked using ASTM D 1556 or ASTM D 2167. Test results from ASTM D 1556 or ASTM D 2167 shall govern if there is a discrepancy with the ASTM D 2922 test results.

I. Disposal Requirements

1. Offsite disposal of contaminated material shall be in accordance with Division 2 Section "Disposal of Hazardous Materials."

J. Closure Report

1. Three copies of a Closure Report shall be prepared and submitted within 14 calendar days of completing work at the site. The report shall be labeled with the contract number, project name, location, date, and name of general contractor. The Closure Report shall include the following information as a minimum:
   a. A cover letter signed by a responsible company official **OR** Professional Engineer registered in the state of the work who is a responsible company official, **as directed**, certifying that all services involved have been performed in accordance with the terms and conditions of the contract documents and regulatory requirements.
   b. A narrative report including, but not limited to, the following:
      1) site conditions, ground water elevation, and cleanup criteria;
      2) excavation logs;
      3) field screening readings;
      4) quantity of materials removed from each area of contamination;
      5) quantity of water/product removed during dewatering;
      6) sampling locations and sampling methods;
      7) sample collection data such as time of collection and method of preservation;
      8) sample chain-of-custody forms; and
      9) source of backfill.
   c. Copies of all chemical and physical test results.
   d. Copies of all manifests and land disposal restriction notifications.
   e. Copies of all certifications of final disposal signed by the responsible disposal facility official.
   f. Waste profile sheets.
   g. Scale drawings showing limits of each excavation, limits of contamination, known underground utilities within 50 feet (15 m) of excavation, sample locations, and sample identification numbers. On-site stockpile, storage, treatment, loading, and disposal areas shall also be shown on the drawings.
   h. Progress Photographs. Color photographs shall be used to document progress of the work. A minimum of four views of the site showing the location of the area of contamination, entrance/exit road, and any other notable site conditions shall be taken before work begins. After work has been started, activities at each work location shall be photographically recorded daily **OR** weekly, **as directed**. Photographs shall be a minimum of 3 x 5 inches (76.2 x 127.0 mm) and shall include:
      1) Soil removal and sampling.
      2) Dewatering operations.
      3) Unanticipated events such as spills and the discovery of additional contaminated material.
      4) Contaminated material/water storage, handling, treatment, and transport.
      5) Site or task-specific employee respiratory and personal protection.
      6) Fill placement and grading.

7) Post-construction photographs. After completion of work at each site, the Contractor shall take a minimum of four views of each excavation site. A digital version of all photos shown in the report shall be included with the Closure Report. Photographs shall be a minimum of 3 inches by 5 inches (76mm by 127 mm) and shall be mounted back-to-back in double face plastic sleeves punched to fit standard three ring binders. Each print shall have an information box attached. The box shall be typewritten and arranged as follows:

Project Name: Direction of View:
Location: Date/Time:
Photograph No.: Description of View:

END OF SECTION 02115a

SECTION 02115b - UNDERGROUND STORAGE TANK REMOVAL

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing of labor and equipment for the underground storage tank removal. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Work Plan: The Work Plan within 30 days after notice to proceed. The Contractor shall allow 30 days in the schedule for the Owner's review and approval. No adjustment for time or money will be made for resubmittals required as a result of noncompliance.
2. Qualifications: A document indicating that the Contractor meets the specified requirements.
3. Reports
   a. Backfill Material.
   b. Tank Contents Verification.
   c. Contaminated Water Disposal.
   d. Soil Examination, Testing, and Analysis.
   e. Reports including the chain-of-custody records.
   f. Backfilling.
   g. Copies of all laboratory and field test reports.
   h. Tank Closure Report: 3 copies of the report for each UST site opened, prepared in a standard 3-ring binder, within 14 days of completing work at each site. Each binder shall be labeled with contract number, project name, location and tank number; each binder shall be indexed. A copy of the report shall be furnished to the Installation Environmental Coordinator.
4. Records
   a. Salvage Rights: A record of the disposition of salvaged materials at the end of the contract.
5. Qualifications
   a. The Contractor shall have a minimum of 2 years of tank removal experience and shall be certified by the State in which the Project is located for tank removal work.
   b. Laboratory Services: For laboratory services the Contractor shall be validated in accordance with state certification requirements.
   c. Support Staff: The Contractor shall identify all staff involved for the various components, including personnel collecting and shipping samples. The qualifications of these staff members shall be detailed by the Contractor.

C. Regulatory Requirements
1. Permits and Licenses: The Contractor, as required or as directed by the Owner, shall obtain local, state, or federal permits and licenses that directly impact the Contractor's ability to perform the work prior to commencing removal operations.
2. Statutes and Regulations: Tank closures shall be carried out in accordance with 40 CFR 280, 40 CFR 262, 40 CFR 264, and 40 CFR 265 as well as the applicable local and State regulations. Hazardous material and/or waste shall be transported in accordance with applicable local and State regulations.

D. Project/Site Conditions: See the Detailed Scope of Work
1. Sequencing and Scheduling: The Contractor shall notify the Installation Environmental Coordinator and the Owner 5 days prior to tank removal. The Contractor shall be responsible for contacting the Implementation Agency (IA) in accordance with the applicable reporting requirements.

2. Work Plan
   a. The Contractor shall develop, implement, maintain, and supervise as part of the work, a comprehensive plan for tank removal and related operations. As a minimum the plan shall include, but not be limited to, excavation, removal, and ultimate disposal of the tank, its contents, and any contaminated materials. The Work Plan shall be based on work experience, on the requirements of this specification, and on the following references from the American Petroleum Institute:
      API RP 1604.
      API Standard 2015.
      API RP 2003.
      API Publication 2217A.
      API Publication 2219.

   No work at the site, with the exception of site inspections and mobilization, shall be performed until the Work Plan is approved. At a minimum, the Work Plan shall include:
   1) Discussion of the removal approach, tank cleaning, and tank cutting procedures.
   2) A Sampling and Analysis Plan.
   3) Methods to be employed for product, sludge, vapor, and pumpable liquid removal; purging and inerting; and storage methods proposed for control of surface water.
   4) Treatment options.
   5) Identification of waste, tank and contaminated soil transporters and means of transportation.
   6) Treatment, disposal, and alternate facilities, and means of treatment, disposal or remediation.
   7) Borrow source.
   8) Spill prevention plan.
   9) Spill contingency plan.
   10) Decontamination procedures, shoring plan, and safety measures.

1.2 PRODUCTS

A. Backfill Material
   1. Backfill shall be classified in accordance with ASTM D 2487 as GW, GP, GM, GC, SW, SP, SM, SC, MH, CL, or CH and shall be free from roots and other organic matter, trash, debris, snow, ice or frozen materials. If off-site materials are used, soil classification test results shall be approved prior to bringing the material onsite. The testing frequency for backfill material shall be 1 per 1000 cubic yards or a minimum of 1 test. Non-contaminated material removed from the excavation shall be used for backfill in accordance with Paragraph BACKFILLING.

1.3 EXECUTION

A. General Requirements
   1. Safety Guidelines: Personnel shall abide by the safety guidelines specified in Division 01.
   2. Burning and Explosives: Use of explosives or burning debris will not be allowed.
   3. Protection of Existing Structures and Utilities: The Contractor shall take all necessary precautions to avoid damage to existing structures, their appurtenances, monitoring wells, or utilities that may be affected by work activities. Any damage to utilities or monitoring wells resulting from the Contractor's operations shall be repaired at no expense to the Owner. The Contractor shall coordinate with the installation to locate underground utilities prior to beginning construction. Utilities encountered which were not previously shown or otherwise located shall not be disturbed without approval from the Owner.
   4. Shoring: Shoring requirements shall be provided.

B. Tank Contents Verification

1. Sampling: Tank product, pumpable liquids, tank coatings and sludge shall be sampled by the Contractor. If the data is not adequate, additional sampling and analysis to the extent required by the approved permitted treatment, storage or disposal (TSD) facility receiving the material shall be the responsibility of the Contractor. Meeting all regulatory requirements, including the preparation of hazardous materials and waste for transportation shall be the responsibility of the Contractor.
2. Analysis: Tank contents shall be tested by the Contractor for the parameters listed herein. Analyses shall include total petroleum hydrocarbons (TPH), benzene, ethylbenzene, toluene and xylene (BETX), and lead.
3. Characterization: Prior to removing any of the tank contents, the contents shall be characterized to determine if the tank contents must be disposed as a hazardous or special waste or in a special manner based on local, state, and Federal disposal regulations. Tank product, pumpable liquids, and sludge shall be characterized in accordance with 40 CFR 261 and 40 CFR 279. The waste contents determination and accompanying test results for each phase present in the tank shall be submitted to the Owner. The Contractor shall be responsible for any additional requirements identified by the disposal facility. The tank contents shall not be removed until approval is given by the Owner.

C. Clearing, Grubbing And Removals
1. Areas designated for clearing and grubbing shall be cleared of all trees, stumps, down timber, brush, rubbish, roots larger than 75 mm (3 inches) in diameter, and matted roots prior to commencing operations. Concrete or asphalt pavement shall be saw cut at the limits of removal, broken and removed with the resulting debris disposed of as directed by the Owner. Chain link fence shall be removed and salvaged for reuse or disposed of off-site, as directed by the Owner.

D. Topsoil
1. Uncontaminated topsoil shall be stripped and stockpiled separately for reuse at a location approved by the Owner if it meets the requirements of clean fill given in Paragraph BACKFILLING. Additional topsoil in excess of that produced by excavation shall be obtained where directed by the Owner. All areas disturbed by tank removal operations, other than areas to receive pavement or similar surface under this contract, shall be topsoiled. Topsoil shall be used wherever directed by the Owner.

E. Preparations For Excavation: Before excavating, the Contractor shall drain product piping back to the tank, remove residual liquids trapped in the product lines, and remove all product from the tank; and the tank shall be purged and vented in accordance with API RP 1604, and as specified herein.
1. Removal of Product, Pumpable Liquids, and Sludge: Tank product, pumpable liquids, and sludge shall be contained, and stored onsite, prior to disposal. Contaminated water shall be treated as specified. Tank product, pumpable liquids, and sludge shall be analyzed and segregated to recover reusable products by the Owner prior to being transported to the designated location or treatment, storage and disposal (TSD) facility. Tank product, pumpable liquids, and sludge shall be removed and disposed of by the Contractor. No Owner facilities shall be used for permanent storage or disposal of the wastes. Temporary storage on Owner's facilities will be allowed only until testing is complete, manifests (if necessary) are complete, and transportation is arranged. The Contractor shall be responsible for obtaining all required permits. Usable product shall be the property of the Contractor. The Contractor shall provide approved containers, vehicles, equipment, labor, signs, labels, placards and manifests and associated land disposal restriction notices and notifications, necessary for accomplishment of the work, including materials necessary for cleaning up spills that could occur from tank removal operations.
2. Contaminated Water Disposal:
   a. Sampling, Analysis, and Containment
      1) Contaminated water shall be sampled and analyzed both prior to and after treatment. Contaminated water produced from excavation operations and tank pumping treated onsite, shall be analyzed for pH; benzene, ethylbenzene, toluene, and xylene (BETX); total lead; oil and grease; total petroleum hydrocarbons (TPH). Sampling and analysis shall be performed prior to disposal for every 200,000 L

(50,000 gallons) of contaminated water treated. Analysis for contaminated water to be taken to an off-site treatment facility shall conform to the requirements of the treatment facility with documentation of all analyses performed furnished to the Owner in accordance with paragraph RECORDS.

2) Contaminated water shall be contained, stored onsite, and analyzed and disposed of by the Contractor in accordance with applicable Federal and state disposal regulations. The Contractor shall provide approved containers, vehicles, equipment, labor, signs, labels, placards and manifests and associated land disposal notices and notifications, necessary for accomplishment of the work.

b. Treatment: Contaminated water shall be treated by oil water separation, filtering, air stripping and activated carbon,or other means as approved by the Owner. If contaminated water is to be treated onsite, the proposed treatment shall be specified in the Work Plan and submitted for approval. Temporary storage and treatment equipment shall be installed at a location approved by the Owner. Treated effluent shall be sampled and analyzed and the results approved by the Owner before discharge to the sanitary sewer or the surface. Effluent shall be treated and discharged in accordance with the discharge permit.

F. Purging And Inerting: After the tank and piping contents have been removed, but prior to excavation beyond the top of the tank, the Contractor shall disconnect all the piping (except the piping needed to purge or inert the tank). Flammable and toxic vapors shall be purged from the tank or the tank made inert in accordance with API RP 1604, with the exceptions that filling with water shall not be used and, if dry ice is employed, the Contractor shall use a minimum of 1.8 kg per 500 L (3 pounds per 100 gallons) of tank volume. The tank atmosphere shall be continuously monitored for combustible vapors if the tank is purged, or continuously monitored for oxygen if the tank is inerted.

G. Excavation: Excavation areas, as well as work near roadways, shall be marked as directed by the Owner.

1. Exploratory Trenches: Exploratory trenches shall be excavated as necessary to determine the tank location, limits and the location of ancillary equipment.
2. Tank Excavation: Excavation around the perimeter of the tank shall be performed limiting the amount of potentially petroleum contaminated soil that could be mixed with previously uncontaminated soil. Petroleum contaminated soil shall be segregated in separate stockpiles. The Contractor shall maintain around the tank an excavation of sufficient size to allow workers ample room to complete the work, but also protect the workers from sliding or cave-ins. Sheeting, bracing, or shoring shall be installed in the absence of adequate side slopes if there is a need for workers to enter the excavated area. Surface water shall be diverted to prevent direct entry into the excavation. Dewatering of the excavation may require a discharge permit by the State and shall be limited to allow adequate access to the tank and piping, to assure a safe excavation, and to ensure that compaction and moisture requirements are met during backfilling. Dewatering may result in the production of petroleum contaminated water and/or free product. Free product shall be recovered from the groundwater only as part of necessary dewatering.
3. Piping Excavation: Excavation shall be performed as necessary to remove tank piping and ancillary equipment in accordance with paragraphs: Shoring, Tank Excavation, and Open Excavations.
4. Open Excavations: Open excavations and stockpile areas shall be secured while awaiting confirmation test results from the soil beneath the tank. The excavation shall be backfilled as soon as possible after tank and contaminated soil removals have been completed and confirmation samples have been taken. The Contractor shall divert surface water around excavations to prevent water from directly entering into the excavation.
5. Stockpiles: Uncontaminated excavated soil and petroleum contaminated soil that is not a state-regulated hazardous waste shall be stockpiled and used for backfill in the tank excavation prior to using borrow material or disposed of off-site. Excavated material that is regulated by the state as a hazardous waste shall be considered contaminated and shall be placed in containers such as drums, roll-offs or dumpsters for sampling in accordance with paragraph Stockpiled Material

Sampling. Uncontaminated soil shall be stockpiled separately from the contaminated soil, a safe distance away from, but adjacent to, the excavation.

H. Removal Of Piping, Ancillary Equipment, And Tank

1. Piping and Ancillary Equipment: All piping and ancillary equipment shall be disconnected from the tank. The piping shall be removed completely (interior and exterior of the tank). All tank ancillary equipment and piping connections shall be capped, except those connections necessary to inert the tank within the excavation zone. The piping exterior and ancillary equipment shall be cleaned to remove all soil and inspected for signs of corrosion and leakage. The Contractor shall ensure no spillage of the piping contents occurs, as specified in the Work Plan, and as required in paragraph SPILLS. If the soil under and around the tank pad is contaminated, the tank pad shall be removed and disposed of off-site at an approved non-hazardous or hazardous waste facility, as required. If the soil under and around the tank pad is not contaminated, the tank pad shall remain in place.
2. Tank: The tank shall be removed from the excavation and the exterior cleaned to remove all soil and inspected for signs of corrosion, structural damage, or leakage. All materials coming into contact with the tank, or in the vicinity of the excavation such as shovels, slings and tools shall be of the non-sparking type. After removal from the excavation, the tank shall be placed on a level surface at an approved location and secured with wood blocks to prevent movement.
3. Contaminated Soil, Tank and Piping Excavation Examination: After the tank has been removed from the ground, the adjacent and underlying soil shall be examined for any evidence of leakage. The soil shall be visually inspected for staining after removal of all obviously contaminated soil, then screened for the presence of volatile and/or semi-volatile contamination using a real time vapor monitoring instrument or immunoassay field kits, as required. Uncontaminated soil or petroleum contaminated soil not regulated by the state as hazardous waste shall be transported off-site for disposal. Contaminated soil or suspected contaminated soil shall be containerized. the Owner shall determine the extent of the contaminated soil to be removed from each site. The Contractor shall report any evidence indicating that the amount of contaminated soil may exceed the individual site limit specified, to the Owner the same day it is discovered. If minimal additional excavation is required, the Owner may allow the Contractor to proceed. If extensive contamination is encountered, the excavation shall be sampled and backfilled in accordance with paragraph BACKFILLING. After the known contaminated soil is removed, the excavation shall be sampled and analyzed.

I. Tank Cleaning

1. Exterior: Soil shall be removed from the exterior of the tank, piping, and associated equipment to eliminate soil deposition on roadways during transportation to a temporary storage area, ensure markings will adhere to the surfaces, and simplify tank cutting. Soil shall be removed using non-sparking tools. Removed uncontaminated soil and soil not regulated by the state as a hazardous waste shall be recovered and used as backfill in the former tank excavation. Soil believed to be contaminated shall be removed and containerized.
2. Temporary Storage: If the tank is stored after the tank exterior is cleaned and ancillary equipment is removed, and prior to being cut into sections, the tank shall be labeled as directed in API RP 1604, placed on blocks, and temporarily stored in the area of the existing tank site. Prior to cleaning the tank interior the tank atmosphere shall be monitored for combustible vapors and purged or inerted if combustible vapors are detected.
3. Interior:
   a. The tank interior shall be cleaned using a high pressure (greater than 500 psi (3.45 Mpa)), low volume (less than 2 gpm (0.13 L/s)) water spray or steam cleaned until all loose scale and sludge is removed, and contamination, in the form of a sheen, is no longer visible in the effluent stream. The interior surfaces of piping shall also be cleaned, to the extent possible, using the same method used for cleaning the tank. Contaminated water generated from interior cleaning operations (of both piping and tank) shall not exceed the following quantities for each UST cleaned:

UST VOLUME (LITERS)	PERCENT OF UST VOLUME

3,785 or less	5
37,850 or less	5 or 378 L, whichever is less
75,700 or less	1 or 568 L, whichever is less
greater than 75,700	1 or 946 L, whichever is less

UST VOLUME (GALLONS)	PERCENT OF UST VOLUME
1,000 or less	5
10,000 or less	5 or 100 gal., whichever is less
20,000 or less	1 or 150 gal., whichever is less
greater than 20,000	1 or 250 gal., whichever is less.

b. All contaminated water resulting from cleaning operations shall be handled in accordance with paragraph Contaminated Water Disposal. Cleaning shall be accomplished eliminating, to the greatest extent possible, the need for personnel to enter the tank. Cleaning shall be done using specially designed tank cleaning equipment which allows the tank to be cleaned prior to cutting into sections without requiring personnel to enter the tank or, if less specialized equipment is used, the tank shall be partially dissected to overcome confined space entry hazards.

J. Soil Examination, Testing, And Analysis
1. Tank Excavation Sampling Procedures: After soil known to be contaminated has been removed or after soil excavation is complete, the excavation shall be sampled with procedures, number, location, and methodology in accordance with state regulations. Samples shall be obtained from the pits, in accordance with ASTM D 1587, using a backhoe with a Shelby tube attached to the bucket.
2. Stockpiled Material Sampling: Sampling locations, number and specific procedures shall be as required by the implementing agency and the disposal facility.
3. Analysis: Soil samples from the excavation and stockpiled material shall be tested in accordance with the approved Sampling and Analysis Plan for the following parameters: total petroleum hydrocarbon (TPH); benzene, ethylbenzene, toluene, xylene (BETX); toxicity characteristic leaching procedure (TCLP). Copies of all test results shall be provided to the Owner.

K. Backfilling: The tank area and any other excavations shall be backfilled only after the soil test results have been approved. Contaminated soil removal shall be complete after the bottom of the tank excavation is determined to have soil contamination levels below the state standards of approval by the Owner. The excavation shall be dewatered if necessary. Stockpiled material subjected to chemical confirmation testing shall be used as backfill if it is found to conform to the requirements of clean fill per appropriate state and local regulations. Backfill consisting of clean fill shall be placed in layers with a maximum loose thickness of 200 mm (8 inches) and compacted to 90 percent maximum density for cohesive soils and 95 percent maximum density for cohesionless soils. Density tests shall be performed by an approved commercial testing laboratory or by facilities furnished by the Contractor. Test results shall be attached to contractor's Quality Control Report. A minimum of 1 density test shall be performed on each lift. Laboratory tests for moisture density relations shall be determined in accordance with ASTM D 1557, Method B, C, or D, or ASTM D 3017. A mechanical tamper may be used provided that the results are correlated with those obtained by the hand tamper. Field in-place density shall be determined in accordance with ASTM D 1556, ASTM D 2922, or ASTM D 2167.

L. Disposal Requirements
1. Treatment, Disposal, and Recycling: Disposal of hazardous or special wastes shall be in accordance with all local, State, and Federal solid and hazardous waste laws and regulations; and conditions specified herein. This work shall include all necessary personnel, labor, transportation, packaging, detailed analyses (if required for disposal, manifesting or completing waste profile sheets), equipment, and reports. Product and pumpable liquids removed from the tank shall be recycled to the greatest extent practicable. The tanks removed shall be disposed of

at one of the state approved facilities. Each tank disposed of in this manner shall be manifested as required by the State to document delivery and acceptance at the disposal facility.

2. Tank and Ancillary Equipment Disposal: After the tank, piping, and ancillary equipment have been removed from the excavation and the tank cleaned, the tank shall be cut into sections with no dimension greater than 1500 mm (5 feet). Tank and piping sections shall be disposed of in a State approved off-site disposal facility or in a salvage yard. The tank shall be cut into sections prior to being taken from the tank removal site. The Contractor shall not sell the tank intact. Ancillary equipment shall be disposed of at an approved off-site disposal facility or a salvage yard. Piping shall be disconnected from the tank and removed or grouted full of a portland cement and water slurry consisting of 22.7 L (6 gallons) of clean water per 42.6 kg (94 pound) sack of portland cement, thoroughly mixed and free of lumps, unless otherwise indicated.
3. Transportation of Wastes: Transportation shall be provided in accordance with Department of Transportation (DOT) Hazardous Material Regulations and State and local requirements, including obtaining all necessary permits, licenses, and approvals. Evidence that a State licensed hazardous waste or waste transporter is being used shall be included in the SUBMITTALS.
4. Salvage Rights: The Contractor shall retain the rights to salvage value of recycled or reclaimed product and metal not otherwise identified, so long as the requirements of 40 CFR 266 and 40 CFR 279, or the applicable State requirements are met. At the end of the contract, the Contractor shall provide documentation on the disposition of salvaged materials.
5. Records: Records shall be maintained of all waste determinations, including appropriate results of analyses performed, substances and sample location, the time of collection, and other pertinent data as required by 40 CFR 280, Section 74 and 40 CFR 262 Subpart D. Transportation, treatment, disposal methods and dates, the quantities of waste, the names and addresses of each transporter and the disposal or reclamation facility, shall also be recorded and available for inspection, as well as copies of the following documents:
   a. Manifests.
   b. Waste analyses or waste profile sheets.
   c. Certifications of final treatment/disposal signed by the responsible disposal facility official.
   d. Land disposal notification records required under 40 CFR 268 for hazardous wastes.
6. Hazardous/Special Waste Manifests: Manifesting shall conform to Federal, State and local requirements.
7. Documentation of Treatment or Disposal: The wastes, other than recyclable or reclaimable product or metal, shall be taken to a treatment, storage, or disposal facility which has EPA or appropriate state permits and hazardous or special waste identification numbers and complies with the provisions of the disposal regulations. Documentation of acceptance of special waste by a facility legally permitted to treat or dispose of those materials shall be furnished to the Owner not later than 5 working days following the delivery of those materials to the facility; and a copy shall be included in the Tank Closure Report. A statement of agreement from the proposed treatment, storage or disposal facility and certified transporters to accept hazardous or special wastes shall be furnished to the Owner not less than 14 days before transporting any wastes. If the Contractor selects a different facility than is identified in the contract, documentation shall be provided for approval to certify that the facility is authorized and meets the standards specified in 40 CFR 264.

M. Spills: Immediate containment actions shall be taken as necessary to minimize effect of any spill or leak. Cleanup shall be in accordance with applicable Federal, State, local laws and regulations, and district policy at no additional cost to the Owner.

N. Tank Closure Report: Tank Closure Reports shall include the following information as a minimum:
1. A cover letter signed by a Professional Engineer registered in the State in which the Project is located certifying that all services involved have been performed in accordance with the terms and conditions of this specification.
2. A narrative report describing what was encountered at each site, including:
   a. condition of the UST.
   b. any visible evidence of leaks or stained soils.
   c. results of vapor monitoring readings.

d. actions taken including quantities of materials treated or removed.
e. reasons for selecting sample locations.
f. sample locations.
g. collection data such as time of collection and method of preservation.
h. reasons for backfilling site.
i. whether or not groundwater was encountered.

3. Copies of all analyses performed for disposal.
4. Copies of all waste analyses or waste profile sheets.
5. Copies of all certifications of final disposal signed by the responsible disposal installation official.
6. Information on who sampled, analyzed, transported, and accepted all wastes encountered, including copies of manifests, waste profile sheets, land disposal restriction, notification and certification forms, certificates of disposal, and other pertinent documentation.
7. Copies of all analyses performed for confirmation that underlying soil is not contaminated, with copies of chain-of-custody for each sample. Analyses shall give the identification number of the sample used. Sample identification numbers shall correspond to those provided on the one-line drawings.
8. Scaled one-line drawings showing tank locations, limits of excavation, limits of contamination, underground utilities within 15 m (50 feet) sample locations, and sample identification numbers.
9. Progress Photographs. The Contractor shall take a minimum of 4 views of the site showing such things as the location of each tank, entrance/exit road, and any other notable site condition before work begins. After work has been started at the site, the Contractor shall photographically record activities at each work location daily. Photographs shall be 76.2 x 127.0 mm (3 x 5 inches) and shall include:
    a. Soil removal, handling, and sampling.
    b. Unanticipated events such as discovery of additional contaminated areas.
    c. Soil stockpile area.
    d. Tank.
    e. Site or task-specific employee respiratory and personal protection.
    f. Fill placement and grading.
    g. Post-construction photographs. After completion of work at each site, the Contractor shall take a minimum of four (4) views of the site. Prints shall illustrate the condition and location of work and the state of progress. The photographs shall be mounted and enclosed back-to-back in a double face plastic sleeve punched to fit standard three ring binders. Each color print shall show an information box, 40 x 90 mm (1-1/2 x 3-1/2 inches). The information box for the 76.2 x 127.0 mm (3 x 5 inch) photographs shall be scaled down accordingly, or taped to the bottom of the photo. The box shall be typewritten and arranged as follows:
        Project No.
        Contract No.
        Location
        Contractor/Photographer
        Photograph No. Date/Time:
        Description
        Direction of View

END OF SECTION 02115b

SECTION 02115c - PRECISION TESTING OF UNDERGROUND FUEL OIL TANKS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing of labor and equipment for the precision testing of underground fuel oil tanks. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 PRODUCTS - (Not Used)

1.3 EXECUTION

A. The Contractor shall furnish all the necessary labor and equipment to complete the Precision Fuel Oil Tank Testing at various buildings under the jurisdiction of the Owner. The pertinent quantity and the capacity of the tanks will be listed on each Job Order. When the contractor elects to use a volumetric tank tester, he shall be responsible to fill up and "top off" tank to a maximum of 100 gallons prior to the start of testing. The cost to "top off" tank will be the contractor's responsibility.

B. The Contractor shall provide the material and labor necessary for the drilling and tapping of the existing oil tank manhole cover and the installation of new air bleeder valves. The air bleeder valve shall be a Hoffman Specialty #40 or #41 or their approved equal.

C. Coordination of Work: Prior to performing any test, the contractor shall notify the Owner of the scheduled test date. Designated personnel from the Owner shall take necessary actions to coordinate fuel oil delivery and shall inform the contractor of the date and time of the fuel delivery. The contractor shall ascertain that the tanks are filled to capacity and shall be responsible to have the tanks "topped off" up to a maximum of 100 gallons prior to the start of testing. The contractor shall make arrangements to perform the testing within forty-eight (48) hours of notification that the oil tank has been filled. The Contractors responsibility to "top off" tank only applies when the contractor elects to utilize a volumetric tank tester.

D. Test Equipment: The Contractor shall be limited to using state approved Precision Testing methods equal to the following:

Ainlay Tank Tegrity Tester
Horner EZY 3
Hunter Leak Lokator
Tank Auditor
Petro Tite

E. Test Results: The Contractor will be required to submit written reports of test results as noted below.
1. The test reports' format shall be approved by the testing equipment manufacturer and the state.
2. The Contractor shall submit one (1) type written report within seven (7) days of completion of the testing to the Owner.
3. The Contractor shall submit one copy of the report to the state within thirty (30) days of completion of the testing. Proof of submission shall be appended to the request for payment.
4. The test results shall include, but not be limited to:
   a. Name and/or Number of Building
   b. Address of Building

c. Date and Time of Test
d. Results of test including (Actual Data Calculations Graphs)
e. Test Method
f. Name and address of Contractor
g. Signature of test technician

5. Should the test indicate a leakage condition, the contractor shall perform the following:
   a. Initiate procedure to isolate piping from tank and determine the source of the leak. This work shall be performed after notification of the Owner.
   b. Submit a written proposal and cost estimate for work required to be performed to repair leak. Recommended proposal shall be submitted to the Owner within 48-hours after determining source of leak. No repair work shall proceed without authorization by the Owner.
   c. Notify the state of leak discovered in underground buried tank. This notification shall take place within 2 hours of determining source of leak.
   d. In these cases, the Owner may direct the Contractor to complete the work or exercise its option to perform the required work by its own forces or under separate contract.
6. After completion of the remedial work when applicable, the contractor shall perform a re-test, and shall issue a final test report in aforementioned format. The contractor shall be paid 50% of the bid unit price for the re-test.

END OF SECTION 02115c

SECTION 02115d - HYDROSTATIC PRESSURE TESTING OF AIR RECEIVING TANKS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing of labor and equipment for the hydrostatic pressure testing of air receiving tanks. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 PRODUCTS - (Not Used)

1.3 EXECUTION

A. General
1. Disconnect all piping and remove safety valve from air receiving tank and temporarily plug all openings on the disconnected tank.
2. Perform hydrostatic test at not less than twice the charging pressure, at 70 degrees Fahrenheit, for fifteen (15) minutes in accordance with the Administrative Code of the applicable Authority.
3. Test shall be performed in the presence of a representative of the Inspection Unit. Contractor shall notify the Owner‘s Inspection Unit seventy-two (72) hours prior to test.
4. At the completion of each test, contractor shall reconnect all piping and reinstall all removed equipment.
5. The Contractor shall issue an affidavit of test to the Owner. The affidavit shall state the date of test, testing pressure and the maximum working pressure allowable until the next test.
6. Furnish and install a glass enclosed aluminum frame of suitable size to display affidavit. Frame shall be open at the top for easy access to affidavit. Frame shall be firmly affixed in a permanent location adjacent to receiver tank as directed by the Owner.

B. Intent: Pursuant to the provisions of the Administrative Code of applicable Authority, and in the interest of public safety, the Owner requires that:
1. All compressed air tanks shall be tested by a person who has received a Certificate of Fitness from the Owner to conduct such a test in the manner and to the pressure set forth in the code before being continued in use.
2. Licensed testers shall submit ten (10) day notice of appointments to the Owner.
3. A sworn statement by the person conducting the test, in proper affidavit form, attesting to the completion of such test, shall be filed with the Owner‘s office and a copy thereof posted on the premises.
4. The submission of such an affidavit or posting a copy thereof, where the required test has not been carried out in accordance with the foregoing provisions of law, shall be cause for the revocation of the Certificate of Fitness, denial of the required permits to maintain and operate equipment and may also subject the individual to criminal liability for filing a false affidavit and a fine of up to five hundred dollars, imprisonment of up to six months, or both.

END OF SECTION 02115d

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Task	Specification	Specification Description
02119	01352	No Specification Required
02201	01352	No Specification Required

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SECTION 02203 - EARTHWORK

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for earthwork. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Preparing subgrades for slabs-on-grade, walks, pavements, turf and grasses, and plants.
   b. Excavating and backfilling for buildings and structures.
   c. Drainage course for concrete slabs-on-grade.
   d. Subbase course for concrete walks and pavements.
   e. Subbase course and base course for asphalt paving.
   f. Subsurface drainage backfill for walls and trenches.
   g. Excavating and backfilling trenches for utilities and pits for buried utility structures.
   h. Excavating well hole to accommodate elevator-cylinder assembly.

C. Definitions
1. Backfill: Soil material or controlled low-strength material used to fill an excavation.
   a. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
   b. Final Backfill: Backfill placed over initial backfill to fill a trench.
2. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.
3. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.
4. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
5. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.
6. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
   a. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by the Owner. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
   b. Bulk Excavation: Excavation more than 10 feet (3 m) in width and more than 30 feet (9 m) in length.
   c. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by the Owner. Unauthorized excavation, as well as remedial work directed by the Owner, shall be without additional compensation.
7. Fill: Soil materials used to raise existing grades.
8. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. (0.76 cu. m) for bulk excavation or 3/4 cu. yd. (0.57 cu. m) for footing, trench, and pit excavation that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:
   a. Excavation of Footings, Trenches, and Pits: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch- (1065-mm-) wide, maximum, short-tip-radius rock bucket; rated at not less than 138-hp (103-kW) flywheel power with bucket-curling force of not less than 28,700 lbf (128 kN) and stick-crowd force of not less than 18,400 lbf (82 kN) with extra-long reach boom; measured according to SAE J-1179.

b. Bulk Excavation: Late-model, track-mounted loader; rated at not less than 230-hp (172-kW) flywheel power and developing a minimum of 47,992-lbf (213.3-kN) breakout force with a general-purpose bare bucket; measured according to SAE J-732.

9. If Standard Penetration Values are used to Define Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd. (0.57 cu. m) or more in volume that exceed a standard penetration resistance of 100 blows/2 inches (97 blows/50 mm) when tested by a geotechnical testing agency, according to ASTM D 1586.
10. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
11. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.
12. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.
13. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

D. Submittals
1. Product Data: For each type of the following manufactured products required:
   a. Geotextiles.
   b. Controlled low-strength material, including design mixture.
   c. Geofoam.
   d. Warning tapes.
2. Samples: For the following products, in sizes indicated below:
   a. Geotextile: 12 by 12 inches (300 by 300 mm).
   b. Warning Tape: 12 inches (300 mm) long; of each color.
3. Qualification Data: For qualified testing agency.
4. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:
   a. Classification according to ASTM D 2487.
   b. Laboratory compaction curve according to ASTM D 698 **OR** ASTM D 1557, **as directed**.
5. Blasting plan approved by authorities having jurisdiction.
6. Seismic survey report from seismic survey agency.
7. Pre-excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by earth moving operations. Submit before earth moving begins.

E. Quality Assurance
1. Blasting:
   a. Blasting will not be allowed.
      OR
      Comply with applicable requirements in NFPA 495, "Explosive Materials Code," and prepare a blasting plan reporting the following:
      1) Types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.
      2) Seismographic monitoring during blasting operations.
2. Seismic Survey Agency: An independent testing agency, acceptable to authorities having jurisdiction, experienced in seismic surveys and blasting procedures to perform the following services:
   a. Report types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.

b. Seismographic monitoring during blasting operations.

3. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.
4. Pre-excavation Conference: Conduct conference at Project site.

F. Project Conditions

1. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.
   a. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
   b. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
2. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.
3. Do not proceed with work on adjoining property until directed by the Owner.
4. Utility Locator Service: Notify utility locator service **OR** Miss Utility" **OR** "Call Before You Dig" **OR** "Dig Safe System" **OR** "One Call", **as directed**, for area where Project is located before beginning earth moving operations.
5. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures, specified in Division 01 Section(s) "Temporary Facilities And Controls" OR Division 02 Section(s) "Site Clearing", **as directed**, are in place.
6. Do not commence earth moving operations until plant-protection measures specified in Division 02 Section "Tree Protection And Trimming" are in place.
7. The following practices are prohibited within protection zones:
   a. Storage of construction materials, debris, or excavated material.
   b. Parking vehicles or equipment.
   c. Foot traffic.
   d. Erection of sheds or structures.
   e. Impoundment of water.
   f. Excavation or other digging unless otherwise indicated.
   g. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
8. Do not direct vehicle or equipment exhaust towards protection zones.
9. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

1.2 PRODUCTS

A. Soil Materials

1. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
2. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D 2487 **OR** Groups A-1, A-2-4, A-2-5, and A-3 according to AASHTO M 145, **as directed**, or a combination of these groups; free of rock or gravel larger than 3 inches (75 mm) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
3. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487 **OR** Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7 according to AASHTO M 145, **as directed**, or a combination of these groups.
   a. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
4. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.
5. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

6. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.
7. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.
8. Drainage Course: Narrowly graded mixture of washed, **as directed**, crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch (37.5-mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.
9. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch (25-mm) sieve and 0 to 5 percent passing a No. 4 (4.75-mm) sieve.
10. Sand: ASTM C 33; fine aggregate.
11. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

B. Geotextiles
1. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
   a. Survivability: Class 2; AASHTO M 288.
   b. Apparent Opening Size: No. 40 (0.425-mm) **OR** No. 60 (0.250-mm) **OR** No. 70 (0.212-mm), **as directed**, sieve, maximum; ASTM D 4751.
   c. Permittivity: 0.5 **OR** 0.2 **OR** 0.1, **as directed**, per second, minimum; ASTM D 4491.
   d. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.
2. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
   a. Survivability: Class 2; AASHTO M 288.
   b. Apparent Opening Size: No. 60 (0.250-mm) sieve, maximum; ASTM D 4751.
   c. Permittivity: 0.02 per second, minimum; ASTM D 4491.
   d. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

C. Controlled Low-Strength Material
1. Controlled Low-Strength Material: Self-compacting, low-density, **as directed**, flowable concrete material produced from the following:
   a. Portland Cement: ASTM C 150, Type I **OR** Type II **OR** Type III, **as directed**.
   b. Fly Ash: ASTM C 618, Class C or F.
   c. Normal-Weight Aggregate: ASTM C 33, 3/4-inch (19-mm) **OR** 3/8-inch (10-mm), **as directed**, nominal maximum aggregate size.
   d. Foaming Agent (if low-density, controlled low-strength material is required): ASTM C 869.
   e. Water: ASTM C 94/C 94M.
   f. Air-Entraining Admixture (not required for low-density, controlled low-strength material using foaming agent): ASTM C 260.
2. Produce low-density, controlled low-strength material with the following physical properties:
   a. As-Cast Unit Weight: 30 to 36 lb/cu. ft. (480 to 576 kg/cu. m) **OR** 36 to 42 lb/cu. ft. (576 to 675 kg/cu. m), **as directed**, at point of placement, when tested according to ASTM C 138/C 138M.
   b. Compressive Strength: 80 psi (550 kPa) **OR** 140 psi (965 kPa), **as directed**, when tested according to ASTM C 495.

   OR

   Produce conventional-weight, controlled low-strength material with 80-psi (550-kPa) **OR** 140-psi (965-kPa), **as directed**, compressive strength when tested according to ASTM C 495.

D. Geofoam

1. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.55-lb/cu. ft. (25-kg/cu. m) density, 25-psi (173-kPa) compressive strength **OR** Type X, 1.30-lb/cu. ft. (21-kg/cu. m) density, 15-psi (104-kPa) compressive strength **OR** Type VI, 1.80-lb/cu. ft. (29-kg/cu. m) density, 40-psi (276-kPa) compressive strength **OR** Type VII, 2.20-lb/cu. ft. (35-kg/cu. m) density, 60-psi (414-kPa) compressive strength **OR** Type V, 3.00-lb/cu. ft. (48-kg/cu. m) density, 100-psi (690-kPa) compressive strength, **as directed**.
2. Molded-Polystyrene Board Insulation: ASTM C 578, Type I, 0.90-lb/cu. ft. (15-kg/cu. m) density, 10-psi (69-kPa) compressive strength **OR** Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) density, 13-psi (90-kPa) compressive strength **OR** Type II, 1.35-lb/cu. ft. (22-kg/cu. m) density, 15-psi (104-kPa) compressive strength, **as directed**.
    a. Manufacture molded polystyrene with an inorganic mineral registered with the EPA and suitable for application as a termite deterrent.
3. Rigid Cellular Polystyrene Geofoam: ASTM D 6817, Type EPS 19, 1.15-lb/cu. ft. (18.4-kg/cu. m) density, 5.8-psi (40-kPa) compressive strength at 1 percent deformation; 16-psi (110-kPa) compressive strength at 10 percent deformation **OR** Type EPS 39, 2.40-lb/cu. ft. (38.4-kg/cu. m) density, 15-psi (103-kPa) compressive strength at 1 percent deformation; 40-psi (276-kPa) compressive strength at 10 percent deformation, **as directed**.
4. Connectors: Geofoam manufacturer's multibarbed, galvanized-steel sheet connectors **OR** Deformed steel reinforcing bars, 3/4 inch (19 mm) in diameter, **as directed**.

E. Accessories
1. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility; colored as follows:
    a. Red: Electric.
    b. Yellow: Gas, oil, steam, and dangerous materials.
    c. Orange: Telephone and other communications.
    d. Blue: Water systems.
    e. Green: Sewer systems.

    OR

    Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored as follows:
    f. Red: Electric.
    g. Yellow: Gas, oil, steam, and dangerous materials.
    h. Orange: Telephone and other communications.
    i. Blue: Water systems.
    j. Green: Sewer systems.

1.3 EXECUTION

A. Preparation
1. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.
2. Protect and maintain erosion and sedimentation controls during earth moving operations.
3. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

B. Dewatering
1. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

2. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
   a. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

C. Explosives
1. Explosives: Do not use explosives.
   OR
   Explosives: Obtain written permission from authorities having jurisdiction before bringing explosives to Project site or using explosives on Project site.
   a. Perform blasting without damaging adjacent structures, property, or site improvements.
   b. Perform blasting without weakening the bearing capacity of rock subgrade and with the least-practicable disturbance to rock to remain.

D. Excavation, General
1. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
   a. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
   b. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:
      1) 24 inches (600 mm) outside of concrete forms other than at footings.
      2) 12 inches (300 mm) outside of concrete forms at footings.
      3) 6 inches (150 mm) outside of minimum required dimensions of concrete cast against grade.
      4) Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
      5) 6 inches (150 mm) beneath bottom of concrete slabs-on-grade.
      6) 6 inches (150 mm) beneath pipe in trenches, and the greater of 24 inches (600 mm) wider than pipe or 42 inches (1065 mm) wide.
2. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by the Owner. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation.
   a. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.
      1) Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.
   b. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:
      1) 24 inches (600 mm) outside of concrete forms other than at footings.
      2) 12 inches (300 mm) outside of concrete forms at footings.
      3) 6 inches (150 mm) outside of minimum required dimensions of concrete cast against grade.
      4) Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
      5) 6 inches (150 mm) beneath bottom of concrete slabs-on-grade.
      6) 6 inches (150 mm) beneath pipe in trenches, and the greater of 24 inches (600 mm) wider than pipe or 42 inches (1065 mm) wide.

E. Excavation For Structures
1. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch (25 mm). If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
   a. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
   b. Pile Foundations: Stop excavations 6 to 12 inches (150 to 300 mm) above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.
   c. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch (25 mm). Do not disturb bottom of excavations intended as bearing surfaces.
2. Excavations at Edges of Tree- and Plant-Protection Zones:
   a. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
   b. Cut and protect roots according to requirements in Division 02 Section "Tree Protection And Trimming".

F. Excavation For Walks And Pavements
1. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

G. Excavation For Utility Trenches
1. Excavate trenches to indicated gradients, lines, depths, and elevations.
   a. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
2. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit unless otherwise indicated.
   a. Clearance: 12 inches (300 mm) each side of pipe or conduit **OR** As indicated, **as directed**.
3. Trench Bottoms (if a bedding course is not required under pipe and conduit): Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
   a. For pipes and conduit less than 6 inches (150 mm) in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
   b. For pipes and conduit 6 inches (150 mm) or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
   c. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
   d. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
4. Trench Bottoms (if a bedding course is required under pipe and conduit): Excavate trenches 4 inches (100 mm) deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.
   a. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
5. Trenches in Tree- and Plant-Protection Zones:
   a. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

b. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
c. Cut and protect roots according to requirements in Division 02 Section "Tree Protection And Trimming".

H. Excavation For Elevator Cylinder
1. Drill well hole plumb in elevator pit to accommodate installation of elevator-cylinder assembly. Coordinate with applicable requirements for diameter and tolerances in Division 14 Section(s) "Hydraulic Elevators" OR "Hydraulic Freight Elevators", **as directed**.
2. Provide well casing as necessary to retain walls of well hole.

I. Subgrade Inspection
1. Notify the Owner when excavations have reached required subgrade.
2. If the Owner determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
3. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes) to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
a. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph (5 km/h).
b. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by the Owner, and replace with compacted backfill or fill as directed.
4. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
5. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by the Owner, without additional compensation.

J. Unauthorized Excavation
1. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi (17.2 MPa), may be used when approved by the Owner.
a. Fill unauthorized excavations under other construction, pipe, or conduit as directed by the Owner.

K. Storage Of Soil Materials
1. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
a. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

L. Backfill
1. Place and compact backfill in excavations promptly, but not before completing the following:
a. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
b. Surveying locations of underground utilities for Record Documents.
c. Testing and inspecting underground utilities.
d. Removing concrete formwork.
e. Removing trash and debris.
f. Removing temporary shoring and bracing, and sheeting.
g. Installing permanent or temporary horizontal bracing on horizontally supported walls.
2. Place backfill on subgrades free of mud, frost, snow, or ice.

M. Utility Trench Backfill
1. Place backfill on subgrades free of mud, frost, snow, or ice.

2. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
3. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches (450 mm) of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Division 03 Section "Cast-in-place Concrete".
4. Trenches under Roadways: Provide 4-inch- (100-mm-) thick, concrete-base slab support for piping or conduit less than 30 inches (750 mm) below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches (100 mm) of concrete before backfilling or placing roadway subbase course. Concrete is specified in Division 03 Section "Cast-in-place Concrete".
5. Backfill voids with satisfactory soil while removing shoring and bracing.
6. If soil material is required as initial backfill, place and compact initial backfill of subbase material **OR** satisfactory soil, **as directed**, free of particles larger than 1 inch (25 mm) in any dimension, to a height of 12 inches (300 mm) over the pipe or conduit.
    a. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
7. Controlled Low-Strength Material: If controlled low-strength material is permitted or required as initial backfill, place initial backfill of controlled low-strength material to a height of 12 inches (300 mm) over the pipe or conduit. Coordinate backfilling with utilities testing.
8. If satisfactory soil material is required as final backfill, place and compact final backfill of satisfactory soil to final subgrade elevation.
9. Controlled Low-Strength Material: If controlled low-strength material is permitted or required as final backfill, place final backfill of controlled low-strength material to final subgrade elevation.
10. Install warning tape directly above utilities, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

N. Soil Fill
1. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
2. Place and compact fill material in layers to required elevations as follows:
    a. Under grass and planted areas, use satisfactory soil material.
    b. Under walks and pavements, use satisfactory soil material.
    c. Under steps and ramps, use engineered fill.
    d. Under building slabs, use engineered fill.
    e. Under footings and foundations, use engineered fill.
3. Place soil fill on subgrades free of mud, frost, snow, or ice.

O. Geofoam Fill
1. Place a leveling course of sand, 2 inches (50 mm) thick, over subgrade. Finish leveling course to a tolerance of 1/2 inch (13 mm) when tested with a 10-foot (3-m) straightedge.
    a. Place leveling course on subgrades free of mud, frost, snow, or ice.
    b. Install geofoam blocks in layers with abutting edges and ends and with the long dimension of each block at right angles to blocks in each subsequent layer. Offset joints of blocks in successive layers.
    c. Install geofoam connectors at each layer of geofoam to resist horizontal displacement according to geofoam manufacturer's written instructions.
2. Cover geofoam with subdrainage **OR** separation, **as directed**, geotextile before placing overlying soil materials.

P. Soil Moisture Control
1. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
    a. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.

b. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

Q. Compaction Of Soil Backfills And Fills
1. Place backfill and fill soil materials in layers not more than 8 inches (200 mm) in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.
2. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
3. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698 **OR** ASTM D 1557, **as directed**:
   a. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches (300 mm) of existing subgrade and each layer of backfill or fill soil material at 95 percent.
   b. Under walkways, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill soil material at 92 percent.
   c. Under turf or unpaved areas, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill soil material at 85 percent.
   d. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

R. Grading
1. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
   a. Provide a smooth transition between adjacent existing grades and new grades.
   b. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
2. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
   a. Turf or Unpaved Areas: Plus or minus 1 inch (25 mm).
   b. Walks: Plus or minus 1 inch (25 mm).
   c. Pavements: Plus or minus 1/2 inch (13 mm).
3. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch (13 mm) when tested with a 10-foot (3-m) straightedge.

S. Subsurface Drainage
1. Subdrainage Pipe: Specified in Division 02 Section "Storm Drainage".
2. Subsurface Drain: If nonwoven geotextile is used in subsurface drainage applications, place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch (150-mm) course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches (300 mm) of filter material, placed in compacted layers 6 inches (150 mm) thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches (150 mm).
   a. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698 **OR** with a minimum of two passes of a plate-type vibratory compactor, **as directed**.
3. Drainage Backfill: If using free-draining granular backfill against walls, place and compact filter material over subsurface drain, in width indicated, to within 12 inches (300 mm) of final subgrade, in compacted layers 6 inches (150 mm) thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches (150 mm).
   a. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698 **OR** with a minimum of two passes of a plate-type vibratory compactor, **as directed**.

b. Place and compact impervious fill over drainage backfill in 6-inch- (150-mm-) thick compacted layers to final subgrade.

T. Subbase And Base Courses Under Pavements And Walks
1. Place subbase course and base course, **as directed**, on subgrades free of mud, frost, snow, or ice.
2. On prepared subgrade, place subbase course and base course, **as directed**, under pavements and walks as follows:
   a. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
   b. Place base course material over subbase course under hot-mix asphalt pavement.
   c. Shape subbase course and base course, **as directed**, to required crown elevations and cross-slope grades.
   d. Place subbase course and base course, **as directed**, 6 inches (150 mm) or less in compacted thickness in a single layer.
   e. Place subbase course and base course, **as directed**, that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.
   f. Compact subbase course and base course, **as directed**, at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698 **OR** ASTM D 1557, **as directed**.
3. Pavement Shoulders: Place shoulders along edges of subbase course and base course, **as directed**, to prevent lateral movement. Construct shoulders, at least 12 inches (300 mm) wide, of satisfactory soil materials and compact simultaneously with each subbase and base, **as directed**, layer to not less than 95 percent of maximum dry unit weight according to ASTM D 698 **OR** ASTM D 1557, **as directed**.

U. Drainage Course Under Concrete Slabs-On-Grade
1. Place drainage course on subgrades free of mud, frost, snow, or ice.
2. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
   a. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
   b. Place drainage course 6 inches (150 mm) or less in compacted thickness in a single layer.
   c. Place drainage course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.
   d. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

V. Field Quality Control
1. Special Inspections: If special inspections are required by code, engage a qualified special inspector to perform the following special inspections:
   a. Determine prior to placement of fill that site has been prepared in compliance with requirements.
   b. Determine that fill material and maximum lift thickness comply with requirements.
   c. Determine, at the required frequency, that in-place density of compacted fill complies with requirements.
2. Testing Agency: Engage a qualified geotechnical engineering testing agency to perform tests and inspections.
3. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
4. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing

subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by the Owner.

5. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
   a. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. (186 sq. m) or less of paved area or building slab, but in no case fewer than three tests.
   b. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet (30 m) or less of wall length, but no fewer than two tests.
   c. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet (46 m) or less of trench length, but no fewer than two tests.
6. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

W. Protection
1. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
2. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
   a. Scarify or remove and replace soil material to depth as directed by the Owner; reshape and recompact.
3. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
   a. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

X. Disposal Of Surplus And Waste Materials
1. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.
   OR
   Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by the Owner.
   a. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 02203

SECTION 02203a - EMBANKMENT

1.1 GENERAL

A. Description Of Work
1. This specification covers the reuse of suitable excavated material or furnishing material at the Contractor's expense to construct embankments where and as required by the Owner.

B. Submittals
1. Preconstruction Submittals
a. Construction equipment list.
b. Contractor shall record Existing Conditions prior to starting work in accordance with the paragraph entitled, "Existing Conditions," of this section.
c. Location of Utilities
d. Location of Tests
e. Location of Inspection
f. Location of Approved Utilities
g. A protection plan verifying the Existing Utilities left in place.
2. Test Reports for Soil Test within three working days of test date. Soil test shall comply with paragraph entitled, "Quality Control Testing During Construction."
3. Certificates of compliance for Proposed Soil Materials shall be submitted in accordance with paragraph entitled, "Tests for Proposed Soil Materials."

C. Definitions
1. Soil Materials
a. Cohesionless soil materials include gravels, gravel-sand mixtures, sands, and gravelly sands. Moisture-density relations of compacted cohesionless soils when plotted on graphs will show straight lines or reverse-shaped moisture-density curves.
b. Cohesive soil materials include clayey and silty gravels, sand-clay mixtures, gravel-silt mixtures, clayey and silty sands, sand-silt mixtures, clays, silts, and very fine sands. Moisture density relations of compacted cohesive soils when plotted on graphs will show normal moisture-density curves.
2. Subgrade shall mean the top surface of a backfill or fill or the uppermost surface of an excavation, graded to conform to the required subgrade elevation and compacted to densities indicated.
3. Degree of compaction required is expressed as a percentage of the maximum density obtained by the test procedure in AASHTO T 180, Method B or D.
4. Classified Excavation: Separate consideration will be given to the nature of the materials excavated, in accordance with the following designations and classifications.
a. Rock excavation shall include blasting, excavating, grading, and disposing of material classified as rock and shall include the satisfactory removal and disposition of boulders 1/2-cu yd (0.4 cu m) or more in volume; solid rock; rock material in ledges, bedded deposits, and unstratified masses which cannot be removed without systematic drilling and blasting; and conglomerate deposits that are so firmly cemented as to possess the characteristics of solid rock that is impossible to remove without systematic drilling and blasting. The removal of any concrete or masonry structures, except pavements, exceeding 1/2-cu yd (0.4 cu m) in volume that may be encountered in the work shall be included in this classification.
b. Common excavation shall include the satisfactory removal and disposition of materials not classified as rock excavation.
5. Unclassified Excavation: No consideration will be given to the nature of the materials, and all excavation will be designated as unclassified excavation.

D. Sampling And Testing

1. Soil Test and Inspection Service: Soil survey for satisfactory soil materials and samples of soil materials shall be furnished by the Contractor. A certified soil testing service approved by the Owner shall be provided by the Contractor. Testing shall include soil survey for satisfactory soil materials, sampling and testing soil materials proposed for use in the work, and field-testing facilities for quality control during construction period.
2. Tests for Proposed Soil Materials: Soil materials proposed for use in the work shall be tested. The materials shall be approved by the Owner prior to start of work as follows:

MATERIAL	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Satisfactory soil materials	Sampling	AASHTO T 2	One for each source of materials to determine conformance to definition of satisfactory soil materials; additional tests whenever there is any apparent change
	Preparation of samples	AASHTO T 87	
	Sieve analysis of fine and coarse aggregate	ASTM C 136	
	Mechanical analysis of soils	ASTM D 422	
	Liquid limit of Soils	ASTM D 4318	
	Plastic limit and plasticity index of soils	ASTM D 4318	
	Moisture-density relations of soil	AASHTO T 180, Method B or D	

3. Quality Control Testing During Construction: Soil Test on materials shall be performed during construction as follows:

MATERIAL	REQUIREMENT	TEST METHOD	MATERIAL TESTED AND NUMBER OF TESTS
Soil material-in-place after compaction	Density of soil-in-place	ASTM D 1556 Sand Cone Method or ASTM D 2922 Nuclear Method	At least three daily for each subgrade soil material, and for each layer of soil material; additional tests whenever there is any change in moisture

4. Field Testing Facilities at Subbase Mixing Plant: Field-testing facilities for the purpose of testing subbase course material at the mixing plant shall be provided by the Contractor's soil-testing service.
5. Reports: No soil material shall be used until soil test reports have been reviewed and approved.
6. Evaluation of Test Results
   a. Soil materials of any classification shall not have a moisture content at the time of compaction that would be classified as unsatisfactory soil materials in the paragraph entitled, "Definitions."
   b. Results of density of soil-in-place tests shall be considered satisfactory if the average of any group of four consecutive density tests which may be selected is in each instance equal to or greater than the specified density, and if no density test has a value more than 2 percentage points below the specified density.

E. Use Of Explosives:
1. Explosives shall not be used or brought to the project site without prior written approval. Such approval shall not be construed as relieving the Contractor of responsibility for injury to persons or for damage to property due to blasting operations. Blasting shall be performed by skilled personnel in accordance with governing authorities and as approved. Minimum safety requirements for blasting shall be in accordance with OSHA Regulations 29 CFR 1926, Subpart U.
   OR
   The use of explosives will not be permitted.

F. Protection Of Persons And Property
1. Excavations shall be barricaded and posted with warning signs for the safety of persons. Warning lights shall be provided during hours of darkness.
2. Structures, utilities, sidewalks, pavements, and other facilities immediately adjacent to excavations shall be protected against damage including settlement, lateral movement, undermining, and washout.
3. Topsoil removal operations shall be conducted to ensure safety of persons and to prevent damage to existing structures and utilities, construction in progress, trees and vegetation to remain standing, and other property.

G. Construction Equipment List: Construction Equipment List for all major equipment to be used in this section shall be submitted to the Owner prior to start of work.

H. Existing Conditions
1. Records of Existing Conditions shall be submitted by the Contractor prior to the start of work. The Contractor shall verify the existing conditions are correct as shown on the plans and described in the specifications. the Owner shall be notified immediately if any discrepancies are found.

2. Records of underground utilities, Location of Utilities, Location of Inspection, Location of Tests, and Location of Approved Utilities shall be submitted to the Owner prior to start of work.

1.2 PRODUCTS

A. Materials
1. Satisfactory Materials shall mean AASHTO M 145 (ASTM D 3282), Soil Classification Groups A-1, A-2-4, A-2-5, and A-3.
2. Unsatisfactory Materials shall mean AASHTO M 145, Soil Classification Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7, peat and other highly organic soils, and soil materials of any classification that have a moisture content, at the time of compaction, beyond the range of 1 percentage point below and 3 percentage points above the optimum moisture content of the soil material as determined by moisture-density relations test.
3. Topsoil shall be any soil removed from the project site which consists of clay or sandy loam. The topsoil shall be reasonably free from subsoil, clay lumps, brush, objectionable weeds, and other litter, and shall be free from stones, stumps, roots, and other objectionable material larger than 2 in. (50 mm) in any dimension.
4. Compost shall be yard trimmings or yard waste compost processed and graded according to state and local regulations.
5. Topsoil Blend: Where insufficient topsoil is removed from the project site for later reuse, the topsoil removed shall be stockpiled and blended with compost at the site to achieve the required volume.

1.3 EXECUTION

A. Blasting:
1. Where explosives are used in rock excavation, the charges shall be so proportioned and placed that they will not loosen the rock outside the excavation lines indicated, or as specified. Contractor shall remove, at no additional cost, any material outside the authorized cross section that may be shattered or loosened by blasting.
OR
Blasting is not required or permitted.

B. Conservation Of Topsoil: Topsoil shall be stripped to a depth of not less than 4 in. (100 mm); when stored it shall be kept separate from other excavated materials, free of roots, stones, and other undesirable materials. Where indicated, topsoil shall be removed without contamination with subsoil and spread on areas already graded and prepared for topsoil, or when so specified, topsoil shall be transported and deposited in stockpiles convenient to areas that are to receive application of the topsoil later or at locations indicated or specified by the Owner. Topsoil blend shall be used on all embankments when there is not enough topsoil available.

C. Excavation
1. Excavations specified shall be done on either a classified or unclassified basis as directed by the Owner.
2. Contractor shall perform excavation of every type of material encountered by cutting accurately to the cross sections to the lines, grades, and elevations indicated. Grading shall be in conformity with the typical sections indicated and the tolerances specified in paragraph entitled, "Finishing."
3. Satisfactory excavated materials shall be transported to and placed in fill or embankment areas within the limits of the work. Unsatisfactory materials encountered within the limits of the work shall be excavated below grade and replaced with satisfactory materials as directed. Surplus satisfactory excavated material not required for fill or embankment shall be disposed in areas approved for surplus materials storage or designated waste areas. Unsatisfactory excavated material shall be disposed in designated waste or spoil areas. During construction, excavation

and filling shall be performed in a manner and sequence that will provide proper drainage at all times. Material required for fill or embankment in excess of that produced by excavation within the grading limits shall be excavated from the borrow areas indicated or from other approved areas selected by the Owner.

4. Excavation of Ditches, Gutters, and Channels: Care shall be taken not to excavate ditches and gutters below grades shown. Excessive open-ditch or gutter excavation shall be backfilled with suitable materials to grades indicated at no additional cost. Materials excavated shall be disposed as indicated, except that in no case shall material be deposited less than 3 ft. (1 m) from the edge of a ditch. Contractor shall maintain excavations free from debris until final acceptance of the work.
5. Excavation for Drainage Structures
   a. Dimensions and elevations of footings and foundation excavations indicated are only approximate and may be changed if necessary to ensure adequate foundation support. Trenches and foundation pits shall be of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations. Rock or other hard foundation material shall be cleaned of loose debris and cut to a firm surface, either level, stepped, or serrated. Loose disintegrated rock and thin strata shall be removed. When concrete or masonry is to be placed in an excavated area, special care shall be taken not to disturb the bottom of the excavation. Excavation to the final grade level shall not be made until just before concrete or masonry is to be placed.
   b. Where pile foundations are to be used, the excavation of each pit shall be stopped at an elevation 1 ft. (300 mm) above the base of the footing, as specified, before piles are driven. After pile driving has been completed, loose and displaced material shall be removed and excavation completed, leaving a smooth, solid, undisturbed surface to receive concrete or masonry.
6. Protection or Removal of Utility Lines: Existing Utilities that are indicated to be retained, or the locations of which have been ascertained from Owner utility drawings, as well as utility lines encountered during excavation, shall be protected from damage during excavation and backfilling. However, reliance on the information obtained from Owner drawings does not absolve the Contractor of responsibility for damages, so careful hand methods shall be used to verify the location of underground utilities. Damage shall be reported immediately and satisfactorily repaired by the Contractor at no additional cost. The Contractor shall provide sketches of existing conditions if there are variances, as well as any modifications, on "as-built" drawings. When utility lines that are to be removed are encountered within the area of operations, the Contractor shall give notice in ample time for the necessary measures to be taken to prevent interruption of service.

D. Classification Of Excavation: Excavations specified shall be done on either a classified or unclassified basis as provided for under the item designations of the Contract.

E. Utilization Of Excavation Materials: Unsatisfactory materials removed from excavations shall be disposed in designated areas. Satisfactory material removed from excavations shall be used, insofar as practicable, in the construction of fills, embankments, subgrades, shoulders, bedding; as backfill; and for similar purposes. No satisfactory excavated material shall be wasted without specific written authorization. Satisfactory material authorized to be wasted shall be disposed in designated areas approved for surplus material storage or designated waste areas as directed. Coarse rock from excavations shall be stockpiled and used for constructing slopes of embankments adjacent to streams, for constructing slopes or sides and bottoms of channels, and for protecting against erosion. Hand placing of coarse rock from excavations will not be required. Excavated material shall not be disposed in a manner as to obstruct the flow of any stream, endanger a partly finished structure, impair the efficiency or appearance of any structure, or be detrimental to the completed work in any way.

F. Selection Of Borrow Material: Borrow material shall be selected to meet the requirements and conditions of the particular fill or embankment for which it is to be used. Borrow material shall be obtained from the borrow areas indicated on the plans or from other approved sources, either private or within the limits of the project site, selected by the Contractor. Unless otherwise provided in the

contract, the Contractor shall obtain from the Owners the right to procure material, pay all royalties and other charges involved, and bear all expense of developing the sources, including rights-of-way for hauling. Borrow material from approved sources on Owner-controlled land may be obtained without payment of royalties. Unless specifically provided, no borrow shall be obtained within the limits of the project site without prior written approval. Necessary clearing, grubbing, and satisfactory drainage of borrow pits and the disposal of debris shall be considered related operations to the borrow excavation and shall be performed by the Contractor at no additional cost to the Owner.

G. Opening And Drainage Of Excavation And Borrow Pits: The Contractor shall give notice sufficiently in advance of the opening of any excavation or borrow pit to permit elevations and measurements of the undisturbed ground surface to be taken. Unless otherwise permitted, borrow pits and other excavation areas shall be excavated in such manner as will afford adequate drainage. Overburden and other spoil material shall be transported to designated spoil areas or otherwise disposed as directed. Borrow pits shall be neatly trimmed and left in such shape as will facilitate accurate measurements after the excavation is completed.

H. Grading Areas: When so provided and indicated, work under contract will be divided into grading areas, within which satisfactory excavated material shall be placed in embankments, fills, and required backfills. Contractor shall not haul satisfactory material excavated in one grading area to another grading area, except when so directed in writing.

I. Preparation Of Ground Surface For Embankments
   1. Ground surface on which fill is to be placed shall be stripped of live, dead, or decayed vegetation, rubbish, debris, and other unsatisfactory material; shall be plowed, disked, or otherwise broken up; pulverized; moistened or aerated as necessary; mixed; and compacted to at least 90 percent maximum density for cohesive materials or 100 percent maximum density for cohesionless materials.
   2. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment. The prepared ground surface shall be scarified and moistened or aerated just prior to placement of embankment materials to ensure adequate bond between embankment material and the prepared ground surface.

J. Embankments
   1. Earth Embankments
      a. Earth embankments shall be constructed from satisfactory materials free of organic or frozen material and rocks with maximum dimensions not greater than 3 in. (75 mm). The material shall be placed in successive horizontal layers of loose material not more than 6 in. (150 mm) in depth. Each layer shall be spread uniformly on a prepared surface, i.e., a soil surface that has been moistened or aerated and scarified plowed, disked, or otherwise broken up in such a manner that the fill will bond with the surface on which it is placed, mixed, and compacted to at least 90 percent maximum density for borrow materials or 100 percent maximum density for excavated materials. Compaction requirements for the upper portion of earth embankments forming subgrade for pavements shall be identical to those requirements specified in paragraph entitled, "Subgrade Preparation."
      b. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment.
   2. Rock Embankments
      a. Rock embankments shall be constructed from material essentially classified as rock excavation, placed in successive horizontal layers of loose material not more than 8 to 10 in. (200 to 250 mm) in depth. Pieces of rock larger than 8 to 10 in. (200 to 250 mm) in greatest dimension shall not be used.
      b. Each layer of material shall be spread uniformly and shall be completely saturated and compacted to density as directed by the Owner.

c. Each layer of material shall be spread uniformly and shall be completely saturated and compacted until the interstices are filled with well-compacted materials and the entire layer is a dense, compacted mass.
d. Each successive layer of material shall adequately bond to the material on which it is placed.
e. Compaction shall be accomplished with vibratory compactors with a minimum static weight of 20,000 lbs. (90 kN), heavy rubber-tired rollers weighing not less than 25,000 lbs. (110 kN) or steel-wheeled rollers with a loaded weight of not less than 4,000 lb/ft (58,400 N/m) of drum length.
f. Rock shall not be used above a point 6 in. (150 mm) below the surface of an embankment that is to be paved.

K. Subgrade Preparation
1. Construction
a. Subgrade shall be shaped to line, grade, and cross section and compacted as specified. This operation shall include plowing, disking, and any moistening or aerating required to obtain proper compaction. Soft or otherwise unsatisfactory material shall be removed and replaced with satisfactory excavated material or other approved material as directed. Rock encountered in the cut sections shall be excavated to a depth of 6 in. (150 mm) below finished grade for the subgrade. Low areas resulting from removal of unsatisfactory material or excavation of rock shall be brought up to required grade with satisfactory materials, and the entire subgrade shall be shaped to line, grade, and cross section and compacted as specified.
b. After rolling, the surface of the subgrade for roadways and/or airfields shall indicate a deviation not greater than 3/8 in. (10 mm) when tested with a 10-ft (3.0 m) straightedge applied both parallel with, and at right angles to, the centerline of the area.
c. Elevation of the finished subgrade shall vary not more than 1/4-in. (6 mm) from the established grade and approved cross section.
2. Compaction: Compaction for pavements and shoulders shall be accomplished with approved equipment until the layer is compacted to the full depth to at least 95 percent maximum density.

L. Shoulder Construction: Shoulders shall be constructed of satisfactory excavated or borrow materials or as otherwise indicated on the plans. Shoulders shall be constructed as soon as possible after adjacent paving is complete, but in the case of rigid pavements, shoulders shall not be constructed until permission has been obtained. The entire shoulder area shall be compacted to at least the percentage of maximum density as specified for specific ranges of depth below the surface of the shoulder. Compaction shall be accomplished with approved equipment. Shoulder construction shall be done in proper sequence in such a manner that adjacent ditches will be drained effectively and no damage of any kind is done to the adjacent, completed pavement. The completed shoulders shall be true to alignment and grade and shaped to drain in conformity with the cross section indicated.

M. Finishing: Surface of excavations, embankments, and subgrades shall be finished to a reasonably smooth and compact surface substantially in accordance with the lines, grades, and cross sections or elevations indicated. Degree of finish for graded areas shall be within 1/10 ft (30 mm) of the grades and elevations indicated, except that the degree of finish for subgrades shall be as specified. Gutters and ditches shall be finished as indicated. Surface of areas to be turfed shall be finished to a smoothness suitable for the application of turfing materials.

N. Subgrade And Embankment Protection: During construction, embankments and excavations shall be kept shaped and drained. Ditches and drains along subgrade shall be maintained in such a manner as to drain effectively at all times. Finished subgrade shall not be disturbed by traffic or other operations and shall be protected and maintained by the Contractor in a satisfactory condition until ballast, subbase, base, or pavement is placed. Storage or stockpiling materials on finished subgrade will not be permitted. Subbase, base course, ballast, or pavement shall not be laid until the subgrade has been checked and approved, and in no case shall subbase, base, surfacing, pavement, or ballast be placed on a muddy, spongy, or frozen subgrade.

END OF SECTION 02203a

Task	Specification	Specification Description
02205	02203	Earthwork

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SECTION 02210 - EXCAVATION SUPPORT AND PROTECTION

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for excavation support and protection. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Performance Requirements
1. Design, **as directed**, furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed and construction loads.
   a. Delegated Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
   b. Prevent surface water from entering excavations by grading, dikes, or other means.
   c. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.
   d. Monitor vibrations, settlements, and movements.

C. Submittals
1. Shop Drawings: For excavation support and protection system.
2. Delegated-Design Submittal: For excavation support and protection system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Quality Assurance
1. Preinstallation Conference: Conduct conference at Project site.

E. Project Conditions
1. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:
   a. Notify the Owner no fewer than two days in advance of proposed interruption of utility.
   b. Do not proceed with interruption of utility without the Owner’s written permission.
2. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
   a. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify the Owner if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

1.2 PRODUCTS

A. Materials
1. General: Provide materials that are either new or in serviceable condition.
2. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.
3. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.

a. Corners: Site-fabricated mechanical interlock **OR** Roll-formed corner shape with continuous interlock, **as directed**.

4. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of size and strength required for application, **OR** 3 inches (75 mm) **OR** 4 inches (100 mm), **as directed**.
5. Shotcrete: Comply with Division 03 Section "Shotcrete" for shotcrete materials and mixes, reinforcement, and shotcrete application.
6. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.
7. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
8. Tiebacks: Steel bars, ASTM A 722/A 722M.
9. Tiebacks: Steel strand, ASTM A 416/A 416M.

1.3 EXECUTION

A. Preparation
1. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.
   a. Shore, support, and protect utilities encountered.
2. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
   a. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
3. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces are not impeded.
4. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.
5. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

B. Soldier Piles And Lagging
1. Install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches (50 mm) from a horizontal line and not more than 1:120 out of vertical alignment.
2. Install wood lagging within flanges of soldier piles as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.
3. Install wales horizontally at locations indicated on Drawings and secure to soldier piles.

C. Sheet Piling
1. Before starting excavation, install one-piece sheet piling lengths and tightly interlock to form a continuous barrier. Accurately place the piling, using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer. Limit vertical offset of adjacent sheet piling to 60 inches (1500 mm). Accurately align exposed faces of sheet piling to vary not more than 2 inches (50 mm) from a horizontal line and not more than 1:120 out of vertical alignment. Cut tops of sheet piling to uniform elevation at top of excavation.

D. Tiebacks
1. Tiebacks: Drill, install, grout, and tension tiebacks. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.
   a. Test loading shall be observed by a qualified professional engineer responsible for design of excavation support and protection system.

b. Maintain tiebacks in place until permanent construction is able to withstand lateral soil and hydrostatic pressures.

E. Bracing
1. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.
   a. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by the Owner.
   b. Install internal bracing, if required, to prevent spreading or distortion of braced frames.
   c. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

F. Removal And Repairs
1. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.
   a. Remove excavation support and protection systems to a minimum depth of 48 inches (1200 mm) below overlaying construction and abandon remainder.
   b. Fill voids immediately with approved backfill compacted to density specified in Division 02 Section "Earthwork".
   c. Repair or replace, as approved by the Owner, adjacent work damaged or displaced by removing excavation support and protection systems.
2. Leave excavation support and protection systems permanently in place.

END OF SECTION 02210

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Task	Specification	Specification Description
02210	02203	Earthwork

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SECTION 02212 - LEVEE CLOSURE

1.1 GENERAL

A. Description Of Work
   1. This specification covers the furnishing of labor and materials for providing levee closures.

1.2 PRODUCTS - (Not Used)

1.3 EXECUTION

A. If there is deemed, by the Owner, to be considerable risk of flooding involved with removing drainage structures and gates in the existing Levee System, the Contractor shall perform the work of this contract as follows:
   1. Only one drainage structure/flap gate will be allowed to be disrupted at one time. All proposed work at each drainage structure shall be completed before proceeding to the next structure.
   2. The Contractor shall have all materials required for each structure installation secured on site, before beginning construction on that structure.
   3. The Contractor shall have all necessary materials on site to temporarily plug existing and/or proposed piping through the levee.
   4. Weather and river flow conditions shall be monitored at all times by the Contractor while each drainage structure is open to flow. The Contractor shall construct an adequate closure in a timely fashion to plug the drainage structure preventing flow through the levee.

END OF SECTION 02212

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Task	Specification	Specification Description
02212	02203	Earthwork
02212	02203a	Embankment

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SECTION 02213 - SUBDRAINAGE

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for subdrainage. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes subdrainage systems for the following:
   a. Foundations.
   b. Underslab areas.
   c. Plaza decks.
   d. Retaining walls.
   e. Landscaped areas.

C. Definitions
1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. HDPE: High-density polyethylene plastic.
3. PE: Polyethylene plastic.
4. PP: Polypropylene plastic.
5. PS: Polystyrene plastic.
6. PVC: Polyvinyl chloride plastic.
7. Subdrainage: Drainage system that collects and removes subsurface or seepage water.

D. Submittals
1. Product Data: For each type of drainage panel indicated.

1.2 PRODUCTS

A. Piping Materials
1. Refer to the "Piping Applications" Article in Part 1.3 for applications of pipe, fitting, and joining materials.

B. Perforated-Wall Pipes And Fittings
1. Perforated PE Pipe and Fittings:
   a. NPS 6 (DN 150) and Smaller: ASTM F 405 or AASHTO M 252, Type CP; corrugated, for coupled joints.
   b. NPS 8 (DN 200) and Larger: ASTM F 667; AASHTO M 252, Type CP; or AASHTO M 294, Type CP; corrugated; for coupled joints.
   c. Couplings: Manufacturer's standard, band type.
2. Perforated PVC Sewer Pipe and Fittings: ASTM D 2729, bell-and-spigot ends, for loose joints.
3. Perforated Clay Pipe and Fittings: ASTM C 700, Standard- and Extra-Strength classes, unglazed, socket-and-spigot ends, for gasketed joints.
   a. Gaskets: ASTM C 425, rubber.
4. Perforated Concrete Pipe and Fittings: ASTM C 444 (ASTM C 444M), Type 1, and applicable requirements in ASTM C 14 (ASTM C 14M), Class 2, socket-and-spigot ends for gasketed joints.
   a. Gaskets: ASTM C 443 (ASTM C 443M), rubber.

C. Solid-Wall Pipes And Fittings
1. ABS Sewer Pipe and Fittings: ASTM D 2751.

a. Solvent Cement: ASTM D 2235.
b. Gaskets: ASTM F 477, elastomeric seal.

2. Cast-Iron Soil Pipe and Fittings: ASTM A 74, Service and Extra-Heavy classes, hub-and-spigot ends, gray, for gasketed joints.
   a. Gaskets: ASTM C 564, rubber, of thickness matching class of pipe.
3. PE Drainage Tubing and Fittings: AASHTO M 252, Type S, corrugated, with smooth waterway, for coupled joints.
   a. Couplings: AASHTO M 252, corrugated, band type, matching tubing and fittings.
4. PE Pipe and Fittings: AASHTO M 294, Type S, corrugated, with smooth waterway, for coupled joints.
   a. Couplings: AASHTO M 294, corrugated, band type, matching tubing and fittings.
5. PVC Sewer Pipe and Fittings: ASTM D 3034, SDR 35, bell-and-spigot ends, for gasketed joints.
   a. Gaskets: ASTM F 477, elastomeric seal.

D. Special Pipe Couplings
1. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant metal tension band and tightening mechanism on each end.
   a. Sleeve Materials:
      1) For Concrete Pipes: ASTM C 443 (ASTM C 443M), rubber.
      2) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
      3) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
      4) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
   b. Unshielded Flexible Couplings: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant metal tension band and tightening mechanism on each end.
   c. Shielded Flexible Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant metal tension band and tightening mechanism on each end.

E. Cleanouts
1. Cast-Iron Cleanouts: ASME A112.36.2M; with round-flanged, cast-iron housing; and secured, scoriated, Medium-Duty Loading class, cast-iron cover. Include cast-iron ferrule and countersunk, brass cleanout plug.
2. Copper-Alloy Cleanouts: ASME A112.36.2M; with round-flanged, cast-iron housing with clamping device; and scoriated, Light-Duty **OR** Medium-Duty, **as directed,** Loading class, copper-alloy cover. Include countersunk, brass cleanout plug.
3. PVC Cleanouts: ASTM D 3034, PVC cleanout threaded plug and threaded pipe hub.

F. Drainage Conduits
1. Molded-Sheet Drainage Conduits: Prefabricated geocomposite with cuspated, molded-plastic drainage core wrapped in geotextile filter fabric.
   a. Nominal Size: 12 inches (305 mm) high by approximately 1 inch (25 mm) thick.
      1) Minimum In-Plane Flow: 30 gpm (114 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
   b. Nominal Size: 18 inches (457 mm) high by approximately 1 inch (25 mm) thick.
      1) Minimum In-Plane Flow: 45 gpm (170 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
   c. Filter Fabric: PP geotextile.
   d. Fittings: HDPE with combination NPS 4 and NPS 6 (DN 100 and DN 150) outlet connection.
2. Multipipe Drainage Conduits: Prefabricated geocomposite with interconnected, corrugated, perforated-pipe core molded from HDPE complying with ASTM D 1248 and wrapped in geotextile filter fabric.
   a. Nominal Size: 6 inches (152 mm) high by approximately 1-1/4 inches (31 mm) thick.

1) Minimum In-Plane Flow: 15 gpm (57 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.

b. Nominal Size: 12 inches (305 mm) high by approximately 1-1/4 inches (31 mm) thick.
1) Minimum In-Plane Flow: 30 gpm (114 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.

c. Nominal Size: 18 inches (457 mm) high by approximately 1-1/4 inches (31 mm) thick.
1) Minimum In-Plane Flow: 45 gpm (170 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.

d. Filter Fabric: Nonwoven, needle-punched geotextile.

e. Fittings: HDPE with combination NPS 4 and NPS 6 (DN 100 and DN 150) outlet connection.

f. Couplings: HDPE.

3. Single-Pipe Drainage Conduits: Prefabricated geocomposite with perforated corrugated core molded from HDPE complying with ASTM D 3350 and wrapped in geotextile filter fabric.
a. Nominal Size: 12 inches (305 mm) high by approximately 1 inch (25 mm) thick.
1) Minimum In-Plane Flow: 30 gpm (114 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.

b. Nominal Size: 18 inches (457 mm) high by approximately 1 inch (25 mm) thick.
1) Minimum In-Plane Flow: 45 gpm (170 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.

c. Filter Fabric: Nonwoven, PP geotextile.

d. Fittings: HDPE with combination NPS 4 and NPS 6 (DN 100 and DN 150) outlet connection.

e. Couplings: Corrugated HDPE band.

4. Mesh Fabric Drainage Conduits: Prefabricated geocomposite with plastic-filament drainage core wrapped in geotextile filter fabric. Include fittings for bends and connection to drainage piping.
a. Nominal Size: 6 inches (2-mm) high by approximately 0.9 inch (23 mm) thick.
1) Minimum In-Plane Flow: 2.4 gpm (9.1 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.

b. Filter Fabric: Nonwoven geotextile made of PP or polyester fibers or combination of both. Flow rates range from 120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m) when tested according to ASTM D 4491.

5. Ring Fabric Drainage Conduits: Drainage conduit with HDPE-rings-in-grid-pattern drainage core, for field-applied geotextile filter fabric. Include fittings for bends and connection to drainage piping.
a. Nominal Size: 0.5 m high by 1 inch (25 mm) thick.
1) Minimum In-Plane Flow: 82 gpm (310 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.

b. Nominal Size: 1 m high by 1 inch (25 mm) thick.
1) Minimum In-Plane Flow: 164 gpm (621 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.

c. Filter Fabric: Specified in Part 1.2 "Geotextile Filter Fabrics" Article.

G. Drainage Panels
1. Molded-Sheet Drainage Panels: Prefabricated geocomposite, 36 to 60 inches (915 to 1525 mm) wide with drainage core faced with geotextile filter fabric.
a. Drainage Core: Three-dimensional, nonbiodegradable, molded PP or PS.
1) Minimum Compressive Strength: 10,000 lbf/sq. ft. (479 kPa) **OR** 15,000 lbf/sq. ft. (718 kPa) **OR** 18,000 lbf/sq. ft. (862 kPa) **OR** 21,000 lbf/sq. ft. (1005 kPa), **as directed**, when tested according to ASTM D 1621.
2) Minimum In-Plane Flow Rate: 2.8 gpm/ft. (35 L/min. per m) **OR** 7 gpm/ft. (87 L/min. per m) **OR** 15 gpm/ft. (188 L/min. per m), **as directed,** of unit width at hydraulic gradient of 1.0 and compressive stress of 25 psig (172 kPa) when tested according to ASTM D 4716.

b. Filter Fabric: Nonwoven needle-punched geotextile, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with the following properties determined according to AASHTO M 288:
   1) Survivability: Class 1 **OR** 2 **OR** 3, **as directed**.
   2) Apparent Opening Size: No. 40 (0.425-mm) **OR** No. 60 (0.25-mm) **OR** No. 70 (0.212-mm), **as directed,** sieve, maximum.
   3) Permittivity: 0.5 **OR** 0.2 **OR** 0.1, **as directed,** per second, minimum.

c. Filter Fabric: Woven geotextile fabric, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation less than 50 percent; complying with the following properties determined according to AASHTO M 288:
   1) Survivability: Class 1 **OR** 2 **OR** 3, **as directed**.
   2) Apparent Opening Size: No. 40 (0.425-mm) **OR** No. 60 (0.25-mm) **OR** No. 70 (0.212-mm) **OR** No. 30 (0.6-mm), **as directed,** sieve, maximum.
   3) Permittivity: 0.5 **OR** 0.2 **OR** 0.1 **OR** 0.02, **as directed,** per second, minimum.

2. Mesh Fabric Drainage Panels: Prefabricated geocomposite with drainage core faced with geotextile filter fabric.
   a. Drainage Core: Open-construction, resilient, approximately 0.4-inch- (10.2-mm-) thick, plastic-filament mesh.
      1) Minimum In-Plane Flow Rate: 2.4 gpm/ft. (30 L/min. per m) of unit width at hydraulic gradient of 1.0 and normal pressure of 25 psig (172 kPa) when tested according to ASTM D 4716.
   b. Filter Fabric: Nonwoven geotextile of PP or polyester fibers or combination of both. Flow rates range from 120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m) when tested according to ASTM D 4491.
3. Net Fabric Drainage Panels: Prefabricated geocomposite with drainage core faced with geotextile filter fabric.
   a. Drainage Core: 3-dimensional, PE nonwoven-strand geonet, approximately 0.25-inch- (6-mm-) thick.
      1) Minimum In-Plane Flow Rate: 2.4 gpm/ft. (30 L/min. per m) **OR** 5 gpm/ft. (62 L/min. per m), **as directed,** of unit width at hydraulic gradient of 1.0 and normal pressure of 25 psig (172 kPa) when tested according to ASTM D 4716.
   b. Filter Fabric: Nonwoven geotextile of PP or polyester fibers or combination of both. Flow rates range from 120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m) when tested according to ASTM D 4491.
4. Ring Fabric Drainage Panels: Drainage-core panel for field application of geotextile filter fabric.
   a. Drainage Core: 3-dimensional, HDPE rings in grid pattern, approximately 0.1 inch (25 mm) thick.
      1) Minimum In-Plane Flow Rate: 50 gpm/ft. (625 L/min. per m) of unit width at hydraulic gradient of 1.0 and normal pressure of 25 psig (172 kPa) when tested according to ASTM D 4716.
5. Fabric-Covered Insulated Drainage Panels: Extruded PS board insulation complying with ASTM C 578; fabricated with shiplap **OR** tongue-and-groove, **as directed**, edges and with one side having grooved drainage channels; unfaced **OR** ; faced with geotextile filter fabric, **as directed**.
   a. Type IV, 1.6-lb/cu. ft. (26-kg/cu. m) minimum density and 25-psig (172-kPa) minimum compressive strength.
   b. Type VI, 1.8-lb/cu. ft. (29-kg/cu. m) minimum density and 40-psig (276-kPa) minimum compressive strength.
   c. Minimum In-Plane Flow Rate: 9 gpm/ft. (112 L/min. per m) of unit width when tested according to ASTM D 4716.
   d. Filter Fabric: Nonwoven geotextile of PP or polyester fibers or combination of both. Flow rates range from 120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m) when tested according to ASTM D 4491.
6. Noncovered Insulated Drainage Panels: Extruded PS board insulation complying with ASTM C 578; fabricated with rabbeted edges and with one side having ribbed drainage channels.

a. Type VI, 1.8-lb/cu. ft. (29-kg/cu. m) minimum density and 40-psig (276-kPa) minimum compressive strength.
b. Type VII, 2.2-lb/cu. ft. (35-kg/cu. m) minimum density and 60-psig (414-kPa) minimum compressive strength.
c. Minimum In-Plane Flow Rate: 9 gpm/ft. (112 L/min. per m) of unit width when tested according to ASTM D 4716.

7. Expanded PS Insulated Drainage Panels: PS bead board insulation; panels are 4 inches (102 mm) thick by 48 inches (1220 mm) wide and faced with geotextile filter fabric.
a. Density: 2 lb/cu. ft. (32 kg/cu. m).
b. Compressive Strength: 800 lbf/sq. ft. (38 kPa).
c. Minimum In-Plane Flow Rate: 3 gpm/ft. (37 L/min. per m) of unit width when tested according to ASTM D 4716.
d. Filter Fabric: Nonwoven geotextile of PP or polyester fibers or combination of both. Flow rates range from 120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m) when tested according to ASTM D 4491.

H. Soil Materials
1. Backfill, drainage course, impervious fill, and satisfactory soil materials are specified in Division 02 Section "Earthwork".

I. Roofing Felts
1. ASTM D 226, Type I, asphalt **OR** ASTM D 227, coal-tar, **as directed**,-saturated roofing felt.
a. Film Backing: Polymeric film bonded to drainage core surface.

J. Geotextile Filter Fabrics
1. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. (4480 to 13 440 L/min. per sq. m) when tested according to ASTM D 4491.
a. Structure Type: Nonwoven, needle-punched continuous filament **OR** woven, monofilament or multifilament, **as directed**.
b. Style(s): Flat **OR** sock, **as directed**.

1.3 EXECUTION

A. Earthwork
1. Excavating, trenching, and backfilling are specified in Division 02 Section "Earthwork".

B. Piping Applications
1. Underground Subdrainage Piping:
a. Perforated PE pipe and fittings, couplings, and coupled joints.
b. Perforated PVC sewer pipe and fittings for loose, bell-and-spigot joints.
c. Perforated clay pipe and fittings, Standard-Strength **OR** Extra-Strength, **as directed,** class; gaskets; and gasketed joints.
2. Underslab Subdrainage Piping:
a. Perforated PE pipe and fittings, couplings, and coupled joints.
b. Perforated PVC sewer pipe and fittings and loose, bell-and-spigot joints.
c. Perforated clay pipe and fittings, Extra-Strength class; gaskets; and gasketed joints.
d. Perforated concrete pipe and fittings, gaskets, and gasketed joints.
3. Header Piping:
a. ABS pipe and fittings, gaskets, and gasketed **OR** and solvent-cemented, **as directed,** joints.
b. Cast-iron soil pipe and fittings, Extra-Heavy **OR** Service, **as directed,** class; gaskets; and gasketed joints.
c. PE drainage tubing and fittings, couplings, and coupled joints.
d. PVC sewer pipe and fittings, couplings, and coupled joints.

C. Cleanout Applications
   1. In Underground Subdrainage Piping:
      a. At Grade in Earth: Cast-iron **OR** PVC, **as directed,** cleanouts.
      b. At Grade in Paved Areas: Cast-iron cleanouts.
   2. In Underslab Subdrainage Piping:
      a. In Equipment Rooms and Unfinished Areas: Cast-iron cleanouts.
      b. In Finished Areas: Copper-alloy cleanouts.

D. Foundation Drainage Installation
   1. Place impervious fill material on subgrade adjacent to bottom of footing after concrete footing forms have been removed. Place and compact impervious fill to dimensions indicated, but not less than 6 inches (150 mm) deep and 12 inches (300 mm) wide.
   2. Place impervious fill on subgrade adjacent to bottom of footing and compact to dimensions indicated, but not less than 6 inches (150 mm) deep and 12 inches (300 mm) wide after concrete footing forms have been removed.
   3. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
   4. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches (100 mm).
   5. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.
   6. Install drainage piping as indicated in Article 1.3 "Piping Installation" for foundation subdrainage.
   7. Add drainage course to width of at least 6 inches (150 mm) on side away from wall and to top of pipe to perform tests.
   8. After satisfactory testing, cover drainage piping to width of at least 6 inches (150 mm) on side away from footing and above top of pipe to within 12 inches (300 mm) of finish grade.
   9. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.
   10. Place layer of flat-style geotextile filter fabric **OR** roofing felt, **as directed,** over top of drainage course, overlapping edges at least 4 inches (100 mm).
   11. Install vertical drainage panels as follows:
      a. Coordinate placement with other drainage materials.
      b. Lay perforated drainage pipe at base of footing. Install as indicated in Article 1.3 "Piping Installation." Do not install aggregate.
      c. Separate 4 inches (100 mm) of fabric at beginning of roll and cut away 4 inches (100 mm) of core. Wrap fabric around end of remaining core.
      d. Wrap bottom of panel around drainage pipe.
      e. Attach panel to wall at horizontal mark and at beginning of pipe. Place core side of panel against wall. Use concrete nails with washers through product cylinders to attach panel to wall. Place nails from 2 to 6 inches (50 to 150 mm) below top of panel, approximately 48 inches (1200 mm) apart. Construction adhesives, metal stick pins, or double-sided tape may be used instead of nails. Do not penetrate waterproofing. Before using adhesives, discuss with waterproofing manufacturer.
      f. If additional panels are required on same row, cut away 4 inches (100 mm) of installed panel core, install new panel against installed panel, and overlap new panel with installed panel fabric.
      g. If additional rows of panels are required, overlap lower panel with 4 inches (100 mm) of fabric.
      h. Cut panel as necessary to keep top 12 inches (300 mm) below finish grade.
      i. For inside corners, bend panel. For outside corners, cut core to provide 3 inches (75 mm) for overlap.
   12. Do not use drainage panels as protection for waterproof membrane unless approved by factory-authorized service representative of waterproofing membrane manufacturer. Submit approval if so used.
   13. Place initial backfill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches (150 mm). Thoroughly compact each layer. Final backfill to finish elevations and slope away from building.

E. Underslab Drainage Installation
   1. Excavate for underslab drainage system after subgrade material has been compacted but before drainage course has been placed. Include horizontal distance of at least 6 inches (150 mm) between drainage pipe and trench walls. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.
   2. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
   3. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches (100 mm).
   4. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.
   5. Install drainage piping as indicated in Part 1.3 "Piping Installation" Article for underslab subdrainage.
   6. Add drainage course to width of at least 6 inches (150 mm) on side away from wall and to top of pipe to perform tests.
   7. After satisfactory testing, cover drainage piping with drainage course to elevation of bottom of slab, and compact and wrap top of drainage course with flat-style geotextile filter fabric.
   8. Install horizontal drainage panels as follows:
      a. Coordinate placement with other drainage materials.
      b. Lay perforated drainage pipe at inside edge of footings.
      c. Place drainage panel over drainage pipe with core side up. Peel back fabric and wrap fabric around pipe. Locate top of core at bottom elevation of floor slab.
      d. Butt additional panels against other installed panels. If panels have plastic flanges, overlap installed panel with flange.

F. Plaza Deck Drainage Installation
   1. Horizontal Drainage Panel: Install between slab and floor cover. Place core on structural floor. Install panels to fit tightly around floor drains of building's storm drainage system. Provide stormwater access into floor drain.
      a. Install drainage piping as indicated in Article 1.3 "Piping Installation" for plaza deck subdrainage.
   2. See Division 02 Section "Unit Pavers".

G. Retaining-Wall Drainage Installation
   1. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
   2. Place supporting layer of drainage course over compacted subgrade to compacted depth of not less than 4 inches (100 mm).
   3. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.
   4. Install drainage piping as indicated in Article 1.3 "Piping Installation" for retaining-wall subdrainage.
   5. Add drainage course to width of at least 6 inches (150 mm) on side away from wall and to top of pipe to perform tests.
   6. After satisfactory testing, cover drainage piping to width of at least 6 inches (150 mm) on side away from footing and above top of pipe to within 12 inches (300 mm) of finish grade.
   7. Place drainage course in layers not exceeding 3 inches (75 mm) in loose depth; compact each layer placed and wrap top of drainage course with flat-style geotextile filter fabric.
   8. Place layer of flat-style geotextile filter fabric **OR** roofing felt, **as directed,** over top of drainage course, overlapping edges at least 4 inches (100 mm).
   9. Install vertical drainage panels as follows:
      a. Coordinate placement with other drainage materials.
      b. Lay perforated drainage pipe at base of footing as described elsewhere in this Specification. Do not install aggregate.
      c. If weep holes are used instead of drainage pipe, cut 1/2-inch- (13-mm-) diameter holes on core side at weep-hole locations. Do not cut fabric.
      d. Mark horizontal calk line on wall at a point 6 inches (150 mm) less than panel width above footing bottom. Before marking wall, subtract footing width.

e. Separate 4 inches (100 mm) of fabric at beginning of roll and cut away 4 inches (100 mm) of core. Wrap fabric around end of remaining core.
f. Wrap bottom of panel around drainage pipe.
g. Attach panel to wall at horizontal mark and at beginning of wall corner. Place core side of panel against wall. Use concrete nails with washers through product. Place nails from 2 to 6 inches (50 to 150 mm) below top of panel, approximately 48 inches (1200 mm) apart. Construction adhesives, metal stick pins, or double-sided tape may be used instead of nails. Do not penetrate waterproofing. Before using adhesives, discuss with waterproofing manufacturer.
h. If another panel is required on same row, cut away 4 inches (100 mm) of installed panel core and wrap fabric over new panel.
i. If additional rows of panel are required, overlap lower panel with 4 inches (100 mm) of fabric.
j. Cut panel as necessary to keep top 12 inches (300 mm) below finish grade.
k. For inside corners, bend panel. For outside corners, cut core to provide 3 inches (75 mm) for overlap.
l. Do not use drainage panels as protection for waterproof membrane unless approved by factory-authorized service representative of waterproofing membrane manufacturer. Submit approval if so used.

10. Fill to Grade: Place satisfactory soil fill material over compacted drainage course . Place material in loose-depth layers not exceeding 6 inches (150 mm). Thoroughly compact each layer. Fill to finish grade.

H. Landscaping Drainage Installation

1. Provide trench width to allow installation of drainage conduit. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.
2. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
3. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches (100 mm).
4. Install drainage conduits as indicated in Article 1.3 "Piping Installation" for landscaping subdrainage with horizontal distance of at least 6 inches (150 mm) between conduit and trench walls. Wrap drainage conduits without integral geotextile filter fabric with flat-style geotextile filter fabric before installation. Connect fabric sections with adhesive or tape.
5. Add drainage course to top of drainage conduits.
6. After satisfactory testing, cover drainage conduit to within 12 inches (300 mm) of finish grade.
7. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.
8. Place layer of flat-style geotextile filter fabric **OR** roofing felt, **as directed,** over top of drainage course, overlapping edges at least 4 inches (100 mm).
9. Fill to Grade: Place satisfactory soil fill material over drainage course. Place material in loose-depth layers not exceeding 6 inches (150 mm). Thoroughly compact each layer. Fill to finish grade.

I. Piping Installation

1. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.
   a. Foundation Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches (915 mm), unless otherwise indicated.
   b. Underslab Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent.
   c. Plaza Deck Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 1.0 percent.

d. Retaining-Wall Subdrainage: When water discharges at end of wall into stormwater piping system, install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches (915 mm), unless otherwise indicated. However, when water discharges through wall weep holes, pipe may be installed with a minimum slope of zero percent.
e. Landscaping Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches (915 mm), unless otherwise indicated.
f. Lay perforated pipe with perforations down.
g. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.

2. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.
3. Install ABS piping according to ASTM D 2321.
4. Install PE piping according to ASTM D 2321.
5. Install PVC piping according to ASTM D 2321.
6. Install clay piping according to ASTM C 12 and NCPI's "Clay Pipe Engineering Manual."
7. Install concrete piping according to ACPA's "Concrete Pipe Handbook."

J. Pipe Joint Construction

1. Cast-Iron Soil Pipe and Fittings: Hub and spigot, with rubber compression gaskets according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook." Use gaskets that match class of pipe and fittings.
2. Join ABS pipe and fittings according to ASTM D 2751.
3. Join PE pipe, tubing, and fittings with couplings for soil-tight joints according to AASHTO's "Standard Specifications for Highway Bridges," Division II, Section 26.4.2.4, "Joint Properties."
4. Join perforated, PE pipe and fittings with couplings for soil-tight joints according to AASHTO's "Standard Specifications for Highway Bridges," Division II, Section 26.4.2.4, "Joint Properties"; or according to ASTM D 2321.
5. Join PVC pipe and fittings according to ASTM D 3034 with elastomeric seal gaskets according to ASTM D 2321.
6. Join perforated PVC pipe and fittings according to ASTM D 2729, with loose bell-and-spigot joints.
7. Join perforated clay pipe and fittings with gaskets according to ASTM C 425.
8. Join perforated concrete pipe and fittings with gaskets according to ASTM C 443 (ASTM C 443M).
9. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

K. Cleanout Installation

1. Cleanouts for Foundation, Retaining-Wall, and Landscaping Subdrainage:
   a. Install cleanouts from piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
   b. In vehicular-traffic areas, use NPS 4 (DN 100) cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 18 by 18 by 12 inches (450 by 450 by 300 mm) in depth. Set top of cleanout flush with grade. Cast-iron pipe may also be used for cleanouts in nonvehicular-traffic areas.
   c. In nonvehicular-traffic areas, use NPS 4 (DN 100) cast-iron **OR** PVC, **as directed,** pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 12 by 12 by 4 inches (300 by 300 by 100 mm) in depth. Set top of cleanout plug 1 inch (25 mm) above grade.
2. Cleanouts for Underslab Subdrainage:

a. Install cleanouts and riser extensions from piping to top of slab. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
b. Use NPS 4 (DN 100) cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout flush with top of slab.

L. Connections
1. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Connect low elevations of subdrainage system to building's solid-wall-piping storm drainage system.
3. Where required, connect low elevations of foundation **OR** Underslab, **as directed,** subdrainage to stormwater sump pumps.

M. Identification
1. Materials and their installation are specified in Division 02 Section "Earthwork". Arrange for installation of green warning tapes directly over piping.
a. Install PE warning tape or detectable warning tape over ferrous piping.
b. Install detectable warning tape over nonferrous piping and over edges of underground structures.

N. Field Quality Control
1. Testing: After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.

O. Cleaning
1. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION 02213

Task	Specification	Specification Description
02213	01352	No Specification Required
02213	02203	Earthwork
02215	02210	Excavation Support And Protection
02215	02203	Earthwork
02223	02203	Earthwork

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SECTION 02224 - TRENCHLESS EXCAVATION USING MICROTUNNELING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of trenchless excavation using microtunneling. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Design Requirements
1. Pipe Casing: Provide pipe casing in thickness indicated of polyvinyl chloride (PVC) plastic **OR** clay tile **OR** concrete **OR** steel, **as directed,** pipe. Provide utility line accessories, valves, connections, and manholes as specified and where indicated. Submit design calculations of pipe casing.

C. Submittals: Submit the following:
1. Preconstruction Submittals: Microtunneling Boring Machine equipment to be used.
2. Product Data
   a. Piping casing, joints, fittings, valves, and couplings
   b. Bentonite
   c. Submit manufacturer's standard drawings or catalog cuts, except submit both drawings and cuts for push-on and rubber-gasketed bell-and-spigot joints. Include information concerning gaskets with submittal for joints and couplings.
3. Design Data: Design calculations of pipe casing
4. Certificates
   a. Piping casing piping, fittings, joints, valves, and coupling
   b. Shop-applied linings
   c. Certificates shall attest that tests set forth in each applicable referenced publication have been performed, whether specified in that publication to be mandatory or otherwise and that production control tests have been performed at the intervals or frequency specified in the publication. Other tests shall have been performed within 3 years of the date of submittal or certificates on the same type, class, grade, and size of material as is being provided for the project.
5. Manufacturer's Instructions: Installation procedures for pipe casing

D. Delivery, Storage, and Handling:
1. Inspect materials delivered to site for damage. Unload and store with minimum handling. Store materials on site in enclosures or under protective covering. Store plastic piping, jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes, fittings, and valves free of dirt and debris.
2. Handle pipe, fittings, valves, hydrants, and other accessories in a manner to ensure delivery to the excavation in sound undamaged condition. Take special care to avoid injury to coatings and linings on pipe and fittings; make satisfactory repairs if coatings or linings are damaged. Carry, do not drag pipe to the excavation. Store plastic piping, jointing materials and rubber gaskets that are not to be installed immediately, under cover out of direct sunlight. Handle steel pipe with coal-tar enamel **OR** coal-tar epoxy, **as directed**, coating in accordance with the provisions for handling coal-tar enamel coated pipe in AWWA C203.

E. Quality Assurance
1. Design Calculations of Pipe Casing: Submit design calculations of pipe casing demonstrating that the pipe casing selected has been designed to support the maximum anticipated earth loads and superimposed live loads, both static and dynamic, which may be imposed on the pipe casing.

1.2 PRODUCTS

A. Piping Casing Materials
1. Ductile-Iron Piping
a. Pipe and Fittings: Pipe, except flanged pipe, ANSI/AWWA C151/A21.51 Pressure Class and/or Thickness Class as required to meet Project requirements. The outside diameter of ductile iron microtunneling pipe shall be in accordance with AWWA C150/A21.50.
b. Joints and Jointing Material: Joints: Pressure and gravity microtunneling pipe shall have either an integral-bell push-on or rubber gasket coupled joint meeting the following criteria:
1) Integral-bell push-on joint microtunneling pile shall consist of a rubber-gasket joint manufactured to conform with AWWA C111/A21.11 and the dimensions shown in ANSI/AWWA C151/A21.51. The exterior of the pipe shall be coated with a durable cement-mortar or concrete coating applied in such a manner as to provide a uniform outside diameter.
2) Cement-mortar or concrete strength, reinforcement and method of placement shall be in accordance with manufacturer's recommendations. Durable Coatings of other types may be substituted provided they maintain a uniform outside diameter and they are approved by the designer. Rubber gasket coupled microtunneling joint shall be manufactured so as to provide a joint which has the same nominal outside diameter as the pipe barrel.
2. Polyvinyl Chloride Pipe (PVC): ASTM F 794. ASTM D 3212 for gasketed joint systems. ASTM F 477 for gasket materials.
3. Reinforced Concrete Pipe
a. Nominal dimensions: Typical nominal dimensions for reinforced concrete pipe are detailed in ASTM standards ASTM C 76 (ASTM C 76M), ASTM C 361 (ASTM C361M), ASTM C 655 (ASTM C 655M), ASTM C 822. Pipe meeting these requirements is generally acceptable for jacking. The permissible variation allowed with respect to these and other dimensions shall be in accordance with the variations listed in the section.
b. Joints and Jointing Material: Joint shall be formed entirely of concrete and as detailed in the contract drawings, may **OR** shall, **as directed**, utilize a rubber gasket or mastic to provide the seal. Incorporate an assembly of steel bands or steel bell ends and spigot rings and rubber gaskets in accordance with contract drawings.
4. Steel Pipe
a. Steel pipe shall be in conformance with ASTM A 139, Grade B with a minimum yield strength of 35,000 psi (242 MPa) **OR** AWWA C200 **OR** API SPEC 5L Grade B **OR** ASTM A 53 **OR** ASTM A 716 **OR** ASTM A 746, **as directed**. Steel pipe shall be welded, seamless, square cut with even lengths and shall comply of Articles 4.2, 4.3, and 4.4 of the API SPEC 5L.
b. Joints: The connection of adjacent pieces of microtunneling steel pipe may be accomplished by field buttwelding, internal weld sleeves, integral press fit connectors, as long as loading and installation design criteria are met.
5. Fiberglass Pipe
a. Pipe: Fiberglass pipe shall meet the requirements of ASTM D 3262, Type 1, Liner 2, Grade 3. The method of the manufacture shall be centrifugal casting resulting in a controlled outside diameter. Minimum wall thickness shall be +1.5 inches (+38 mm).
b. Joints: The pipes shall be connected by gasket-sealed bell-spigot joints. The gasket material shall meet requirements of ASTM F 477. The joint shall meet the requirements of ASTM D 4161 and shall be leak-free under the following conditions:
1) External pressures up to 2 bars, 29 psi (200 kPa) from bentonite injection, slurry system operation or groundwater head.
2) Internal air testing up to 5 psi (35 kPa).
3) Gaps between the pipe ends up to two percent of the diameter (maximum of 1-inch (25 mm)).

c. The liner shall consist of a minimum thickness of 0.04 inch (1.2 mm) of reinforced polyester resin. The outside pipe coating shall have a minimum thickness of 0.03 inches (one mm) and shall consist of thermosetting polyester resin and sand.

6. Vitrified Clay Pipe: ASTM C 700.
   a. Pipe: Vitrified clay pipe shall be manufactured from fire clay, shale, surface clay, or a combination that can meet three edge bearing strength for nominal diameters ranging from 4 inches 2000 lb/linear foot (100 mm 2980 kg/m) to 42 inches 7000 lb/linear foot (1050 mm 10430 kg/m).
   b. Joints: Joints shall be capable of supporting a shear load of 50 pounds per inch (8755 N/m) of nominal diameter uniformly applied over an arc of not less than 120 degrees (2.09 rad) and along a distance of 12 inches (300 mm) adjacent to the joint. Apply an internal 10 foot (3 m) head 4.3 psi (30 kPa) of water pressure for a period of one hour. Joints shall fully comply with ASTM C 1208 (ASTM C 1208M).
7. Concrete: Concrete shall be 3000 psi (25 MPa) and conform with Division 03 Section "Cast-in-place Concrete".
8. Bentonite: Bentonite shall conform with API SPEC 13A and have the capacity of mixing with water to form a stable and homogeneous suspension.
9. Backfill: Reuse excavated sand for backfill that conforms with Division 02 Section "Earthwork".

1.3 EXECUTION

A. Preparation
   1. Access Shafts
      a. Construction methods required to provide access shafts for microtunneling shall be subject to approval of the Owner. Acceptable construction methods may include the use of interlocked steel sheet piling or precast circular concrete segments lowered in place during excavation.
      b. Final dimensions of access shafts selected by the Contractor shall be modified as required following installation of pipe casings to the size and shape of acceptable manhole designs shown on the Contract Drawings to permit installation of conveyance piping.
      c. Shafts shall be of a size commensurate with safe working practices and located as shown on plans. With the approval of the Owner, the Contractor may relocate shafts to better suit the capabilities of the microtunneling method proposed. Where no locations are given, the Contractor shall determine suchfficer.
      d. Shaft locations shall, where possible, be kept clear of road intersections and within a single traffic lane, in order to minimize disruption to the flow of traffic. Support equipment, spoil piles, and materials shall also be located such as to minimize disruption to traffic and are subject to the approval of the Owner.
      e. The Contractor shall properly support all excavations and prevent movement of the soil, pavement, utilities or structures outside of the excavation. The Contractor shall furnish, place and maintain sheeting, bracing, and lining required to support the sides and floor of all pits and to provide adequate protection of the work, personnel, and the general public. Design loads on the sides of the jacking and receiving pit walls are dependent on the construction method and flexibility of the wall systems.
      f. Construct a starter shaft to accommodate the installation of pipe casings, slurry shield and piping jacking device. Install thrust block as required and consolidate the ground (grout) where the casings exit the shaft.
      g. Construct a receiver shaft to accommodate the installation of pipe casings and the slurry shield. Consolidate the ground (grout) where the casings enter the shaft.
      h. The Contractor shall furnish, install, and maintain equipment to keep the jacking shaft free of excess water. The Contractor shall also provide surface protection during the period of construction to ensure that surface runoff does not enter driving shaft(s). Groundwater dewatering shall comply with the approved dewatering plan and shall not affect surrounding soils or structures beyond the tolerances stated in paragraph entitled "Settlement, Alignment and Tolerances."

i. Provide security fence around all access shaft areas and provide shaft cover(s) when the shaft area is not in use.

j. Design of the jacking and receiving pit supports should also take into account the loading from shield or pipe jacking where appropriate, as well as special provisions and reinforcement around the breakout location. The base of the pits shall be designed to withstand uplift forces from the full design head of water, unless approved dewatering or other ground modification methods are employed.

k. Where a thrust block is required to transfer jacking loads into the soil, it shall be properly designed and constructed by the Contractor. The backstop shall be normal (square) with the proposed pipe alignment and shall be designed to withstand the maximum jacking pressure to be used with a factor of safety of at least 2.0. It shall also be designed to minimize excessive deflections in such a manner as to avoid disturbance of adjacent structures or utilities or excessive ground movement. If a concrete thrust block or treated soil zone is utilized to transfer jacking loads into the soil, the tunnel boring is not to be jacked until the concrete or other materials have attained the required strength.

l. Pit Backfill and Compaction: Upon completion of the pipe drive and approval of the installed pipeline by the Owner, remove all equipment, debris, and unacceptable materials from the pits and commence backfilling operation. Backfilling, compaction and pavement repairs shall be completed in accordance with Division 02 Section "Earthwork".

m. If tremie concrete sealing slabs are placed within the earth support system to prevent groundwater inflow when access shafts are dewatered, the sealing slabs shall be of sufficient thickness to provide a factor of safety equal to 1.2 against hydrostatic uplift in order to prevent bottom blowout when the excavation is completely dewatered.

B. Installation

1. Installation of Tracer Wire: Install a continuous length of tracer wire for the full length of each run of nonmetallic pipe. Attach wire to top of pipe in such a manner that will not be displaced during construction operations.
2. Connections to Existing Lines: Make connections to existing lines after the Owner approval is obtained and with a minimum interruption of service on the existing line. Make connections to existing lines under pressure in accordance with the recommended procedures of the manufacturer of the pipe being tapped.
3. Minimum depth of cover over the pipe being installed shall be 6 feet (1.8 m) or 1.5 times the outer diameter of the pipe being installed.
4. Settlement, Alignment and Tolerances
   a. Settlement or heave of ground surface along centerline of microtunneling alignments during and after installation of pipe casings shall not exceed 1 inch (25 mm).
   b. No more than 1 inch (25 mm) lateral and 1 inch (25 mm) vertical deviation shall be permitted in the position of the completed jacked pipe casings. Water shall be free draining between any two points at the pipe invert. No reverse grades will be allowed.
   c. Overcut shall not exceed 1 inch (25 mm) on the radius of the pipe being installed. The annular space created by the overcut must be filled with the lubrication material that is used to reduce soil friction drag on the pipe.
5. Microtunneling
   a. Using Unmanned Tunneling Machine
      1) The microtunneling boring machine shall be an unmanned mechanical type earth pressure counter-balanced bentonite slurry shield system. The machine shall be laser guided and monitored continuously, with a closed circuit television system. The machine shall be capable of fully supporting the face both during excavation and during shutdown and shall have the capability, of positively measuring the earth pressure at the face. Excavation face pressure shall be maintained at all times between the measured active earth pressure and 50 percent of the computed passive earth pressure. Fluid pressure applied at the face to stabilize the excavation shall be maintained at a level slightly in excess of normal hydrostatic pressure and shall be monitored continuously. The machine shall be operated so as

to prevent either surface heave or loss of ground during tunneling and shall be steerable and capable of controlling the advance of the heading to maintain line and grade within the tolerances specified in paragraph entitled "Settlement, Alignment and Tolerances." The machine shall be capable of handling and removing materials of high water content from the machine head.

2) Each pipe casing section shall be jacked forward as the excavation progresses in such a way to provide complete and adequate, ground support at all times. A bentonite slurry (driller's mud) shall be applied to the external surface of the pipe to reduce skin friction. A jacking frame shall be provided for developing a uniform distribution of jacking forces around the periphery of the pipe. A plywood spacer shall be placed on the outer shoulder of the pipe casing joint. The thrust reaction backstop shall be properly designed and constructed.

3) The backstop shall be normal (square) with the proposed pipe casing alignment and shall be designed to support the maximum obtainable jacking pressure with a safety factor at least 2.0.

4) The jacking system shall be capable of continuously monitoring the jacking pressure and rate of advancement. Special care shall be taken when setting the pipe guard rails in the starter shaft to ensure correctness of the alignment, grade and stability.

b. Using Tunneling Shields

1) Only tunneling equipment capable of fully supporting the face of the tunnel shall be used for pipe jacking work described.

2) Tunneling equipment selected for the project shall be compatible with the geotechnical information contained in this contract. The tunneling equipment shall be capable of tunneling through mixed face conditions without exceeding the settlement tolerances specified in paragraph "Settlement, Alignment and Tolerances."

3) Face pressure exerted at the heading by the tunneling machine shall be maintained as required to prevent loss of ground, groundwater inflows, and settlement or heave of the ground surface by balancing soils and groundwater pressures present.

4) Dewatering for groundwater control shall be allowed at the jacking and receiving pits only.

c. Do not jack pipe casing until the concrete thrust block and tremie seal (if selected), and grouted soil zone in starter and receiving shafts have attained the required strength.

d. The pipe casing shall be jacked in place without damaging the pipe casing joints or completed pipe casing section.

e. After completion of the jacking operation between starter and receiver shafts, the lubricate material shall be displaced from between the pipe casing exterior and the surrounding ground by a cement grout. Pressure and the amount of grout shall be controlled to avoid pipe damage and displacement of the pipe and soil beyond the tolerances specified in paragraph "Settlement, Alignment and Tolerances." Grouting shall be accomplished promptly after pipe installation has been completed to prevent any surface settlement due to movement of soil material into the void space or loosened zone around the pipe casing.

f. Any pipe casing which has been damaged during installation shall be replaced by the Contractor at no additional cost. If a new replacement pipe casing is required extending from the starter to the receiver shaft, it shall be installed in conformance with the contract drawings and this section.

g. Steel pipe casing joints shall be continuously welded with butt joint per AWS D1.1. The welds shall attain the full strength of the pipe and shall result in a full watertight section. The inner face of internal weld seam shall be flush with the pipe to facilitate the installation of the conveyance pipe in the pipe casing.

h. Perform all welding in accordance with requirements for shielded metal arc welding of AWS D1.5 for bridges and AWS D1.1 for buildings and other structures.

i. Fiberglass pipe casing joints shall be fully watertight and shall attain the full strength of the pipe. Casing joints shall be field connected with sleeve couplings or bell and spigot type joints that utilize elastomeric sealing gaskets as the sole means to maintain joint water tightness.

j. The joint shall have the same outside diameter as the pipe so when the pipelines are assembled such that the joints are flush with the pipe inside and outside surface to facilitate installation of he conveyance pipe in the pipe casing.

k. All excavated material from tunnel and shaft construction shall be disposed of away from the construction site. On-site storage of material must comply with Division 01 requirements and must be stored in areas shown on site drawings or as directed. Stockpiling shall be permitted on the construction site and material shall be removed at regular intervals as directed by the Owner.

l. Monitor ground movements associated with the project and make suitable changes in the construction methods that control ground movements and prevent damage or detrimental movement to the work and adjacent structures and pavements.

m. Install instrumentation, take readings and provide the Owner with weekly reports containing measurements data with weekly reports to inspector. These actions are meant to supplement the Contractor's monitoring system and do not relieve the Contractor of his responsibility, nor place on the Owner, responsibility for control of ground movement and protection of the project and adjacent structures. Instrumentation readings shall be continued for a period of time as directed by the Owner after pipe casings have been installed to establish that detrimental settlement has not occurred.

n. Unprotected mining of the tunnel bore is not permitted. The tunnel face and bore shall be fully supported at all times.

o. A topographic survey will be performed by the Contractor before and after microtunneling and at intervals as directed by the Owner. Survey markers will be installed by the contractor at grid points located as directed by the Owner centered on the proposed tunnel alignments. Perform all remedial work including repaired if heave or settlement greater than 1 inch (25 mm) is recorded.

p. Approval by the Owner of the topographic survey and final set of readings provided by the Contractor will constitute partial approval of the microtunneling phase of work.

6. Ventilation: Adequate ventilation shall be provided for all cased tunnels and shafts. Follow confined space entry procedures. Local burn permit regulations must be obeyed and complied with. The design of ventilating system shall include such factors as the volume required to furnish fresh air in the shafts, and the volume to remove dust that may be caused by the cutting of the face and other operations which may impact the laser guidance system.

7. Lighting: Adequate lighting shall be provided for the nature of the activity being conducted by workers for the microtunneling. Both power and lighting circuits shall be separated and thoroughly insulated with ground fault interrupters are required. Lights shall comply with requirements with regards to shatter resistance and illumination requirements.

8. Spoil Transportation: The soil transportation system shall match the excavation rate with rate of spoil removal. The system must also be capable of balancing groundwater pressures and adjustment to maintain face stability for the particular soil conditions of this project.

9. Pipe Jacking Equipment: The main jacking equipment installed must have a capacity greater than the anticipated jacking load. Intermediate jacking stations shall be provided by the Contractor when the total anticipated jacking force needed to complete the installation may exceed the capacity of the main jacks or the designed maximum jacking force for the pipe. The jacking system shall develop a uniform distribution of jacking forces on the end of the pipe by use of thruster rings and cushioning material.

10. Jacking Pipe: In general, pipe used for jacking shall be smooth, round, have an even outer surface, and joints that allow for easy connections between pipes. Pipe ends shall be square and smooth so that jacking loads are minimized when the pipe is jacking. Pipe used for pipe jacking shall be capable of withstanding the jacking forces that will be imposed by the process or installation, as well as the final place loading conditions. The driving ends of the pipe and intermediate joints shall be protected from damage.

    a. Any pipe showing signs of failure may be jacked through to the receiving shaft and removed. Other methods of repairing the damaged pipe may be used, as recommended by the manufacturer and subject to approval by the Owner.

b. The pipe manufacturer's design jacking loads shall not be exceeded during the installation process. The pipe shall be designed to take full account of all temporary installation loads.

C. Field Quality Control

1. Field Tests and Inspections: The Contractor shall perform field tests, and provide labor, equipment, and incidentals required for testing. The Contractor shall product evidence, when required, that any item of work has been constructed in accordance with drawings and specifications.
2. Testing Requirements: For pressure test, use a hydrostatic pressure 50 percent greater than the maximum working pressure of the system. Hold this pressure for not less than 2 hours. For leakage test, use a hydrostatic pressure not less than the maximum working pressure of the system. Leakage test may be performed at the same time and at the same test pressure as the pressure test.

END OF SECTION 02224

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SECTION 02242 - PIPED UTILITIES BASIC MATERIALS AND METHODS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for piped utilities - basic materials and methods. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
   a. Piping joining materials.
   b. Transition fittings.
   c. Dielectric fittings.
   d. Sleeves.
   e. Identification devices.
   f. Grout.
   g. Flowable fill.
   h. Piped utility demolition.
   i. Piping system common requirements.
   j. Equipment installation common requirements.
   k. Painting.
   l. Concrete bases.
   m. Metal supports and anchorages.

C. Definitions
1. Exposed Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.
2. Concealed Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
3. ABS: Acrylonitrile-butadiene-styrene plastic.
4. CPVC: Chlorinated polyvinyl chloride plastic.
5. PE: Polyethylene plastic.
6. PVC: Polyvinyl chloride plastic.

D. Submittals
1. Product Data: For the following:
   a. Dielectric fittings.
   b. Identification devices.
2. Welding certificates.

E. Quality Assurance
1. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. Steel Piping Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   a. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   b. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
3. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

F. Delivery, Storage, And Handling
1. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
2. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.2 PRODUCTS

A. Piping Joining Materials
1. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
a. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch (3.2-mm) maximum thickness, unless otherwise indicated.
1) Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
2) Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
b. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
3. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
4. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
5. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
6. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
7. Solvent Cements for Joining Plastic Piping:
a. ABS Piping: ASTM D 2235.
b. CPVC Piping: ASTM F 493.
c. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
d. PVC to ABS Piping Transition: ASTM D 3138.
8. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

B. Transition Fittings
1. Transition Fittings, General: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
2. Transition Couplings NPS 1-1/2 (DN 40) and Smaller:
a. Underground Piping: Manufactured piping coupling or specified piping system fitting.
b. Aboveground Piping: Specified piping system fitting.
3. AWWA Transition Couplings NPS 2 (DN 50) and Larger:
a. Description: AWWA C219, metal sleeve-type coupling for underground pressure piping.
4. Plastic-to-Metal Transition Fittings:
a. Description: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint or threaded end.
5. Plastic-to-Metal Transition Unions:
a. Description: MSS SP-107, CPVC and PVC four-part union. Include brass or stainless-steel threaded end, solvent-cement-joint or threaded plastic end, rubber O-ring, and union nut.
6. Flexible Transition Couplings for Underground Nonpressure Drainage Piping:
a. Description: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

C. Dielectric Fittings
   1. Dielectric Fittings, General: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.
   2. Dielectric Unions:
      a. Description: Factory fabricated, union, NPS 2 (DN 50) and smaller.
         1) Pressure Rating: 150 psig (1035 kPa) minimum **OR** 250 psig (1725 kPa), **as directed**, at 180 deg F (82 deg C).
         2) End Connections: Solder-joint copper alloy and threaded ferrous; threaded ferrous.
   3. Dielectric Flanges:
      a. Description: Factory-fabricated, bolted, companion-flange assembly, NPS 2-1/2 to NPS 4 (DN 65 to DN 100) and larger.
         1) Pressure Rating: 150 psig (1035 kPa) minimum **OR** 175 psig (1200 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
         2) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
   4. Dielectric-Flange Kits:
      a. Description: Nonconducting materials for field assembly of companion flanges, NPS 2-1/2 (DN 65) and larger.
         1) Pressure Rating: 150 psig (1035 kPa) minimum.
         2) Gasket: Neoprene or phenolic.
         3) Bolt Sleeves: Phenolic or polyethylene.
         4) Washers: Phenolic with steel backing washers.
   5. Dielectric Couplings:
      a. Description: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining, NPS 3 (DN 80) and smaller.
         1) Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
         2) End Connections: Threaded.
   6. Dielectric Nipples:
      a. Description: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining.
         1) Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
         2) End Connections: Threaded or grooved.

D. Sleeves
   1. Mechanical sleeve seals for pipe penetrations are specified in Division 15 Section "Common Work Results For Plumbing".
   2. Galvanized-Steel Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
   3. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized, plain ends.
   4. Cast-Iron Sleeves: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
   5. Molded PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.
   6. PVC Pipe Sleeves: ASTM D 1785, Schedule 40.
   7. Molded PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

E. Identification Devices
   1. Equipment Nameplates: Metal permanently fastened to equipment with data engraved or stamped.
      a. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and essential data.
      b. Location: Accessible and visible.
   2. Stencils: Standard stencils prepared with letter sizes complying with recommendations in ASME A13.1. Minimum letter height is 1-1/4 inches (30 mm) for ducts, and 3/4 inch (20 mm) for access door signs and similar operational instructions.
      a. Material: Fiberboard **OR** Brass, **as directed**.

b. Stencil Paint: Exterior, oil-based, alkyd-gloss black enamel, unless otherwise indicated. Paint may be in pressurized spray-can form.
c. Identification Paint: Exterior, oil-based, alkyd enamel in colors according to ASME A13.1, unless otherwise indicated.

3. Snap-on Plastic Pipe Markers: Manufacturer's standard preprinted, semirigid, snap-on type. Include color-coding according to ASME A13.1, unless otherwise indicated.
4. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, color-coded, pressure-sensitive-vinyl type with permanent adhesive.
5. Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): Full-band pipe markers, extending 360 degrees around pipe at each location.
6. Pipes with OD, Including Insulation, 6 Inches (150 mm) and Larger: Either full-band or strip-type pipe markers, at least three times letter height and of length required for label.
7. Lettering: Manufacturer's standard preprinted captions as selected by the Owner.
8. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
   a. Arrows: Either integrally with piping system service lettering to accommodate both directions of flow, or as separate unit on each pipe marker to indicate direction of flow.
9. Plastic Tape: Manufacturer's standard color-coded, pressure-sensitive, self-adhesive vinyl tape, at least 3 mils (0.08 mm) thick.
   a. Width: 1-1/2 inches (40 mm) on pipes with OD, including insulation, less than 6 inches (150 mm); 2-1/2 inches (65 mm) for larger pipes.
   b. Color: Comply with ASME A13.1, unless otherwise indicated.
10. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) sequenced numbers. Include 5/32-inch (4-mm) hole for fastener.
    a. Material: 0.032-inch- (0.8-mm-) thick, polished brass **OR** aluminum, **as directed**.
    b. Material: 0.0375-inch- (1-mm-) thick stainless steel.
    c. Material: 3/32-inch- (2.4-mm-) thick plastic laminate with 2 black surfaces and a white inner layer.
    d. Material: Valve manufacturer's standard solid plastic.
    e. Size: 1-1/2 inches (40 mm) in diameter, unless otherwise indicated.
    f. Shape: As indicated for each piping system.
11. Valve Tag Fasteners: Brass, wire-link or beaded chain; or brass S-hooks.
12. Engraved Plastic-Laminate Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.
    a. Engraving: Engraver's standard letter style, of sizes and with terms to match equipment identification.
    b. Thickness: 1/16 inch (1.6 mm), for units up to 20 sq. in. (130 sq. cm) or 8 inches (200 mm) in length, and 1/8 inch (3 mm) for larger units.
    c. Fasteners: Self-tapping, stainless-steel screws or contact-type permanent adhesive.
13. Plastic Equipment Markers: Manufacturer's standard laminated plastic, in the following color codes:
    a. Green: Cooling equipment and components.
    b. Yellow: Heating equipment and components.
    c. Brown: Energy reclamation equipment and components.
    d. Blue: Equipment and components that do not meet criteria above.
    e. Hazardous Equipment: Use colors and designs recommended by ASME A13.1.
    f. Terminology: Match schedules as closely as possible. Include the following:
       1) Name and plan number.
       2) Equipment service.
       3) Design capacity.
       4) Other design parameters such as pressure drop, entering and leaving conditions, and speed.

g. Size: 2-1/2 by 4 inches (65 by 100 mm) for control devices, dampers, and valves; 4-1/2 by 6 inches (115 by 150 mm) for equipment.

14. Plasticized Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with mat finish suitable for writing.
    a. Size: 3-1/4 by 5-5/8 inches (83 by 143 mm).
    b. Fasteners: Brass grommets and wire.
    c. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
15. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in piped utility identification with corresponding designations indicated. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of piped utility systems and equipment.
    a. Multiple Systems: Identify individual system number and service if multiple systems of same name are indicated.

F. Grout
1. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
    a. Characteristics: Post hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
    b. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
    c. Packaging: Premixed and factory packaged.

G. Flowable Fill
1. Description: Low-strength-concrete, flowable-slurry mix.
    a. Cement: ASTM C 150, Type I, portland.
    b. Density: 115- to 145-lb/cu. ft. (1840- to 2325-kg/cu. m).
    c. Aggregates: ASTM C 33, natural sand, fine and crushed gravel or stone, coarse
    OR
    Aggregates: ASTM C 33, natural sand, fine with admixture, ASTM C 618, fly-ash mineral.
    d. Water: Comply with ASTM C 94/C 94M.
    e. Strength: 100 to 200 psig (690 to 1380 kPa) at 28 days.

1.3 EXECUTION

A. Piped Utility Demolition
1. Refer to Division 01 Section(s) "Cutting And Patching" AND "Selective Demolition" for general demolition requirements and procedures.
2. Disconnect, demolish, and remove piped utility systems, equipment, and components indicated to be removed.
    a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
    b. Piping to Be Abandoned in Place: Drain piping. Fill abandoned piping with flowable fill, and cap or plug piping with same or compatible piping material.
    c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
    d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make operational.
    e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
3. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

B. Dielectric Fitting Applications
1. Dry Piping Systems: Connect piping of dissimilar metals with the following:
    a. NPS 2 (DN 50) and Smaller: Dielectric unions.
    b. NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Dielectric flanges or dielectric flange kits.

2. Wet Piping Systems: Connect piping of dissimilar metals with the following:
   a. NPS 2 (DN 50) and Smaller: Dielectric couplings **OR** dielectric nipples, **as directed**.
   b. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Dielectric nipples.
   c. NPS 2-1/2 to NPS 8 (DN 65 to DN 200): Dielectric nipples or dielectric flange kits.
   d. NPS 10 and NPS 12 (DN 250 and DN 300): Dielectric flange kits.

C. Piping Installation
1. Install piping according to the following requirements and Division 02 specifying piping systems.
2. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on the Coordination Drawings.
3. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
4. Install piping to permit valve servicing.
5. Install piping at indicated slopes.
6. Install piping free of sags and bends.
7. Install fittings for changes in direction and branch connections.
8. Select system components with pressure rating equal to or greater than system operating pressure.
9. Sleeves are not required for core-drilled holes, unless directed otherwise.
10. Permanent sleeves are not required for holes formed by removable PE sleeves, unless directed otherwise.
11. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
    a. Cut sleeves to length for mounting flush with both surfaces.
       1) Exception: Extend sleeves installed in floors of equipment areas or other wet areas 2 inches (50 mm) above finished floor level.
    b. Install sleeves in new walls and slabs as new walls and slabs are constructed.
       1) PVC **OR** Steel, **as directed**, Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
       2) Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.
12. Verify final equipment locations for roughing-in.
13. Refer to equipment specifications in other Sections for roughing-in requirements.

D. Piping Joint Construction
1. Join pipe and fittings according to the following requirements and Division 02 specifying piping systems.
2. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
3. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
4. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
5. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1.1 "Quality Assurance" Article.
6. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
7. Grooved Joints: Assemble joints with grooved-end pipe coupling with coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

8. Soldered Joints: Apply ASTM B 813 water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy (0.20 percent maximum lead content) complying with ASTM B 32.
9. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
10. Pressure-Sealed Joints: Assemble joints for plain-end copper tube and mechanical pressure seal fitting with proprietary crimping tool to according to fitting manufacturer's written instructions.
11. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
    a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
    b. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 appendixes.
    c. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
    d. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
    e. PVC Nonpressure Piping: Join according to ASTM D 2855.
    f. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.
12. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
13. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
14. Plastic Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
    a. Plain-End PE Pipe and Fittings: Use butt fusion.
    b. Plain-End PE Pipe and Socket Fittings: Use socket fusion.
15. Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

E. Piping Connections
1. Make connections according to the following, unless otherwise indicated:
    a. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
    b. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
    c. Install dielectric fittings at connections of dissimilar metal pipes.

F. Equipment Installation
1. Install equipment level and plumb, unless otherwise indicated.
2. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference with other installations. Extend grease fittings to an accessible location.
3. Install equipment to allow right of way to piping systems installed at required slope.

G. Painting
1. Painting of piped utility systems, equipment, and components is specified in Division 09.
2. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

H. Identification
1. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.
    a. Stenciled Markers: According to ASME A13.1.
    b. Plastic markers, with application systems. Install on insulation segment if required for hot noninsulated piping.
    c. Locate pipe markers on exposed piping according to the following:
        1) Near each valve and control device.

2) Near each branch, excluding short takeoffs for equipment and terminal units. Mark each pipe at branch if flow pattern is not obvious.
3) Near locations where pipes pass through walls or floors or enter inaccessible enclosures.
4) At manholes and similar access points that permit view of concealed piping.
5) Near major equipment items and other points of origination and termination.

2. Equipment: Install engraved plastic-laminate sign or equipment marker on or near each major item of equipment.
   a. Lettering Size: Minimum 1/4 inch (6.4 mm) high for name of unit if viewing distance is less than 24 inches (610 mm), 1/2 inch (13 mm) high for distances up to 72 inches (1800 mm), and proportionately larger lettering for greater distances. Provide secondary lettering two-thirds to three-fourths of size of principal lettering.
   b. Text of Signs: Provide name of identified unit. Include text to distinguish among multiple units, inform user of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
3. Adjusting: Relocate identifying devices that become visually blocked by work of this or other Divisions.

I. Concrete Bases
1. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
   a. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
   b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of base.
   c. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   d. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   e. Install anchor bolts to elevations required for proper attachment to supported equipment.
   f. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   g. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-place Concrete".

J. Erection Of Metal Supports And Anchorages
1. Refer to Division 05 Section "Metal Fabrications" for structural steel.
2. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor piped utility materials and equipment.
3. Field Welding: Comply with AWS D1.1/D1.1M.

K. Grouting
1. Mix and install grout for equipment base bearing surfaces, pump and other equipment base plates, and anchors.
2. Clean surfaces that will come into contact with grout.
3. Provide forms as required for placement of grout.
4. Avoid air entrapment during placement of grout.
5. Place grout, completely filling equipment bases.
6. Place grout on concrete bases and provide smooth bearing surface for equipment.
7. Place grout around anchors.
8. Cure placed grout.

END OF SECTION 02242

SECTION 02242a - GEOSYNTHETIC FABRIC

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing of labor, material and equipment for the installation of geosynthetic fabric.

1.2 PRODUCTS

A. Materials
1. Erosion Control Fabric - Photo and biodegradable plastic Curlex Blanket as manufactured by American Excelsior Co. or approved equal.
2. Drainage/Leach Bed - Non-woven polypropylene/polyethylene fabric, Mirafi 140N or approved equal.
3. Road Base and Structure Reinforcement - Woven polypropylene fabric, Mirafi 600X or approved equal.
4. Sediment and Job Site erosion control - woven polypropylene fabric - Envirofence by Mirafi or approved equal.

1.3 EXECUTION

A. For sediment and job site erosion control fabric, the Contractor shall provide and install silt fence as detailed on the Storm Water Management and Erosion Control Plan. It shall be the Contractor's option to provide fabricated reinforced silt fence or prefabricated units, unless otherwise noted. In all installations, the bottom flap of filter cloth shall be firmly embedded into undisturbed or stabilized grade. Embedment shall resist pullout and prevent flow under the installation.

END OF SECTION 02242a

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SECTION 02242b - SEWAGE TREATMENT LAGOONS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for the repair and maintenance of sewage treatment lagoons. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Materials
1. Concrete Block shall comply with ASTM C 129.
2. Concrete Grout shall comply with Fed. Spec. MMM-A-001993.
3. Riprap Stone shall comply with AREA-01.
4. Concrete Repair Material shall comply with Fed. Spec. MMM-A-001993.
5. Sand shall comply with ASTM C 33.
6. Portland Cement shall comply with ASTM C 150, Type V.
7. Rubble shall consist of broken concrete or broken stone.

1.3 EXECUTION

A. Algae Removal shall be by mechanical or manual methods and shall include, but not be limited to, skimming, pumping through a screen, raking, or draining and cleaning the lagoon.

B. Slope and Dike Reconstruction shall be made to re-establish the original design configuration and grades. Place riprap, where required, so that its angle of repose is not exceeded.

C. Liner Reconstruction and Repair shall be made with materials compatible with the existing liner and compatible with the wastewater and sludge to be contained therein.

D. Repairs to Elastomeric Membrane Liners shall be made with like material and shall overlap all cuts, tears, fractures or other defects a minimum of 4 inches. Cut repair pieces square or rectangular. The method of bonding the new material to existing material shall be similar to the original joint banding method, except when the original joints have failed. In this case, the material supplier shall demonstrate that an alternate jointing system shall be satisfactory to the Owner. Replace earth or sand cover removed during repair or replacement of plastic liner to the same thickness as the original installation.

E. Repairs to Non-Elastomeric Membrane Liners shall be made by cutting out defective areas back to sound liner material and replacing with similar material. Joints shall be watertight.

END OF SECTION 02242b

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SECTION 02242c - POND RESERVOIR LINERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for pond and reservoir liners. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes geomembrane liners and floating covers for ponds and reservoirs.

C. Definitions
1. Plastics Terminology: See ASTM D 1600 for definitions of abbreviated terms for plastics not otherwise defined in this Section.
2. CSPE: Chlorosulfonated polyethylene.
3. EIA: Ethylene interpolymer alloy.
4. EPDM: Ethylene-propylene-diene terpolymer.
5. PE: Polyethylene.
6. PP: Polypropylene.

D. Performance Requirements
1. Provide geomembrane liners and floating covers, **as directed**, that prevent the passage of water and gas, **as directed**.

E. Submittals
1. Product Data: For each type of product indicated. Include the following:
   a. Sheets for geomembrane liners and floating covers.
   b. Seaming adhesives, solvents, and extrusions.
   c. Penetration assemblies.
   d. Accessories for floating covers.
2. Shop Drawings: Show fabrication and installation details for geomembrane liners. Show panel layout, seams, penetrations, perimeter anchorage, floating cover, and methods of attachment and sealing to other construction. Differentiate between factory and field seams and joints.
3. Samples: For the following products, in sizes indicated:
   a. Geomembrane Panels: For each type, not less than one 12-inch (300-mm) seam length for factory-bonded sheets and one 12-inch (300-mm) seam length for field-bonded sheets.
4. Qualification Data: For qualified Installer **OR** testing agency, **as directed**.
5. Product Certificates: For each type of geomembrane liner and floating cover, from manufacturer.
6. Product Test Reports: For each geomembrane sheet, based on evaluation of comprehensive tests performed by a qualified testing agency.
7. Source quality-control reports.
8. Field quality-control reports.
9. Maintenance Data: For geomembrane liner and floating cover to include in maintenance manuals.
10. Warranty: Special warranty specified in this Section.

F. Quality Assurance
1. Installer Qualifications: Fabricator of products **OR** An employer of workers trained and approved by manufacturer, **as directed**.
2. Source Limitations: Obtain geomembrane liner and floating cover, accessories, and required seaming materials, solvents, and adhesives from single source.
3. Preinstallation Conference: Conduct conference at Project site.

a. Inspect and discuss condition of substrate and other preparatory work performed by other trades.
b. Review structural load limitations.
c. Review limitations on equipment and Installer's personnel.
d. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
e. Review required testing, inspecting, and certifying procedures.
f. Review existing and forecasted weather conditions and procedures for unfavorable conditions.

G. Project Conditions
1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit placement and seaming of geomembrane liners and floating covers to be performed according to manufacturers' written instructions and warranty requirements.

H. Warranty
1. Special Warranty: Specified form in which geomembrane manufacturer, geomembrane liner and floating cover fabricator, and geomembrane liner and floating cover Installer agree to repair or replace geomembrane liner and floating cover that fail(s) in materials or workmanship or that deteriorate(s) under conditions of normal weather within specified warranty period. Warranty does not include deterioration or failure of geomembrane liner and floating cover due to exposure to harmful chemicals, gases or vapors, abnormal and severe weather phenomena, fire, earthquakes, floods, vandalism, or abuse by persons, animals, or equipment.
a. Failures include, but are not limited to, the following:
1) Leaks in geomembrane liner and floating cover.
2) Defects in seams.
3) Cracks and holes in floating cover.
b. Warranty Period: One **OR** Five **OR** 10, **as directed**, year(s) from date of Substantial Completion.

1.2 PRODUCTS

A. CSPE Sheet Materials
1. CSPE Sheet: Formulated from CSPE for use in hydraulic structures and formed into uniform, flexible sheets.
a. Reinforcing Scrim: One-ply polyester fabric totally encapsulated between two sheets.
1) Construction: 6 x 6 - 1000 d **OR** 8 x 8 - 250 d **OR** 10 x 10 - 1000 d, **as directed**.
b. Nominal Thickness: 45-mil- (1.14-mm-) thick sheet per ASTM D 5199 or ASTM D 751, Optical Method.
c. Nominal Thickness over Scrim: 11-mil- (0.28-mm-) thick sheet per ASTM D 5199 or ASTM D 751, Optical Method.
d. Breaking Strength: Not less than 200 lbf (0.89 kN) minimum average per ASTM D 751, Procedure A.
e. Tear Strength, Initial: Not less than 70 lbf (0.31 kN) minimum average per ASTM D 5884 or ASTM D 751, Procedure B.
f. Tear Strength, after Aging: Not less than 35 lbf (0.16 kN) minimum average per ASTM D 5884 or ASTM D 751, Procedure B.
g. Puncture Resistance: Not less than 200 lbf (0.89 kN) minimum average per ASTM D 4833.
h. Hydrostatic Resistance: Not less than 250-psi (1725-kPa) minimum average resistance per ASTM D 5514, Procedure A or ASTM D 751, Method A, Procedure 1.
i. Dimensional Stability, Reinforced Sheet: Not more than plus or minus 2 percent per ASTM D 1204.

j. Low-Temperature Flexibility: Pass, 1/8-inch (3-mm) mandrel, four hours at minus 40 deg F (minus 40 deg C), and per ASTM D 2136.
k. UV-Light Resistance: Pass, 4000 hours at 176 deg F (80 deg C), per ASTM G 155.
l. Ply Adhesion: Not less than 7 lbf/in. (1.2 kN/m) **OR** 10 lbf/in. (1.75 kN/m), **as directed**, of seam width, or film tearing bond, according to ASTM D 413, Machine Method.
m. Water Absorption (for low-water-absorption CSPE): Not more than 2 percent at 70 deg F (21 deg C) and not more than 30 percent at 158 deg F (70 deg C) for 30 days each per ASTM D 471, 30-mil- (0.76-mm-) thick sheet.

B. EIA Sheet Materials
1. EIA Sheet: Formulated from EIA for use in hydraulic structures and formed into uniform, flexible sheets.
a. Reinforcing Scrim: One-ply polyester fabric totally encapsulated between two sheets.
1) Construction: 6 x 6 - 1000 d **OR** 8 x 8 - 500 d **OR** 10 x 10 - 1000 d **OR** 10 x 11 - 2520 d x 2000 d, **as directed**.
b. Nominal Thickness: 36-mil- (0.91-mm-) thick sheet per ASTM D 1593 or ASTM D 751, Optical Method.
c. Tensile Strength: Not less than 400 lbf (1.8 kN) minimum average per ASTM D 751, Procedure A.
d. Tear Strength: Not less than 35 lbf (0.16 kN) minimum average per ASTM D 5884 or ASTM D 751, Procedure B.
e. Puncture Resistance: Not less than 150 lbf (0.67 kN) minimum average per ASTM D 4833.
f. Hydrostatic Resistance: Not less than 100-psi (690-kPa) minimum average resistance per ASTM D 751, Procedure A.
g. Dimensional Stability, Reinforced Sheet: Not more than plus or minus 2 percent per ASTM D 1204.
h. Low-Temperature Flexibility: Pass, 1/8-inch (3-mm) mandrel, four hours at minus 30 deg F (minus 34 deg C), and per ASTM D 2136.
i. UV-Light Resistance: Pass, 4000 hours at 176 deg F (80 deg C), per ASTM G 155.
j. Ply Adhesion: Not less than 7 lbf/in. (1.2 kN/m) **OR** 10 lbf/in. (1.75 kN/m), **as directed**, of seam width, or film tearing bond, according to ASTM D 413, Machine Method.

C. EPDM Sheet Materials
1. EPDM Sheet: Formulated from EPDM, compounded for use in hydraulic structures and formed into uniform, flexible sheets.
a. Reinforcing Scrim: One-ply polyester fabric totally encapsulated between two sheets.
1) Construction: 9 x 9 - 1000 d **OR** 10 x 10 - 1000 d, **as directed**.
b. Nominal Thickness: 45-mil- (1.14-mm-) thick sheet per ASTM D 5199 or ASTM D 751, Optical Method.
c. Breaking Strength: Not less than 190 lbf (0.85 kN) minimum average per ASTM D 882, ASTM D 7004, or ASTM D 751, Procedure A.
d. Tear Resistance: Not less than 130 lb (0.58 kN) minimum average per ASTM D 1004.
e. Puncture Strength: Not less than 60 lbf (0.27 kN) minimum average per ASTM D 4833.

D. PE Sheet Materials
1. PE Sheet: Formulated from virgin PE, compounded for use in hydraulic structures, and formed into uniform sheets.
a. Sheet Texture: One side smooth; other side smooth **OR** textured, **as directed**.
b. Nominal Density: Low density, 0.910 to 0.925 g/cu. cm **OR** Linear low density, 0.919 to 0.925 g/cu. cm **OR** Medium density, 0.926 to 0.939 g/cu. cm **OR** High density, 0.940 to 0.959 g/cu. Cm, **as directed**, per ASTM D 1505.
c. Nominal Thickness: 60-mil- (1.5-mm-) thick sheet per ASTM D 5199 **OR** ASTM D 5994, **as directed**.
d. Melt Flow Index: Not more than 0.035 oz./10 minutes (1.0 g/10 minutes) per ASTM D 1238, Condition 190/2.16.

e. Carbon Black Content: 2 to 3 percent per ASTM D 1603 or ASTM D 4218.
f. Carbon Black Dispersion: Per ASTM D 5596, Category 1 and 2.
g. Oxidation Induction Time: Not less than 100 minutes per ASTM D 3895.
h. Tensile Properties: Not less than indicated for each direction, per ASTM D 638, Type IV or ASTM D 6693, Type IV.
   1) Strength at Yield: Not less than 126 lbf/in. (22 kN/m) and 2100 psi (14.5 MPa) minimum average.
   2) Strength at Break: Not less than 228 lbf/in. (40 kN/m) and 3800 psi (26.2 MPa) minimum average.
   3) Elongation at Yield: Not less than 12 percent minimum average.
   4) Elongation at Break: Not less than 700 percent minimum average.
i. Tear Resistance: Not less than 39 lbf (0.18 kN) minimum average per ASTM D 1004.
j. Puncture Resistance: Not less than 108 lbf (0.48 kN) minimum average per ASTM D 4833.
k. Dimensional Stability, Reinforced Sheet: Not more than plus or minus 2 percent per ASTM D 1204.
l. Low-Temperature Brittleness: Four hours at minus 76 deg F (minus 60 deg C) per ASTM D 746.
m. Environmental Stress Cracking Resistance: Not less than 1500 hours per ASTM D 1693, Condition B.

E. PP Sheet Materials
1. PP Sheet: Formulated from virgin PP, compounded for use in hydraulic structures, and formed into uniform, flexible sheets.
   a. Reinforcing Scrim: One-ply polyester fabric totally encapsulated between two sheets.
      1) Construction: 9 x 9 - 1000 d **OR** 10 x 10 - 1000 d, **as directed**.
   b. Sheet Texture: One side smooth; other side smooth **OR** textured, **as directed**.
   c. Nominal Thickness: 45-mil- (1.14-mm-) thick sheet per ASTM D 5199 or ASTM D 751, Optical Method **OR** ASTM D 5994, **as directed**.
   d. Tensile Strength: Not less than 250 lbf (1.1 kN) minimum average per ASTM D 412, ASTM D 7003, ASTM D 6693, or ASTM D 751, Procedure A.
   e. Tear Resistance: Not less than 55 lbf (0.24 kN) minimum average per ASTM D 1004, ASTM D 5884, ASTM D 7003, or ASTM D 751, Procedure B.
   f. Puncture Resistance: Not less than 200 lbf (0.88 kN) minimum average per ASTM D 4833 or ASTM D 7003.
   g. Low-Temperature Flexibility: Pass, 1/8-inch (3-mm) mandrel, four hours at minus 40 deg F (minus 40 deg C), and per ASTM D 2136.
   h. Hydrostatic Resistance: Not less than 250-psi (1725-kPa) minimum average resistance per ASTM D 5514, Procedure A or ASTM D 751, Method A, Procedure 1.
   i. Dimensional Stability, Reinforced Sheet: Not more than plus or minus 1 percent per ASTM D 1204.
   j. Ply Adhesion: Not less than 20 lbf/in. (3.5 kN/m) of seam width, or film tearing bond, according to ASTM D 413, Machine Method.

F. PVC Sheet Materials
1. PVC Sheet: Formulated from virgin PVC with plasticizers and other modifiers, compounded for use in hydraulic structures, and formed into uniform, flexible sheets with material properties complying with ASTM D 7176 **OR** PGI 1104, "Specification for PVC Geomembranes", **as directed**, for nominal thickness indicated.
   a. Nominal Thickness: 10 mils (0.25 mm) **OR** 20 mils (0.51 mm) **OR** 30 mils (0.76 mm) **OR** 40 mils (1.02 mm) **OR** 50 mils (1.3 mm) **OR** 60 mils (1.5 mm), **as directed**.
   b. Sheet Texture: One side smooth; other side smooth **OR** matte **OR** faille textured, **as directed**.

G. Floating Cover Accessories

1. Screened Scupper Hoses: Manufacturer's standard.
2. Flotation Blocks: Closed-cell polyethylene foam blocks approximately 4 by 12 inches (102 by 300 mm), 2.2 lb/cu. ft. (35.2 kg/cu. m).
3. Access Hatch: Manufacturer's standard, in size indicated.

H. Miscellaneous Materials
1. Adhesives: Provide types of adhesive primers, compounds, solvents, and tapes recommended in writing by geomembrane liner manufacturer for bonding to structures (if required), for sealing of seams in geomembrane liner, and for sealing penetrations through geomembrane liner.
2. Penetration Assemblies: Provide manufacturer's standard factory-fabricated assemblies for sealing penetrations. Include joint sealant recommended in writing by geomembrane liner manufacturer and compatible with geomembrane liner, containment conditions, and materials.
3. Battens: Long-length strips of material indicated, size as shown on Drawings. Fabricate battens with sharp projections removed and edges eased and then predrilled or punched for anchors. Provide anchors, or other type of attachment, of type and spacing recommended in writing by geomembrane liner manufacturer for attaching geomembrane liner system to substrate and as indicated.
   a. Batten Material: Liner manufacturer's standard system.
      OR
      Batten Material: Aluminum; with stainless-steel anchors, complete with gasket and sealant compatible with geomembrane liner, containment conditions, and materials.
      OR
      Batten Material: Stainless steel; with stainless-steel anchors, complete with gasket and sealant compatible with geomembrane liner, containment conditions, and materials.
      OR
      Batten Material: Plastic compatible with geomembrane liner, cast in place or fastened with stainless-steel anchors, designed to continuously seal geomembrane liner to batten.
4. Sand: ASTM C 33; fine aggregate, natural or manufactured sand.

I. Fabrication
1. Fabricate geomembrane liner and floating cover, **as directed**, panels from sheets in sizes as large as possible with factory-sealed seams, consistent with limitations of weight and installation procedures. Minimize field seaming.
2. Fabricate flotation blocks, wrap in geomembrane, and attach to underside of floating cover according to manufacturer's written instructions.
3. Fabricate ballast tubes of sand-filled geomembrane and attach to top surface of floating cover according to manufacturer's written instructions.
4. Install built-in accessories, hatches, access panels, vents, and walkways on geomembrane floating cover.

J. Source Quality Control
1. Testing Agency: Engage a qualified testing agency to evaluate geomembrane seams.
2. Destructive Testing: Test for bonded seam strength and peel adhesion every 3000 feet (915 m) or once per panel, whichever is more frequent.
3. CSPE Liner and Floating Cover: Test and inspect factory seams, according to ASTM D 4545, for peel adhesion not less than 10 lbf/in. (1.75 kN/m) of seam width and for bonded seam strength not less than 180 lbf/in. (32 kN/m) of seam width for seams constructed from two scrim-reinforced sheets, each with nominal sheet thickness of not less than 45 mils (1.14 mm).
4. EIA Liner and Floating Cover: Test and inspect factory seams, according to ASTM D 4545, for peel adhesion not less than 10 lbf/in. (1.75 kN/m) of seam width and for bonded seam strength not less than 270 lbf/in. (48 kN/m) of seam width for seams constructed from two scrim-reinforced sheets, each with nominal sheet thickness of not less than 36 mils (0.91 mm).
5. EPDM Liner: Test and inspect factory seams, according to ASTM D 4545, for peel adhesion not less than 10 lbf/in. (1.75 kN/m) of seam width and for bonded seam strength not less than 160 lbf/in. (28 kN/m) of seam width for seams constructed from two scrim-reinforced sheets, each with nominal sheet thickness of not less than 45 mils (1.14 mm).

6. PE Liner: Test and inspect factory seams, according to ASTM D 4545, for peel adhesion and for bonded seam strength indicated.
   a. Peel Adhesion/Extrusion: Film tear bond and not less than 78 lbf/in. (13.7 kN/m) of extrusion-bonded seam width.
      OR
      Peel Adhesion/Fusion: Film tear bond and not less than 90 lbf/in. (15.8 kN/m) of fused seam width.
   b. Bonded Seam Strength: Not less than 120 lbf/in. (21 kN/m) of seam width for seams constructed from two scrim-reinforced sheets, each with nominal sheet thickness of not less than 45 mils (1.14 mm).
7. PP Liner and Floating Cover: Test and inspect factory seams, according to ASTM D 4545, for peel adhesion not less than 20 lbf/in. (3.5 kN/m) of seam width and for bonded seam strength not less than 200 lbf/in. (35 kN/m) of seam width for seams constructed from two scrim-reinforced sheets, each with nominal sheet thickness of not less than 45 mils (1.14 mm).
8. PVC Liner and Floating Cover: Test and inspect factory seams, according to ASTM D 4545, for peel adhesion not less than 10 lbf/in. (1.75 kN/m) of seam width and for bonded seam strength not less than that indicated below for seams constructed from two sheets of minimum nominal thickness indicated for each:
   a. Bonded Seam Strength for 10-mil- (0.25-mm-) Thick Sheets: 20 lbf/in. (3.5 kN/m) of seam width.
   b. Bonded Seam Strength for 20-mil- (0.51-mm-) Thick Sheets: 38.5 lbf/in. (6.7 kN/m) of seam width.
   c. Bonded Seam Strength for 30-mil- (0.76-mm-) Thick Sheets: 58.4 lbf/in. (10.2 kN/m) of seam width.
   d. Bonded Seam Strength for 40-mil- (1.02-mm-) Thick Sheets: 77.6 lbf/in. (13.6 kN/m) of seam width.
   e. Bonded Seam Strength for 50-mil- (1.3-mm-) Thick Sheets: 96 lbf/in. (16.8 kN/m) of seam width.
   f. Bonded Seam Strength for 60-mil- (1.5-mm-) Thick Sheets: 116 lbf/in. (20.3 kN/m) of seam width.

1.3 EXECUTION

A. Examination
   1. Examine substrates, with Installer present, for compliance with requirements for soil compaction and grading; for subgrade free from angular rocks, rubble, roots, vegetation, debris, voids, protrusions, and ground water; and for other conditions affecting performance of geomembrane liner.
   2. Examine anchor trench excavation **OR** concrete perimeter, **as directed,** where geomembrane liner and floating cover, **as directed**, will be secured, for substrate conditions indicated above and for correct location and configuration.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
   1. Provide temporary ballast, until edges are permanently secured, that does not damage geomembrane liner or substrate, to prevent uplift of geomembrane liner in areas with prevailing winds.
   2. Prepare surfaces of construction penetrating through geomembrane liner according to geomembrane liner manufacturer's written instructions.
   3. Remove curing compounds and coatings from concrete surfaces to be sealed to geomembrane liner.

C. Installation

1. General: Place geomembrane liner over prepared surfaces to ensure minimum handling. Install according to Shop Drawings and in compliance with geomembrane liner manufacturer's written instructions. Begin placing geomembrane liner at Project's upwind direction and proceed downwind. Install geomembrane liner in a relaxed condition, free from stress and with minimum wrinkles, and in full contact with subgrade. Do not bridge over voids or low areas in the subgrade. Fit closely and seal around inlets, outlets, and other projections through geomembrane liner. Permanently secure edges.
2. Field Seams: Comply with geomembrane liner and floating cover manufacturer's written instructions. Form seams by lapping edges of panels 2 to 4 inches (50 to 102 mm) unless instructions require a larger overlap. Wipe contact surfaces clean and free of dirt, dust, moisture, and other foreign materials. Use solvent-cleaning methods and grind geomembrane seam surfaces if recommended by geomembrane liner manufacturer. Proceed with seaming at required temperatures for materials and ambient conditions. Continuously bond sheet to sheet to construct single or double seams of width recommended for method of seaming used. Seal or fuse free seam edges. Inspect seams and reseal voids.
   a. Adhesive Bonding: Apply bonding cement to both contact surfaces in seam area and press together immediately, or use other seaming methods as instructed by geomembrane liner manufacturer. Roll to press surfaces together, to distribute adhesive to leading edges of panels, and to remove wrinkles and fishmouths. Remove excess adhesive.

      OR

      Thermal Bonding: Use thermal-welding technique recommended by geomembrane liner manufacturer. Apply pressure to smoothly bond surfaces together. Examine for and patch wrinkles and fishmouths.
3. Installation in Anchor Trench: Install geomembrane liner and floating cover in trench according to manufacturer's written instructions. Backfill and compact to lock liner into trench.
4. Attachment to Concrete: Use manufacturer's standard system to suit Project conditions. Support adhesive and geomembrane on minimum 8-inch- (200-mm-) wide concrete substrate unless otherwise indicated.
   a. Install batten strips over geomembrane liner and floating cover as shown on Drawings.
   b. Install antichafing strips of geomembrane sheet between geomembrane liner and floating cover according to manufacturer's written instructions.
   c. Install floating cover with perimeter fold.
5. Floating Cover Flotation Control: Connect drainage hoses in perimeter fold, sumps, or scuppers to pump or gravity drain system.
6. Liner Repairs: Repair tears, punctures, and other imperfections in geomembrane liner field and seams using patches of geomembrane liner material, liner-to-liner bonding materials, and bonding methods according to geomembrane liner manufacturer's written instructions. Apply bonding solvent or weld to contact surfaces of both patch and geomembrane liner, and press together immediately. Roll to remove wrinkles.

D. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Nondestructive Testing: Visually inspect seams and patches. Comply with ASTM D 4437 for Air Lance Test, Vacuum Box Testing, or Ultrasonic (High Frequency) Pulse Echo Testing or with GRI Test Method GM6, as applicable to geomembrane liner and floating cover and seam construction. Record locations of failed seams and patches. Individually number and date occurrences and details of leak and remedial action. Repair leaking seams and patches.
3. Prepare test and inspection reports.

E. Disinfection
1. Disinfect the complete installation according to procedures in AWWA C652.

F. Protection
1. Protect installed geomembrane liner and floating cover according to manufacturer's written instructions. Repair or replace areas of geomembrane liner damaged by scuffing, punctures, traffic, rough subgrade, or other unacceptable conditions.

2. Before initial filling of pond or placement of earth cover, inspect seams and patched areas to ensure tight, continuously bonded installation. Repair damaged geomembrane and seams and reinspect repaired work.

END OF SECTION 02242c

SECTION 02244 - TREE PROTECTION AND TRIMMING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for tree protection and trimming. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes general protection and pruning of existing trees and plants that are affected by execution of the Work, whether temporary or permanent construction.

C. Definitions
1. Caliper: Diameter of a trunk measured by a diameter tape or the average of the smallest and largest diameters at 6 inches (150 mm) above the ground for trees up to, and including, 4-inch (100-mm) size; and 12 inches (300 mm) above the ground for trees larger than 4-inch (100-mm) size.
2. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.
3. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and indicated on Drawings **OR** defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated, **as directed**.
4. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

D. Submittals
1. Product Data: For each type of product indicated.
2. Tree Pruning Schedule: Written schedule detailing scope and extent of pruning of trees to remain that interfere with or are affected by construction.
3. Qualification Data: For qualified arborist and tree service firm.
4. Certification: From arborist, certifying that trees indicated to remain have been protected during construction according to recognized standards and that trees were promptly and properly treated and repaired when damaged.
5. Maintenance Recommendations: From arborist, for care and protection of trees affected by construction during and after completing the Work.
6. Existing Conditions: Documentation of existing trees and plantings indicated to remain, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.
    a. Use sufficiently detailed photographs or videotape.
    b. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

E. Quality Assurance
1. Arborist Qualifications: Certified Arborist as certified by ISA **OR** Certified Arborist-Municipal Specialist as certified by ISA **OR** Licensed arborist in jurisdiction where Project is located **OR** Current member of ASCA **OR** Registered Consulting Arborist as designated by ASCA, **as directed**.
2. Tree Service Firm Qualifications: An experienced tree service firm that has successfully completed temporary tree and plant protection work similar to that required for this Project and that will assign an experienced, qualified arborist to Project site during execution of the Work.
3. Preinstallation Conference: Conduct conference at Project site.

F. Project Conditions

1. The following practices are prohibited within protection zones:
   a. Storage of construction materials, debris, or excavated material.
   b. Parking vehicles or equipment.
   c. Foot traffic.
   d. Erection of sheds or structures.
   e. Impoundment of water.
   f. Excavation or other digging unless otherwise indicated.
   g. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
2. Do not direct vehicle or equipment exhaust toward protection zones.
3. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones and organic mulch.

1.2 PRODUCTS

A. Materials
1. Topsoil: Natural or cultivated top layer of the soil profile or manufactured topsoil; containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 1 inch (25 mm) in diameter; and free of weeds, roots, and toxic and other nonsoil materials.
   a. Obtain topsoil only from well-drained sites where topsoil is 4 inches (100 mm) deep or more; do not obtain from bogs or marshes.

   OR

   Topsoil: Stockpiled topsoil from location shown on Drawings **OR** Imported or manufactured topsoil complying with ASTM D 5268, **as directed**.
2. Organic Mulch: Free from deleterious materials and suitable as a top dressing for trees and shrubs, consisting of one of the following:
   a. Type: Shredded hardwood **OR** Ground or shredded bark **OR** Wood and bark chips, **as directed**.
   b. Size Range: 3 inches (76 mm) maximum, 1/2 inch (13 mm) minimum.
3. Protection-Zone Fencing: Fencing fixed in position and meeting one of the following requirements, **as directed**. Previously used materials may be used when approved by the Owner.
   a. Chain-Link Protection-Zone Fencing: Galvanized-steel **OR** Polymer-coated steel **OR** Polymer-coated galvanized-steel, **as directed**, fencing fabricated from minimum 2-inch (50-mm) opening, 0.148-inch- (3.76-mm-) diameter wire chain-link fabric; with pipe posts, minimum 2-3/8-inch- (60-mm-) OD line posts, and 2-7/8-inch- (73-mm-) OD corner and pull posts; with 1-5/8-inch- (42-mm-) OD top rails **OR** with 0.177-inch- (4.5-mm-) diameter top tension wire, **as directed**, and 0.177-inch- (4.5-mm-) diameter bottom tension wire; with tie wires, hog ring ties, and other accessories for a complete fence system.
      1) Height: 4 feet (1.2 m) **OR** 6 feet (1.8 m) **OR** 8 feet (2.4 m), **as directed**.
      2) Polymer-Coating Color (if polymer coating is required): Dark green **OR** Olive green **OR** Brown **OR** Black, **as directed**.
   b. Plywood Protection-Zone Fencing: Plywood framed with four 2-by-4-inch (50-by-100-mm) rails, with 4-by-4-inch (100-by-100-mm) preservative-treated wood posts spaced not more than 8 feet (2.4 m) apart.
      1) Height: 4 feet (1.2 m) **OR** 6 feet (1.8 m), **as directed**.
      2) Plywood and Lumber: Comply with requirements in Division 06 Section "Rough Carpentry" **OR** Division 06 Section "Miscellaneous Carpentry", **as directed**.
   c. Wood Protection-Zone Fencing: Constructed of two 2-by-4-inch (50-by-100-mm) horizontal rails, with 4-by-4-inch (100-by-100-mm) preservative-treated wood posts spaced not more than 8 feet (2.4 m) apart, and lower rail set halfway between top rail and ground.
      1) Height: 4 feet (1.2 m).

2) Lumber: Comply with requirements in Division 06 Section "Rough Carpentry" **OR** Division 06 Section "Miscellaneous Carpentry", **as directed**.

d. Plastic Protection-Zone Fencing: Plastic construction fencing constructed of high-density extruded and stretched polyethylene fabric with 2-inch (50-mm) maximum opening in pattern and weighing a minimum of 0.4 lb/ft. (0.6 kg/m); remaining flexible from minus 60 to plus 200 deg F (minus 16 to plus 93 deg C); inert to most chemicals and acids; minimum tensile yield strength of 2000 psi (13.8 MPa) and ultimate tensile strength of 2680 psi (18.5 MPa); secured with plastic bands or galvanized-steel or stainless-steel wire ties; and supported by tubular or T-shape galvanized-steel posts spaced not more than 8 feet (2.4 m) apart.

1) Height: 4 feet (1.2 m).

2) Color: High-visibility orange, nonfading.

e. Gates: Single **OR** Double, **as directed**, swing access gates matching material and appearance of fencing, to allow for maintenance activities within protection zones; leaf width 24 inches (610 mm) **OR** 36 inches (914 mm) **OR** As indicated, **as directed**.

4. Protection-Zone Signage: Shop-fabricated, rigid plastic or metal sheet with attachment holes prepunched and reinforced; legibly printed with nonfading lettering and as follows:

a. Size and Text: As shown on Drawings.

b. Lettering: 3-inch- (75-mm-) high minimum, white **OR** black, **as directed**, characters on white **OR** red, **as directed**, background.

1.3 EXECUTION

A. Examination

1. Erosion and Sedimentation Control: Examine the site to verify that temporary erosion- and sedimentation-control measures are in place. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
2. For the record, prepare written report, endorsed by arborist, listing conditions detrimental to tree and plant protection.

B. Preparation

1. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated. Flag **OR** Tie a 1-inch (25-mm) blue-vinyl tape around, **as directed**, each tree trunk at 54 inches (1372 mm) above the ground.
2. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.
3. Tree-Protection Zones: Mulch areas inside tree-protection zones and other areas indicated.
   a. Apply 4-inch (100-mm) **OR** 6-inch (150-mm), **as directed**, average thickness of organic mulch. Do not place mulch within 6 inches (150 mm) of tree trunks.

C. Tree- And Plant-Protection Zones

1. Protection-Zone Fencing: Install protection-zone fencing along edges of protection zones before materials or equipment are brought on the site and construction operations begin in a manner that will prevent people and animals from easily entering protected area except by entrance gates. Construct fencing so as not to obstruct safe passage or visibility at vehicle intersections where fencing is located adjacent to pedestrian walkways or in close proximity to street intersections, drives, or other vehicular circulation.
   a. Chain-Link Fencing: Install to comply with ASTM F 567 and with manufacturer's written instructions.
   b. Posts: Set or drive posts into ground one-third the total height of the fence without concrete footings. Where a post is located on existing paving or concrete to remain, provide appropriate means of post support acceptable to the Owner.
   c. Access Gates: Install where indicated; adjust to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption,

or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

2. Protection-Zone Signage: Install protection-zone signage in visibly prominent locations in a manner approved by the Owner. Install one sign spaced approximately every 20 feet (6 m) **OR** 35 feet (10.5 m) **OR** 50 feet (15 m), **as directed**, on protection-zone fencing, but no fewer than four signs with each facing a different direction.
3. Maintain protection zones free of weeds and trash.
4. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by the Owner.
5. Maintain protection-zone fencing and signage in good condition as acceptable to the Owner and remove when construction operations are complete and equipment has been removed from the site.
   a. Do not remove protection-zone fencing, even temporarily, to allow deliveries or equipment access through the protection zone.
   b. Temporary access is permitted subject to preapproval in writing by arborist if a root buffer effective against soil compaction is constructed as directed by arborist. Maintain root buffer so long as access is permitted.

D. Excavation
1. General: Excavate at edge of protection zones and for trenches indicated within protection zones according to requirements in Division 02 Section "Earthwork".
2. Trenching near Trees: Where utility trenches are required within protection zones, hand excavate under or around tree roots or tunnel under the roots by drilling, auger boring, or pipe jacking. Do not cut main lateral tree roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots as required for root pruning.
3. Redirect roots in backfill areas where possible. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and redirect them without breaking. If encountered immediately adjacent to location of new construction and redirection is not practical, cut roots approximately 3 inches (75 mm) back from new construction and as required for root pruning.
4. Do not allow exposed roots to dry out before placing permanent backfill. Provide temporary earth cover or pack with peat moss and wrap with burlap. Water and maintain in a moist condition. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.

E. Root Pruning
1. Prune roots that are affected by temporary and permanent construction. Prune roots as follows:
   a. Cut roots manually by digging a trench and cutting exposed roots with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
   b. Cut Ends: Do not paint cut root ends **OR** Coat cut ends of roots more than 1-1/2 inches (38 mm) in diameter with an emulsified asphalt or other coating formulated for use on damaged plant tissues and that is acceptable to arborist, **as directed**.
   c. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
   d. Cover exposed roots with burlap and water regularly.
   e. Backfill as soon as possible according to requirements in Division 02 Section "Earthwork".
2. Root Pruning at Edge of Protection Zone: Prune roots 12 inches (300 mm) outside **OR** 12 inches (300 mm) inside **OR** 6 inches (150 mm) outside **OR** 6 inches (150 mm) inside **OR** flush with the edge, **as directed**, of the protection zone, by cleanly cutting all roots to the depth of the required excavation.
3. Root Pruning within Protection Zone: Clear and excavate by hand to the depth of the required excavation to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.

F. Crown Pruning
1. Prune branches that are affected by temporary and permanent construction. Prune branches as follows:
   a. Prune trees to remain to compensate for root loss caused by damaging or cutting root system. Provide subsequent maintenance during Contract period as recommended by arborist.
   b. Pruning Standards: Prune trees according to ANSI A300 (Part 1) and the following:
      1) Type of Pruning: Cleaning **OR** Thinning **OR** Raising **OR** Reduction, **as directed**.
      2) Specialty Pruning: Restoration **OR** Vista **OR** Palm **OR** Utility, **as directed**.
   c. Cut branches with sharp pruning instruments; do not break or chop.
   d. Do not apply pruning paint to wounds.
2. Chip removed branches and spread over areas identified by the Owner **OR** stockpile in areas approved by the Owner **OR** dispose of off-site, **as directed**.

G. Regrading
1. Lowering Grade: Where new finish grade is indicated below existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.
   OR
   Lowering Grade within Protection Zone: Where new finish grade is indicated below existing grade around trees, slope grade away from trees as recommended by arborist unless otherwise indicated.
   a. Root Pruning: Prune tree roots exposed by lowering the grade. Do not cut main lateral roots or taproots; cut only smaller roots. Cut roots as required for root pruning.
2. Raising Grade: Where new finish grade is indicated above existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.
   OR
   Minor Fill within Protection Zone: Where existing grade is 2 inches (50 mm) or less below elevation of finish grade, fill with topsoil. Place topsoil in a single uncompacted layer and hand grade to required finish elevations.

H. Field Quality Control
1. Inspections: Engage a qualified arborist to direct plant-protection measures in the vicinity of trees, shrubs, and other vegetation indicated to remain and to prepare inspection reports.

I. Repair And Replacement
1. General: Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by the Owner.
   a. Submit details of proposed root cutting and tree and shrub repairs.
   b. Have arborist perform the root cutting, branch pruning, and damage repair of trees and shrubs.
   c. Treat damaged trunks, limbs, and roots according to arborist's written instructions.
   d. Perform repairs within 24 hours.
   e. Replace vegetation that cannot be repaired and restored to full-growth status, as determined by the Owner.
2. Trees: Remove and replace trees indicated to remain that are more than 25 **OR** 66, **as directed**, percent dead or in an unhealthy condition before the end of the corrections period or are damaged during construction operations that the Owner determines are incapable of restoring to normal growth pattern.
   a. Provide new trees of same size and species as those being replaced for each tree that measures 6 inches (150 mm) **OR** 4 inches (100 mm), **as directed**, or smaller in caliper size.
      OR
      Provide one **OR** two, **as directed**, new tree(s) of 6-inch (150-mm) **OR** 4-inch (100-mm), **as directed**, caliper size for each tree being replaced that measures more than 6 inches (150 mm) **OR** 4 inches (100 mm), **as directed**, in caliper size.
      1) Species: Species selected by the Owner.

b. Plant and maintain new trees as specified in Division 02 Section "Exterior Plants".

3. Soil Aeration: Where directed by the Owner, aerate surface soil compacted during construction. Aerate 10 feet (3 m) beyond drip line and no closer than 36 inches (900 mm) to tree trunk. Drill 2-inch- (50-mm-) diameter holes a minimum of 12 inches (300 mm) deep at 24 inches (600 mm) o.c. Backfill holes with an equal mix of augered soil and sand.

J. Disposal Of Surplus And Waste Materials

1. Disposal: Remove excess excavated material, displaced trees, trash and debris, and legally dispose of them off Owner's property.

END OF SECTION 02244

SECTION 02244a - TERMITE CONTROL

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for termite control. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Soil and wood treatment with termiticide.
   b. Bait-station system.
   c. Metal mesh barrier system.
   d. Polymer sheet barrier system with termiticide.
   e. Polymer barrier fittings with termiticide for installation around utility penetrations.

C. Submittals
1. Product Data: For each type of termite control product.
   a. Include the EPA-Registered Label for termiticide products.
2. Qualification Data: For qualified Installer.
3. Product Certificates: For termite control products, from manufacturer.
4. Soil Treatment Application Report: After application of termiticide is completed, submit report for Owner's records and include the following:
   a. Date and time of application.
   b. Moisture content of soil before application.
   c. Termiticide brand name and manufacturer.
   d. Quantity of undiluted termiticide used.
   e. Dilutions, methods, volumes used, and rates of application.
   f. Areas of application.
   g. Water source for application.
5. Wood Treatment Application Report: After application of termiticide is completed, submit report for Owner's records and include the following:
   a. Date and time of application.
   b. Termiticide brand name and manufacturer.
   c. Quantity of undiluted termiticide used.
   d. Dilutions, methods, volumes used, and rates of application.
   e. Areas of application.
6. Bait-Station System Application Report: After installation of bait-station system is completed, submit report for Owner's records and include the following:
   a. Location of areas and sites conducive to termite feeding and activity.
   b. Plan drawing showing number and locations of bait stations.
   c. Dated report for each monitoring and inspection occurrence indicating level of termite activity, procedure, and treatment applied before time of Substantial Completion.
   d. Termiticide brand name and manufacturer.
   e. Quantities of termiticide and nontoxic termite bait used.
   f. Schedule of inspections for one year from date of Substantial Completion.
7. Polymer Sheet Barrier System with Termiticide Application Report: After installation of polymer sheet barrier system with termiticide is completed, submit report for Owner's records and include the following:
   a. Plan drawing showing extent of sheet barrier and number and locations of each type of polymer barrier fitting.
   b. Termiticide brand name and manufacturer.

c. Schedule of inspections for one year from date of Substantial Completion.

8. Polymer Barrier Fittings with Termiticide Application Report: After installation of polymer barrier fittings with termiticide is completed, submit report for Owner's records and include the following:
   a. Plan drawing showing number and locations of each type of polymer barrier fitting with termiticide.
   b. Termiticide brand name and manufacturer.
   c. Schedule of inspections for one year from date of Substantial Completion.
9. Warranties: Sample of special warranties.

D. Quality Assurance
1. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located, and who employs workers trained and approved by manufacturer to install manufacturer's products.
2. Regulatory Requirements: Formulate and apply termiticides and termiticide devices according to the EPA-Registered Label.
3. Source Limitations: Obtain termite control products from single source.
4. Preinstallation Conference: Conduct conference at Project site.

E. Project Conditions
1. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.
2. Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.
3. Apply wood treatment after framing, sheathing, and exterior weather protection is completed but before electrical and mechanical systems are installed.
4. Install bait-station system during construction to determine areas of termite activity and after construction, including landscaping, is completed.
5. Install polymer sheet barrier system with termiticide prior to placing concrete slab reinforcement and pouring concrete and after installation and inspection of footings, foundations, and plumbing and electrical pipes and conduits.
6. Install polymer barrier fittings with termiticide around utility penetrations prior to pouring concrete and after installation and inspection of plumbing and electrical pipes and conduits, slab vapor barrier, and concrete slab reinforcement.

F. Warranty
1. Soil Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work, consisting of applied soil termiticide treatment, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.
   a. Warranty Period: Three **OR** Five, **as directed**, years from date of Substantial Completion.
2. Wood Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work, consisting of applied wood termiticide treatment, will prevent infestation of subterranean termites. If subterranean termite damage is discovered during warranty period, repair or replace damage caused by termite infestation and treat replacement wood.
   a. Warranty Period: 12 years from date of Substantial Completion.
3. Polymer Sheet Barrier System with Termiticide Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work, consisting of installation of polymer sheet barrier system with termiticide, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, re-treat and repair or replace damage caused by termite infestation.
   a. Warranty Period: 10 years from date of Substantial Completion.

4. Polymer Barrier Fittings with Termiticide Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work, consisting of installation of polymer barrier fittings with termiticide, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, re-treat and repair or replace damage caused by termite infestation.
   a. Warranty Period: Five years from date of Substantial Completion.

G. Maintenance Service
1. Continuing Service (as directed): Beginning at Substantial Completion, provide 12 months' continuing service including monitoring, inspection, and re-treatment for occurrences of termite activity. Provide a standard continuing service agreement. State services, obligations, conditions, terms for agreement period, and terms for future renewal options.

1.2 PRODUCTS

A. Soil Treatment
1. Termiticide: Provide an EPA-Registered termiticide, complying with requirements of authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation. Provide quantity required for application at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to product's EPA-Registered Label.
   a. Service Life of Treatment: Soil treatment termiticide that is effective for not less than three **OR** five, **as directed**, years against infestation of subterranean termites.

B. Wood Treatment
1. Borate: Provide an EPA-Registered borate temiticide, complying with requirements of authorities having jurisdiction, in an aqueous solution for spray application and a gel solution for pressure injection, formulated to prevent termite infestation in wood. Provide quantity required for application at the label volume and rate for the maximum diffusible borate concentration allowed for each specific use, according to product's EPA-Registered Label.

C. Bait-Station System
1. Provide bait stations based on the dimensions of building perimeter indicated on Drawings, according to manufacturer's EPA-Registered Label for product, manufacturer's written instructions, and the following:
   a. No fewer than one bait station per 8 linear feet (2.4 linear meters) **OR** 20 linear feet (6.1 linear meters), **as directed**.
   b. No fewer than one cluster of bait stations per 20 linear feet (6.1 linear meters), consisting of no fewer than three bait stations per cluster.

D. Metal Mesh Barrier System
1. Stainless-Steel Mesh: 0.025-by-0.018-inch (0.64-by-0.45-mm) mesh of 0.08-inch- (2.0-mm-) diameter, stainless-steel wire, Type 316.

E. Polymer Sheet Barrier System
1. Polymer Sheet: 16-mil- (0.40-mm-) thick, multilayered, laminated, polymer sheet with lambda-cyhalothrin termiticide sealed between two outer polymer layers.

F. Polymer Barrier Fittings
1. Pipe/Conduit Fitting: Integral 2-1/2-inch- (65-mm-) long polymer sleeve and 1-inch- (25-mm-) wide circular flange with lambda-cyhalothrin termiticide sealed between two outer polymer layers; with fasteners.
2. Tub Trap Fitting: Integral polymer boot and 23-by-23-inch (585-by-585-mm) flange with lambda-cyhalothrin termiticide sealed between two outer polymer layers; with fasteners.

1.3 EXECUTION

A. Examination
1. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of soil per termiticide label requirements, interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.
2. Proceed with application only after unsatisfactory conditions have been corrected.

B. Preparation
1. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's written instructions for preparation before beginning application of termite control treatment. Remove all extraneous sources of wood cellulose and other edible materials such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.
2. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.
    a. Fit filling hose connected to water source at the site with a backflow preventer, complying with requirements of authorities having jurisdiction.

C. Application, General
1. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's EPA-Registered Label for products.

D. Applying Soil Treatment
1. Application: Mix soil treatment termiticide solution to a uniform consistency. Provide quantity required for application at the label volume and rate for the maximum specified concentration of termiticide, according to manufacturer's EPA-Registered Label, to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction. Distribute treatment evenly.
    a. Slabs-on-Grade and Basement Slabs: Under ground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
    b. Foundations: Adjacent soil, including soil along the entire inside perimeter of foundation walls; along both sides of interior partition walls; around plumbing pipes and electric conduit penetrating the slab; around interior column footers, piers, and chimney bases; and along the entire outside perimeter, from grade to bottom of footing. Avoid soil washout around footings.
    c. Crawlspaces: Soil under and adjacent to foundations as previously indicated. Treat adjacent areas including around entrance platform, porches, and equipment bases. Apply overall treatment only where attached concrete platform and porches are on fill or ground.
    d. Masonry: Treat voids.
    e. Penetrations: At expansion joints, control joints, and areas where slabs will be penetrated.
2. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.
3. Protect termiticide solution, dispersed in treated soils and fills, from being diluted until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.
4. Post warning signs in areas of application.
5. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

E. Applying Wood Treatment

1. Application: Mix wood treatment solution to a uniform consistency. Provide quantity required for application at the label volume and rate for the maximum specified concentration of borate, according to manufacturer's EPA-Registered Label, so that wood framing, sheathing, siding, and structural members subject to infestation receive treatment.
    a. Framing and Sheathing: Apply termiticide solution by spray to bare wood for complete coverage.
    b. Wood Members More Than 4 Inches (100 mm) Thick: Inject termiticide gel solution under pressure into holes of size and spacing required by manufacturer for treatment.
    c. Exterior Uncoated Wood Trim and Siding: Apply termiticide solution to bare wood siding. After 48 hours, apply a seal coat of paint as specified in Division 07.

F. Installing Bait-Station System
1. Place bait stations according to the EPA-Registered Label for the product and manufacturer's written instructions, in the following areas that are conducive to termite feeding and activity:
    a. Conducive sites and locations indicated on Drawings.
    b. In and around infested trees and stumps.
    c. In mulch beds.
    d. Where wood directly contacts soil.
    e. Areas of high soil moisture.
    f. Near irrigation sprinkler heads.
    g. Each area where roof drainage system, including downspouts and scuppers, drains to soil.
    h. Along driplines of roof overhangs without gutters.
    i. Where condensate lines from mechanical equipment drip or drain to soil.
    j. At plumbing penetrations through ground-supported slabs.
    k. Other sites and locations as determined by licensed Installer.
2. Inspect and service bait stations from time of their application until Substantial Completion unless extended by continuing service agreement, according to the EPA-Registered Label for product and manufacturer's written instructions for termite management system and bait products.
    a. Service Frequency: Inspect bait stations not less than once every **OR** every three, **as directed**, month(s).

G. Installing Metal Mesh Barrier System
1. Install metal mesh barrier system where indicated to provide a continuous barrier to entry of subterranean termites according to manufacturer's written instructions.
    a. Fit mesh tightly around pipe or other penetrations, and terminate at slab and foundation perimeters.
    b. Install mesh under the perimeter of concrete slab edges and joints after vapor barrier and reinforcing steel are in place, and comply with manufacturer's written installation methods.
2. Inspect annually for termite activity and effectiveness of metal mesh barrier system according to manufacturer's written instructions.

H. Installing Polymer Sheet Barrier System
1. Install polymer sheet barrier system according to manufacturer's EPA-Registered Label to provide a complete and continuous barrier to entry of subterranean termites.
2. Remove any pipe wrap material so that the polymer sheet barrier system and fittings can be applied directly to the pipe or conduit. After installing the barrier, reapply pipe wrap material both below and above the blocker to protect the pipe from contact with concrete.
3. Install polymer barrier fittings around each utility pipe and conduit penetrating concrete slab and/or foundation walls according to the EPA-Registered Label for the product and manufacturer's written instructions.

I. Installing Polymer Barrier Fittings
1. Remove any pipe wrap material so that the polymer barrier fittings can be applied directly to the pipe or conduit. After installing the barrier, reapply pipe wrap material both below and above the blocker to protect the pipe from contact with concrete.

2. Install polymer barrier fittings around each utility pipe and conduit penetrating concrete slab and/or foundation walls according to the EPA-Registered Label for the product and manufacturer's written instructions.

END OF SECTION 02244a

Task	Specification	Specification Description
02261	02242b	Sewage Treatment Lagoons

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SECTION 02262 - WIRE MESH GABIONS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of wire mesh gabions. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Description: Gabion units shall consist of compartmented rectangular basket containers filled with stone. The required sizes of the gabion units are Length times Width times Depth. Twisted or welded wire mesh shall be used. Baskets shall be fabricated from galvanized steel wire formed into a nonraveling mesh.

C. Submittals
1. Samples: Stone fill material submitted for approval prior to delivery.

1.2 PRODUCTS

A. Steel Twisted Wire Mesh Gabions: Gabion basket units shall be of nonraveling construction and fabricated from a double twisted hexagonal wire mesh. The size of mesh openings shall be approximately 3-1/4 in. by 4-1/2 in. (80 by 115 mm). The gabion mesh wires shall be wrapped around the selvage wire no less than 1 1/2 times and shall interconnect with adjacent mesh wires. All steel wire used shall be galvanized prior to fabrication into mesh. All gabion diaphragm and frame wire shall equal or exceed ASTM A 641, and possess soft tensile strength of 60,000 psi (415 Mpa) with a tolerance of minus 2,000 psi (14 Mpa). The galvanized wire shall have a Finish 5, Class 3, zinc coating, as indicated in ASTM A 641. The weight of coating shall be determined by ASTM A 90. The grade of zinc used for coating shall be High Grade or Special High Grade as prescribed in ASTM B 6, Table 1. The uniformity of coating shall equal or exceed four 1-minute dips by the Preece Test, as determined by ASTM A 239.

B. Steel Welded Wire Mesh Gabions: Gabion basket units shall be of nonraveling construction and fabricated from a welded square wire mesh. The size of mesh openings shall be approximately 3 in. by 3 in. (75 by 75 mm). The welded joints of the wire mesh shall conform to ASTM A 185 except that the weld shears shall be at least 600 lbs (2700 N). All gabion diaphragm and frame wire shall equal or exceed ASTM A 641, and possess soft tensile strength of 60,000 psi (415 Mpa) with a tolerance of minus 2,000 psi (14 Mpa). The galvanized wire shall have a Finish 5 Class 3 zinc coating, indicated in ASTM A 641. The weight of coating shall be determined by ASTM A 90. The grade of zinc used for coating shall be High Grade or Special High Grade as prescribed in ASTM B 6, Table 1. The uniformity of coating shall equal or exceed four 1-minute dips by the Preece Test, as determined by ASTM A 239.

C. Mesh wire shall be minimum 0.120-in. (3.05 mm) diameter after coating with 0.85 oz/sq ft (240 g/sq m) zinc coating.

D. Selvage wire shall be minimum 0.150-in. (3.80 mm) diameter after coating with 0.85 oz/sq ft (240 g/sq m) zinc coating.

E. Wire used for lacing or as internal connecting wire within basket cells shall be minimum 0.087-in. (2.21 mm) diameter after coating with 0.70 oz/sq ft (220 g/sq m) zinc coating and may have soft tensile strength designation.

F. Stone Fill

1. Quality: Stone shall be durable and of suitable quality to ensure permanence in the structure and climate in which it is to be used. It shall be free of cracks, seams, and other defects that would tend to increase unduly its deterioration from natural causes or reduce its size to that which could not be retained in the gabion baskets. The inclusion of more than 5% by weight of dirt, sand, clay, and rock fines will not be permitted. The sources from which the Contractor proposes to obtain the material shall be selected well in advance of the time when the material will be required in the work. Suitable samples of stone fill material shall be collected in the presence of the Owner's representative and submitted to the Owner for approval prior to delivery of any such material to the site of the work. Unless otherwise specified, all test samples shall be obtained by the Contractor and delivered at his expense to the Owner. Suitable tests and/or service records will be used to determine the acceptability of the stone. In the event suitable test reports and service records are not available, the material shall be subjected to such tests as are necessary to determine its acceptability for use in the work. Tests to which the material may be subjected include petrographic analysis, specific gravity, absorption, wetting and drying, freezing and thawing, and such other tests as may be considered necessary to demonstrate to the satisfaction of the Owner that the materials are acceptable for use in the work.
2. Gradation: Stone fill used in the gabions shall be a well-graded mixture with sizes ranging between 4 in. and 8 in. (100 and 200 mm), based on US Standard square mesh sieves. No stone shall have a minimum dimension less than 4 in. (100 mm) and a maximum dimension greater than 12 in. (300 mm) in any direction. The ratio of the maximum dimension to the minimum dimension shall not be greater than two. If the height of the gabion basket is 12 in. (300 mm) or less, stone shall have no dimensions greater than 8 in. (200 mm) in any direction.
3. Filter Material: The material shall be composed of tough durable particles, reasonably free from thin, flat, and elongated pieces, and contain no organic matter or soft friable particles in quantities considered objectionable by the Owner. Filter material shall consist of sand and gravel or crushed stone, well graded between the prescribed limits listed below, and conform to the requirements of paragraph STONE FILL, subparagraph QUALITY as to quality.

1.3 EXECUTION:

A. Foundation Preparation: No foundation preparation work shall take place on frozen or snow-covered ground. After excavation or stripping to the extent indicated on the drawings or as directed by the Owner, all remaining loose or otherwise unsuitable materials shall be removed. All depressions shall be carefully backfilled to grade. If pervious materials are encountered in the foundation depressions, the areas shall be backfilled with free-draining materials. Otherwise, the depressions shall be backfilled with suitable materials from adjacent required excavation, or other approved source, and compacted to a density at least equal to that of the adjacent foundation. Any buried debris protruding from the foundation that will impede the proper installation and final appearance of the gabion layer shall also be removed, and the voids carefully backfilled and compacted as specified above. Immediately prior to placing the material, the prepared foundation surface shall be inspected by the Owner, and no material shall be placed thereon until that area has been approved.

B. Filter Placement: Filter material shall be spread uniformly on the prepared foundation surface in a manner satisfactory to the Owner, and to the slopes, lines, and grades as indicated on the drawings or as directed. Placing of filter material by methods which will tend to segregate particle sizes will not be permitted. Any damage to the foundation surface during filter placement shall be repaired before proceeding with the work. Compaction of the filter materials will not be required, but it shall be finished to present a reasonably even surface free from mounds or windrows.

C. Fabrication: Gabions shall be fabricated in such a manner that the sides, ends, lid, and diaphragms can be assembled at the construction site into rectangular baskets of the sizes specified and shown on the drawings. Gabions shall be of single unit construction, i.e., the base, lid, ends, and sides shall be either woven into a single unit, or one edge of these members connected to the base section of the gabion in such a manner that the minimum strengths of the wire mesh and connections as stated in paragraph

MATERIALS are met. Where the length of the gabion exceeds one and one-half its horizontal width, the gabion shall be equally divided by diaphragms of the same mesh and gage as the body of the gabions, into cells whose length does not exceed the horizontal width. The gabion shall be furnished with the necessary diaphragms secured in proper position on the base in such a manner that no additional tying at this juncture will be necessary. For twisted wire gabions, all perimeter edges of the mesh forming the gabion shall be securely selvaged. In addition, the selvaged edges shall be so wrapped and reinforced with the mesh ends that the selvage wire will not be deformed locally about the lacing wire or wire fasteners when baskets are filled or during lid closing. Lacing wire, connecting wire, and/or wire fasteners shall be supplied in sufficient quantity for securely fastening all diaphragms and edges of the gabion.

D. Assembly And Installation: For gabion units in excess of 4 ft. (1.3 m) in thickness, and placed in horizontal or near horizontal position to resist high velocity flow, or as part of a stilling basin feature, a minimum of two uniformly spaced vertical connecting wires per cell linking the foundation mesh to basket lid mesh should be specified. Empty gabion units shall be assembled individually and placed on the approved surface with the sides, ends, and diaphragms erected in such a manner to ensure the correct position of all creases and that the tops of all sides are level. Filling of gabion units in one place and then transporting them to their final position in the work will not be permitted. The front row of gabion units shall be placed first and successively constructed toward the top of the slope or the back of the structure. All gabion units shall be properly staggered horizontally and vertically. Finished gabion structure shall have no gaps along the perimeter of the contact surfaces between adjoining gabion basket units. All adjoining empty gabion units shall be connected by lacing wire/or wire fasteners along the perimeter of their contact surfaces in order to obtain a monolithic structure. Lacing of adjoining basket units shall be accomplished by continuous stitching with alternating single and double loops at intervals of not more than 5 in. (125 mm), and a half hitch shall be included at every double loop. All lacing wire terminals shall be securely fastened. Wire fasteners may be used in lieu of lacing wire for forming individual baskets and joining empty baskets together prior to stone filling. All joining shall be made through selvage-to-selvage or selvage-to-edge wire connection; mesh-to-mesh or selvage-to-mesh wire connection is prohibited except in the case where baskets are offset or stacked and selvage-to-mesh or mesh-to-mesh wire connection would be necessary. Wire fasteners shall not be used to tie or join stone-filled baskets, unless approved by the Owner. As a minimum, a fastener shall be installed at each mesh opening at the location where mesh wire meets selvage or edge wire. The initial line of basket units shall be placed on the prepared filter layer surface and partially filled to provide anchorage against deformation and displacement during filling operations. After adjoining empty basket units are set to line and grade and common sides with adjacent units thoroughly laced or fastened, they shall be placed in tension and stretched to remove any kinks from the mesh and to a uniform alignment. The stretching of empty basket units shall be accomplished in such a manner as to prevent any possible unraveling. Stone filling operations shall carefully proceed with placement by hand or machine so as not to damage galvanized wire coating, to assure a minimum of voids between the stones, and the maintenance of alignment throughout the filling process. Undue deformation and bulging of the mesh shall be corrected prior to further stone filling. To avoid localized deformation, the basket units in any row are to be filled in stages consisting of maximum 12-in. (300 mm) courses, and at no time shall any cell be filled to a depth exceeding 1 ft. (300 mm) more than the adjoining cell. The maximum height from which the stone may be dropped into the basket units shall be 36 in. (1 m). For gabion units in excess of 2 ft. (0.67 m) in height, two uniformly spaced internal connecting wires shall be placed between each stone layer in all front and side gabion units, connecting the back and the front faces of the compartments. Connecting wires or alternatively the preformed stiffeners shall be looped around two twisted wire mesh openings or a welded wire joint at each basket face and the wire terminals shall be securely twisted to prevent their loosening. For twisted wire gabions, the internal connecting wires or preformed stiffeners are installed. For welded wire gabion units, preformed stiffeners are installed across the corners of gabion panels. Along all exposed faces, the outer layer of stone shall be carefully placed and arranged by hand to ensure a neat and compact appearance. The last layer of stone shall be uniformly overfilled 1 to 2 in. (25 to 50 mm) to compensate for the future settlement in rock but still allow for the proper closing of the lid and to provide an even surface that is uniform in appearance. Final adjustments for compaction and surface tolerance shall be done by hand. Lids shall be stretched tight over the stone fill using only an approved lid closing tool, until the lid meets the perimeter edges of

the front and end panels. Using crowbars or other single point leverage bars for lid closing shall be prohibited. The lid shall then be tightly tied with lacing wire, or with wire fasteners if approved by the Owner, along all edges, ends, and internal cell diaphragms by continuous stitching with alternating single and double loops at intervals of not more than 5 in. (125 mm), and a half hitch shall be included at every double loop. Special attention shall be given to see that all projections or wire ends are turned into the baskets. The Contractor shall have the option of providing gabion baskets with separate roll-out lids for the slope baskets. Roll-out lids shall be fabricated of the same material as the basket units and shall be furnished in widths as required for the contract work. as directed by the Owner, or where a complete gabion unit cannot be installed because of space limitations, the basket unit shall be cut, folded, and wired together to suit existing site conditions. The mesh must be cleanly cut and the surplus mesh cut out completely, or folded back and neatly wired to an adjacent gabion face. The assembling, installation, filling, lid closing, and lacing of the reshaped gabion units shall be carried out as specified above.

END OF SECTION 02262

SECTION 02264 - EROSION CONTROL

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of mesh or netting for erosion control. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 PRODUCTS

A. Materials
1. Jute Mesh: Fed. Spec. CCC-C-467.
2. Plastic Mesh: Manufacturer's recommendation.
3. Plastic Netting: Manufacturer's recommendation.
4. Polypropylene Mesh: Manufacturer's recommendation.
5. Woven Fabric Fence: EPA specifications.
6. Hay-Bales: EPA specifications.

1.3 EXECUTION:

A. Preparation: Grade, compact, fertilize, and seed the area to be protected.

B. Installation: Apply blankets either horizontally or vertically to the slope. In ditches, apply blanket in direction of water flow. Lap and anchor blankets according to the manufacturer's instructions. Install woven fabric fence and hay bales adjacent to all excavated areas.

END OF SECTION 02264

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SECTION 02264a - SILT FENCES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing of labor, material and equipment for the installation of silt fencing.

1.2 PRODUCTS

A. Materials
1. Fabricated Units
a. Posts: 36" long, 2" hardwood or "T" or "U" type steel.
b. Fence: Woven wire, 14-1/2 ga. 6-inch max. mesh opening.
c. Filter Cloth: MIRAFI 100X or approved equal.
2. Prefabricated Units
a. Envirofence by MIRAFI or approved equal.

1.3 EXECUTION

A. The Contractor shall provide and install silt fences as directed by the Owner. It shall be the Contractor's option to provide fabricated reinforced silt fence or prefabricated units, unless otherwise directed. In all installations, the bottom flap of filter cloth shall be firmly embedded into undisturbed or stabilized grade. Embedment shall resist pullout and prevent flow under the installation.

END OF SECTION 02264a

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SECTION 02264b - UNIT PAVERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for unit pavers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Brick pavers set in aggregate, bituminous or mortar setting beds.
b. Concrete pavers set in aggregate, bituminous or mortar setting beds.
c. Asphalt-block pavers set in bituminous setting beds.
d. Rough-stone pavers set in aggregate or mortar setting beds.
e. Plastic or Steel or Aluminum edge restraints.
f. Cast-in-place concrete edge restraints.
g. Precast concrete curbs.
h. Stone curbs.

C. Submittals
1. Product Data: For materials other than water and aggregates.
2. Samples for unit pavers, joint materials, edge restraints, precast concrete curbs, and granite for stone curbs.

D. Quality Assurance
1. Mockups: Build mockups for each form and pattern of unit paver.
a. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

E. Delivery, Storage, And Handling
1. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.
2. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
3. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
4. Store liquids in tightly closed containers protected from freezing.
5. Store asphalt cement and other bituminous materials in tightly closed containers.

F. Project Conditions
1. Cold-Weather Protection: Do not use frozen materials or build on frozen subgrade or setting beds.
2. Weather Limitations for Bituminous Setting Bed: Install bituminous setting bed only when ambient temperature is above 40 deg F (4 deg C) and when base is dry.
3. Cold-Weather Requirements for Mortar and Grout: Heat materials to provide mortar and grout temperatures between 40 and 120 deg F (4 and 49 deg C). Protect unit paver work against freezing for 24 hours after installation.

1.2 PRODUCTS

A. Brick Pavers

1. Brick Pavers: Light-traffic paving brick; ASTM C 902; Class SX for exposure to freezing weather **OR** Class MX for exterior uses that do not expose brick to freezing, **as directed**, Type I for locations exposed to extensive abrasion, such as sidewalks and driveways in public spaces **OR** Type II for locations exposed to intermediate abrasion, such as heavily traveled residential walkways and driveways **OR** Type III for locations exposed to low abrasion, such as floors and patios exposed in single-family homes, **as directed**. Application PS normal tolerance for installation with grouted joints **OR** Application PX close tolerance for ungrouted joints **OR** Application PA non-uniform sized for decorative effect, **as directed**. Provide brick without frogs or cores in surfaces exposed to view in the completed Work.
   a. Thickness: 1-1/4 inches (32 mm) **OR** 1-1/2 inches (38 mm) **OR** 1-5/8 inches (41 mm) **OR** 2-1/4 inches (57 mm) **OR** 2-5/8 inches (67 mm), **as directed**.
   b. Face Size: 3-5/8 by 7-5/8 inches (92 by 194 mm) **OR** 3-5/8 by 11-5/8 inches (92 by 295 mm) **OR** 7-5/8 by 7-5/8 inches (194 by 194 mm), **as directed**.
   c. Color: As selected from manufacturer's full range.
2. Temporary Protective Coating: Precoat exposed surfaces of brick pavers with a temporary protective coating that is compatible with brick, mortar, and grout products.
3. Brick Pavers: Heavy vehicular paving brick; ASTM C 1272, Type F, Application PX **OR** Type R, Application PS **OR** Type R, Application PX **OR** Type R, Application PA, **as directed**. Provide brick without frogs or cores in surfaces exposed to view in the completed Work.
   a. Type R is for units set in a mortar setting bed or a bituminous setting bed supported by an adequate base. Type F is for units set in a sand setting bed with sand between the pavers. Application PS is for general use; Application PX is for pavers with close dimensional tolerances. Application PX must be selected if specifying Type F
   b. Thickness: 2-1/4 inches (57 mm) **OR** 2-5/8 inches (67 mm), **as directed**.
   c. Face Size: 3-3/4 by 7-1/2 inches (95 by 190 mm) **OR** 3-5/8 by 7-5/8 inches (92 by 194 mm) **OR** 3-5/8 by 11-5/8 inches (92 by 295 mm) **OR** 7-5/8 by 7-5/8 inches (194 by 194 mm) **OR** 4 by 8 inches (102 by 203 mm) **OR** 4 by 12 inches (102 by 305 mm) **OR** 8 by 8 inches (203 by 203 mm), **as directed**.
   d. Color: As selected from manufacturer's full range.
4. Efflorescence: Brick shall be rated "not effloresced" when tested according to ASTM C 67.
5. Temporary Protective Coating: Precoat exposed surfaces of brick pavers with a continuous film of a temporary protective coating that is compatible with brick, mortar, and grout products and can be removed without damaging grout or brick. Do not coat unexposed brick surfaces.

B. Concrete Pavers
1. Concrete Pavers: Solid interlocking paving units complying with ASTM C 936 and resistant to freezing and thawing when tested according to ASTM C 67, made from normal-weight aggregates.
   a. Thickness: 2-3/8 inches (60 mm) **OR** 3-1/8 inches (80 mm), **as directed**.
   b. Face Size and Shape: 3-7/8 inches (98 mm) square **OR** 4-7/16 inches (113 mm) square, **as directed**.
   c. Face Size and Shape: 3-7/8-by-7-7/8 inch (98-by-200 mm) **OR** 4-7/16-by-8-7/8 inch (113-by 225-mm), **as directed,** rectangle.
   d. Face Size and Shape: 5-1/2-inch (140-mm) octagon with attached 3-1/2-inch (89-mm) square **OR** 4-1/2-by-9 inch (114-by-229 mm) rectangle with saw-tooth edges, **as directed**.
   e. Color: As selected from manufacturer's full range.
2. Concrete Pavers: Solid paving units, made from normal-weight concrete with a compressive strength not less than 5000 psi (34 MPa) **OR** 6000 psi (41 MPa), **as directed**, water absorption not more than 5 percent according to ASTM C 140, and no breakage and not more than 1 percent mass loss when tested for freeze-thaw resistance according to ASTM C 67.
   a. Thickness: 1-5/8 inches (41 mm) **OR** 1-3/4 inches (45 mm) **OR** 2 inches (51 mm) **OR** 2-3/8 inches (60 mm), **as directed**.
   b. Face Size and Shape: 8-7/8 inches (225 mm) square **OR** 9 inches (229 mm) square **OR** 12 inches (305 mm) square **OR** 18 inches (457 mm) square **OR** 24 inches (610 mm) square, **as directed**.

c. Face Size and Shape: 9-by-18 inch (229-by-457 mm) **OR** 12-by-24 inch (305-by-610 mm), **as directed,** rectangle.
d. Face Size and Shape: As indicated.
e. Color: As selected from manufacturer's full range.

C. Asphalt-Block Pavers
1. Asphalt-Block Pavers: Solid units made from asphalt cement complying with ASTM D 312, Type III; inorganic stone dust or cement filler; and coarse aggregate, consisting of clean, hard, unweathered stone crushed into angular particles varying in size up to 3/8 inch (9.5 mm).
a. Thickness: 1-1/4 inches (32 mm) **OR** 2 inches (51 mm), **as directed**.
b. Face Size: 4 by 6 inches (102 by 152 mm) **OR** 6 by 6 inches (152 by 152 mm) **OR** 8 by 8 inches (203 by 203 mm) **OR** 8-inch- (203-mm-) wide hexagon, **as directed**.
c. Finish: Natural, smooth **OR** Ground **OR** Ground and sandblasted, **as directed**.
d. Color: As selected from manufacturer's full range.

D. Rough-Stone Pavers
1. Rough-Stone Pavers: Rectangular tumbled paving stones, with split or thermal-finished faces and edges, made from granite complying with ASTM C 615.
a. Granite Color and Grain: Light gray **OR** Dark gray **OR** Buff **OR** White **OR** Black **OR** Pink, **as directed,** with medium **OR** fine, **as directed,** grain.
b. Thickness: 1-1/4 inches (32 mm) **OR** 2 inches (51 mm) **OR** 3 inches (76 mm) **OR** 4 inches (102 mm) **OR** 4 inches (102 mm), plus or minus 1/2 inch (13 mm), -**as directed**.
c. Face Size: 4 by 4 inches (100 by 100 mm), plus or minus 1/2 inch (13 mm) **OR** 3 to 5 inches (75 to 125 mm) by 8 to 12 inches (200 to 300 mm), **as directed**.

E. Accessories
1. Plastic Edge Restraints: Triangular PVC extrusions 1-3/4 inches (45 mm) high by 3-1/2 inches (89 mm) wide **OR** 3-1/8 inches (79 mm) high by 9-1/2 inches (241 mm) wide, **as directed**; rigid type for straight edges and flexible type for curved edges, with pipe connectors and 3/8-inch (9.5-mm) diameter by 12-inch- (300-mm-) long steel spikes.
2. Steel Edge Restraints: Painted steel edging 3/16 inch (4.8 mm) thick by 4 inches (100 mm) high **OR** 1/4 inch (6.4 mm) thick by 5 inches (125 mm) high, **as directed,** with loops pressed from or welded to face to receive stakes at 36 inches (900 mm) o.c., and steel stakes 15 inches (380 mm) long for each loop.
a. Color: As selected from manufacturer's full range.
3. Aluminum Edge Restraints: Straight, 1/8-inch- (3.2-mm-) thick by 4-inch- (100-mm-) high **OR** Straight, 3/16-inch- (4.8-mm-) thick by 4-inch- (100-mm-) high **OR** L-shaped, 1/8-inch- (3.2-mm-) thick by 1-3/8-inch- (35-mm-) high **OR** L-shaped, 3/16-inch- (4.8-mm-) thick by 2-1/4-inch- (57-mm-) high, **as directed,** extruded-aluminum edging with loops pressed from face to receive stakes at 12 inches (300 mm) o.c., and aluminum stakes 12 inches (300 mm) long for each loop.
4. Job-Built Concrete Edge Restraints: Comply with requirements in Division 03 Section "Cast-in-place Concrete" for normal-weight, air-entrained, ready-mixed concrete with minimum 28-day compressive strength of 3000 psi (20 MPa).
5. Precast Concrete Curbs: Made from normal-weight concrete with a compressive strength not less than 5000 psi (34 MPa) **OR** 6000 psi (41 MPa), **as directed,** and water absorption not more than 5 percent, in shapes and sizes indicated.
a. Color and Texture: As selected from manufacturer's full range.
6. Stone Curbs: Granite curbing, with face battered 1 inch per foot (1:12), produced in random lengths not less than 36 inches (900 mm) from granite complying with ASTM C 615.
a. Granite Color and Grain: Light gray **OR** Dark gray **OR** Buff **OR** White **OR** Black **OR** Pink, **as directed**, with fine **OR** medium **OR** coarse, **as directed,** grain.
b. Top Width: 4 inches (102 mm) **OR** 5 inches (127 mm) **OR** 6 inches (152 mm), **as directed**.
c. Face Height: 4 inches (102 mm) **OR** 6 inches (152 mm) **OR** 8 inches (203 mm), **as directed**.

d. Total Height: 12 inches (305 mm) **OR** 16 inches (406 mm) **OR** 18 inches (457 mm), **as directed**.
e. Top Finish: Sawed **OR** Thermal **OR** Bush hammered, **as directed**.
f. Face Finish: Split **OR** Sawed **OR** Thermal **OR** Bush hammered, **as directed**.

7. Cork Joint Filler: Preformed strips complying with ASTM D 1752, Type II.
8. Compressible Foam Filler: Preformed strips complying with ASTM D 1056, Grade 2A1.

F. Aggregate Setting-Bed Materials
1. Graded Aggregate for Sub-base: Sound, crushed stone or gravel complying with ASTM D 448 for Size No. 57 **OR** ASTM D 2940, sub-base material **OR** requirements in Division 02 Section "Earthwork" for sub-base material, **as directed**.
2. Graded Aggregate for Base: Sound, crushed stone or gravel complying with ASTM D 448 for Size No. 8 **OR** ASTM D 2940, base material **OR** requirements in Division 02 Section "Earthwork" for base course, **as directed**.
3. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33 for fine aggregate.
4. Stone Screenings for Leveling Course: Sound stone screenings complying with ASTM D 448 for Size No. 10.
5. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing No. 16 (1.18-mm) sieve and no more than 10 percent passing No. 200 (0.075-mm) sieve.
6. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications; made from polyolefins or polyesters, with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
   a. Apparent Opening Size: No. 60 (0.250-mm) sieve, maximum; ASTM D 4751.
   b. Permittivity: 0.02 per second, minimum; ASTM D 4491.
7. Drainage Geotextile: Nonwoven needle-punched geotextile made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following:
   a. Apparent Opening Size: No. 40 (0.425-mm) sieve, maximum; ASTM D 4751.
   b. Permittivity: 0.5 per second, minimum; ASTM D 4491.
8. Herbicide: Commercial chemical for weed control, registered with the EPA. Provide in granular, liquid, or wettable powder form.

G. Bituminous Setting-Bed Materials
1. Primer for Base: ASTM D 2028, cutback asphalt, grade as recommended by unit paver manufacturer.
2. Fine Aggregate for Setting Bed: ASTM D 1073, No. 2 or No. 3.
3. Asphalt Cement: ASTM D 3381, Viscosity Grade AC-10 or Grade AC-20.
4. Neoprene-Modified Asphalt Adhesive: Paving manufacturer's standard adhesive consisting of oxidized asphalt combined with 2 percent neoprene and 10 percent long-fibered mineral fibers containing no asbestos.
5. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing No. 16 (1.18-mm) sieve and no more than 10 percent passing No. 200 (0.075-mm) sieve.

H. Mortar Setting-Bed Materials
1. Portland Cement: ASTM C 150, Type I or II.
2. Hydrated Lime: ASTM C 207, Type S.
3. Sand: ASTM C 144.
4. Latex Additive: Water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by manufacturer for use with field-mixed portland cement mortar bed, and not containing a retarder.
5. Water: Potable.
6. Reinforcing Wire: Galvanized, welded, 0.062-inch- (1.57-mm-) diameter wire; 2-by-2-inch (51-by-51-mm) mesh; comply with ASTM A 185 and ASTM A 82 except for minimum wire size.

I. Grout Materials

1. Sand-Portland Cement Grout: ANSI A108.10, composed of white or gray cement, unfading mineral pigments and white or colored sand as required to produce required color.
   a. Latex Additive: Manufacturer's standard acrylic-resin or styrene-butadiene-rubber water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed sand-portland cement grout.
2. Polymer-Modified Grout: ANSI A118.7, sanded grout; in color indicated.
   a. Product Type: Dry mix, containing ethylene vinyl acetate, in dry, redispersible form, prepackaged with other dry ingredients.
   b. Product Type: Two-component mix, containing liquid-latex and prepackaged dry-grout mix.
   c. Product Type: Either dry mix, containing ethylene vinyl acetate, in dry, redispersible form, prepackaged with other dry ingredients, or two-component mix, containing liquid-latex and prepackaged dry-grout mix.
3. Grout Colors: As selected from manufacturer's full range.
4. Water: Potable.

J. Bituminous Setting-Bed Mix
1. Mix bituminous setting-bed materials at an asphalt plant in approximate proportion, by weight, of 7 percent asphalt cement to 93 percent fine aggregate, unless otherwise indicated. Heat mixture to 300 deg F (149 deg C).

K. Mortar And Grout Mixes
1. General: Comply with referenced standards and with manufacturers' written instructions. Discard mortars and grout if they have reached their initial set before being used.
2. Mortar-Bed Bond Coat: Mix neat cement or cement and sand with latex additive **OR** water, **as directed,** to a creamy consistency.
3. Portland Cement-Lime Setting-Bed Mortar: Type M complying with ASTM C 270, Proportion Specification.
4. Latex-Modified, Portland Cement Setting-Bed Mortar: Comply with written instructions of latex-additive manufacturer to produce stiff mixture with a moist surface when bed is ready to receive pavers.
5. Latex-Modified, Portland Cement Slurry Bond Coat: Mix portland cement, sand, and latex additive to comply with written instructions of latex-additive manufacturer.
6. Job-Mixed Portland Cement Grout: Mix portland cement and sand to match setting-bed mortar, except omit hydrated lime and use enough water to produce a pourable mixture.
7. Job-Mixed, Polymer-Modified Portland Cement Grout: Add liquid-latex additive to portland cement and sand in proportion and concentration recommended by liquid-latex manufacturer. Proportion cement and sand to comply with written instructions of latex-additive manufacturer.
   a. Pigmented Grout: Select and proportion pigments with other ingredients to produce color required. Do not exceed pigment-to-cement ratio of 1:10, by weight.
   b. Colored-Aggregate Grout: Produce color required by combining colored sand with portland cement of selected color.
8. Polymer-Modified Grout Mix: Proportion and mix grout ingredients according to grout manufacturer's written instructions.

1.3 EXECUTION

A. Installation, General
1. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
2. Cut unit pavers with motor-driven masonry saw equipment to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible.
   a. For concrete pavers, a block splitter may be used.

3. Joint Pattern: Running bond **OR** Herringbone **OR** Basket weave **OR** Match and continue existing unit paver joint pattern, **as directed**.
4. Pavers over Waterproofing: Exercise care in placing pavers and setting materials over waterproofing so protection materials are not displaced and waterproofing is not punctured or otherwise damaged. Carefully replace protection materials that become displaced and arrange for repair of damaged waterproofing before covering with paving.
   a. Provide joint filler at waterproofing that is turned up on vertical surfaces, unless otherwise indicated; where unfilled joints are indicated, provide temporary filler or protection until paver installation is complete.
5. Tolerances: Do not exceed 1/16-inch (1.6-mm) unit-to-unit offset from flush (lippage) nor 1/8 inch in 24 inches (3 mm in 600 mm) and 1/4 inch in 10 feet (6 mm in 3 m) from level, or indicated slope, for finished surface of paving. For smooth pavers where slopes to drains are critical, do not exceed 1/32-inch (0.8-mm) unit-to-unit offset from flush (lippage) nor 1/8 inch in 10 feet (3 mm in 3 m) from level, or indicated slope, for finished surface of paving.
6. Expansion and Control Joints:
   a. Provide foam filler as backing for sealant-filled joints. Install joint filler before setting pavers.

      OR

      Provide joint filler at locations and of widths indicated. Install joint filler before setting pavers. Make top of joint filler flush with top of pavers.
7. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.
8. Provide steps made of pavers as indicated. Install paver steps before installing adjacent pavers.

B. Aggregate Setting-Bed Applications
1. Compact soil subgrade uniformly to at least 95 percent of ASTM D 698 **OR** ASTM D 1557, **as directed,** laboratory density.
2. Proof-roll prepared subgrade to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined, and replace with compacted backfill or fill as directed.
3. Place separation geotextile over prepared subgrade, overlapping ends and edges at least 12 inches (300 mm).
4. Place aggregate subbase and base **OR** base, **as directed.** Do not exceed 1/32-inch (0.8-mm) unit-to-unit offset from flush (lippage) nor 1/8 inch in 10 feet (3 mm in 3 m) from level, or indicated slope, for finished surface of paving, compact by tamping with plate vibrator, and screed to depth indicated.
5. Place drainage geotextile over compacted base course, overlapping ends and edges at least 12 inches (300 mm).
6. Place leveling course and screed to a thickness of 1 to 1-1/2 inches (25 to 38 mm), taking care that moisture content remains constant and density is loose and constant until pavers are set and compacted.
7. Treat leveling course with herbicide to inhibit growth of grass and weeds.
8. Set pavers with a minimum joint width of 1/16 inch (1.5 mm) and a maximum of 1/8 inch (3 mm), being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars.
9. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbf (16- to 22-kN) compaction force at 80 to 90 Hz.
10. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.
11. Do not allow traffic on installed pavers until sand has been vibrated into joints.
12. Repeat joint-filling process 30 days later.

C. Bituminous Setting-Bed Applications
1. Apply primer to concrete slab or binder course immediately before placing setting bed.

2. Prepare for setting-bed placement by locating 3/4-inch- (19-mm-) deep control bars approximately 11 feet (3.3 m) apart, to serve as guides for striking board. Adjust bars for accurate setting of paving units to finished grades indicated.
3. Place bituminous setting bed between control bars. Spread mix at a minimum temperature of 250 deg F (121 deg C). Strike setting bed smooth, firm, even, and not less than 3/4 inch (19 mm) thick. Add fresh bituminous material to low, porous spots after each pass of striking board. Carefully fill depressions that remain after removing depth-control bars.
   a. Roll setting bed with power roller to a nominal depth of 3/4 inch (19 mm). Adjust thickness as necessary to allow accurate setting of unit pavers to finished grades indicated. Complete rolling before mix temperature cools to 185 deg F (85 deg C).
4. Apply neoprene-modified asphalt adhesive to cold setting bed by squeegeeing or troweling to a uniform thickness of 1/16 inch (1.6 mm). Proceed with setting of paving units only after adhesive is tacky and surface is dry to touch.
5. Place pavers carefully by hand, maintaining accurate alignment and uniform top surface. Protect newly laid pavers with plywood panels on which workers can stand. If additional leveling of paving is required, and before treating joints, roll paving with power roller.
6. Joint Treatment: Place unit pavers with hand-tight joints. Fill joints by sweeping sand over paved surface until joints are filled. Remove excess sand after joints are filled.

D. Mortar Setting-Bed Applications
1. Saturate concrete sub-base with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.
2. Apply mortar-bed bond coat over surface of concrete sub-base about 15 minutes before placing setting bed. Limit area of bond coat to avoid its drying out before placing setting bed. Do not exceed 1/16-inch (1.6-mm) thickness for bond coat.
3. Apply mortar bed over bond coat immediately after applying bond coat. Spread and screed to subgrade elevations required for accurate setting of pavers to finished grades indicated.
4. Place reinforcing wire over concrete sub-base, lapped at joints by at least one full mesh and supported so mesh becomes embedded in the middle of setting bed. Hold edges back from vertical surfaces approximately 1/2 inch (13 mm).
5. Place mortar bed with reinforcing wire fully embedded in middle of setting bed. Spread and screed setting bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.
6. Mix and place only that amount of mortar that can be covered with pavers before initial set. Cut back and discard setting-bed material that has reached initial set before placing pavers.
7. Wet brick pavers before laying if the initial rate of absorption exceeds 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.
8. Place pavers before initial set of cement occurs. Immediately before placing pavers, apply uniform 1/16-inch- (1.5-mm-) thick, slurry bond coat to bed or to back of each paver.
9. Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation before initial set of mortar; do not return to areas already set or disturb pavers for purposes of realigning finished surfaces or adjusting joints.
10. Spaced Joint Widths: Provide 3/8-inch (10-mm) **OR** 1/2-inch (13-mm) **OR** 3/4-inch (19-mm), **as directed,** nominal joint width with variations not exceeding plus or minus 1/16 inch (1.5 mm) **OR** 1/8 inch (3 mm) **OR** 3/16 inch (4.5 mm), **as directed**.
11. Grout joints as soon as possible after initial set of setting bed.
    a. Force grout into joints, taking care not to smear grout on adjoining surfaces.
    b. Tool exposed joints slightly concave when thumbprint hard.
12. Cure grout by maintaining in a damp condition for seven days, unless otherwise recommended by grout or liquid-latex manufacturer.
13. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.
    a. Remove temporary protective coating from brick pavers as recommended by protective coating manufacturer and as acceptable to unit paver and grout manufacturer. Trap and remove coating to prevent it from clogging drains.

END OF SECTION 02264b

Task	Specification	Specification Description
02264	02242a	Geosynthetic Fabric
02411	02210	Excavation Support And Protection

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SECTION 02452 - STORM DRAINAGE

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for storm drainage. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Pipe and fittings.
b. Nonpressure transition couplings.
c. Pressure pipe couplings.
d. Expansion joints and deflection fittings.
e. Backwater valves.
f. Cleanouts.
g. Drains.
h. Encasement for piping.
i. Manholes.
j. Channel drainage systems.
k. Catch basins.
l. Stormwater inlets.
m. Stormwater detention structures.
n. Pipe outlets.
o. Dry wells.
p. Stormwater disposal systems.

C. Definitions
1. FRP: Fiberglass-reinforced plastic.

D. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings:
a. Manholes: Include plans, elevations, sections, details, frames, and covers.
b. Catch basins, stormwater inlets, and dry wells. Include plans, elevations, sections, details, frames, covers, and grates.
c. Stormwater Detention Structures: Include plans, elevations, sections, details, frames, covers, design calculations, and concrete design-mix reports.
3. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
4. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1 inch equals 50 feet (1:500) and vertical scale of not less than 1 inch equals 5 feet (1:50). Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.
5. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.
6. Field quality-control reports.

E. Delivery, Storage, And Handling
1. Do not store plastic manholes, pipe, and fittings in direct sunlight.
2. Protect pipe, pipe fittings, and seals from dirt and damage.
3. Handle manholes according to manufacturer's written rigging instructions.

4. Handle catch basins and stormwater inlets according to manufacturer's written rigging instructions.

F. Project Conditions
1. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
a. Notify the Owner no fewer than two days in advance of proposed interruption of service.
b. Do not proceed with interruption of service without the Owner written permission.

1.2 PRODUCTS

A. Hub-And-Spigot, Cast-Iron Soil Pipe And Fittings
1. Pipe and Fittings: ASTM A 74, Service class **OR** Extra-Heavy class, **as directed**.
2. Gaskets: ASTM C 564, rubber.
3. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

B. Hubless Cast-Iron Soil Pipe And Fittings
1. Pipe and Fittings: ASTM A 888 or CISPI 301.
2. CISPI-Trademarked, Shielded Couplings:
a. Description: ASTM C 1277 and CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
3. Heavy-Duty, Shielded Couplings:
a. Description: ASTM C 1277 and ASTM C 1540, with stainless-steel shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
4. Cast-Iron, Shielded Couplings:
a. Description: ASTM C 1277 and ASTM A 48/A 48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Ductile-Iron, Culvert Pipe And Fittings
1. Pipe: ASTM A 716, for push-on joints.
2. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.
3. Compact Fittings: AWWA C153, for push-on joints.
4. Gaskets: AWWA C111, rubber.

D. Ductile-Iron, Pressure Pipe And Fittings
1. Push-on-Joint Piping:
a. Pipe: AWWA C151, for push-on joints.
b. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.
c. Compact Fittings: AWWA C153, for push-on joints.
d. Gaskets: AWWA C111, rubber, of shape matching pipe and fittings.
2. Mechanical-Joint Piping:
a. Pipe: AWWA C151, with bolt holes in bell.
b. Standard Fittings: AWWA C110, ductile or gray iron, with bolt holes in bell.
c. Compact Fittings: AWWA C153, with bolt holes in bells.
d. Glands: Cast or ductile iron, with bolt holes and high-strength, cast-iron or high-strength, low-alloy steel bolts and nuts.
e. Gaskets: AWWA C111, rubber, of shape matching pipe, fittings, and glands.

E. Steel Pipe And Fittings

1. Corrugated-Steel Pipe and Fittings: ASTM A 760/A 760M, Type I with fittings of similar form and construction as pipe.
   a. Special-Joint Bands: Corrugated steel with O-ring seals.
   b. Standard-Joint Bands: Corrugated steel.
   c. Coating: Aluminum **OR** Zinc, **as directed**.

F. Aluminum Pipe And Fittings
1. Corrugated Aluminum Pipe and Fittings: ASTM B 745/B 745M, Type I with fittings of similar form and construction as pipe.
   a. Special-Joint Bands: Corrugated steel with O-ring seals.
   b. Standard-Joint Bands: Corrugated steel.

G. ABS Pipe And Fittings
1. ABS Sewer Pipe and Fittings: ASTM D 2751, with bell-and-spigot ends for gasketed joints.
   a. NPS 3 to NPS 6 (DN 80 to DN 150): SDR 35.
   b. NPS 8 to NPS 12 (DN 200 to DN 300): SDR 42.
2. Gaskets: ASTM F 477, elastomeric seals.

H. PE Pipe And Fittings
1. Corrugated PE Drainage Pipe and Fittings NPS 3 to NPS 10 (DN 80 to DN 250): AASHTO M 252M, Type S, with smooth waterway for coupling joints.
   a. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with tube and fittings.
   b. Soiltight Couplings: AASHTO M 252M, corrugated, matching tube and fittings.
2. Corrugated PE Pipe and Fittings NPS 12 to NPS 60 (DN 300 to DN 1500): AASHTO M 294M, Type S, with smooth waterway for coupling joints.
   a. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.
   b. Soiltight Couplings: AASHTO M 294M, corrugated, matching pipe and fittings.

I. PVC Pipe And Fittings
1. PVC Cellular-Core Piping:
   a. PVC Cellular-Core Pipe and Fittings: ASTM F 891, Sewer and Drain Series, PS 50 minimum stiffness, PVC cellular-core pipe with plain ends for solvent-cemented joints.
   b. Fittings: ASTM D 3034, SDR 35, PVC socket-type fittings.
2. PVC Corrugated Sewer Piping:
   a. Pipe: ASTM F 949, PVC, corrugated pipe with bell-and-spigot ends for gasketed joints.
   b. Fittings: ASTM F 949, PVC molded or fabricated, socket type.
   c. Gaskets: ASTM F 477, elastomeric seals.
3. PVC Profile Sewer Piping:
   a. Pipe: ASTM F 794, PVC profile, gravity sewer pipe with bell-and-spigot ends for gasketed joints.
   b. Fittings: ASTM D 3034, PVC with bell ends.
   c. Gaskets: ASTM F 477, elastomeric seals.
4. PVC Type PSM Sewer Piping:
   a. Pipe: ASTM D 3034, SDR 35, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
   b. Fittings: ASTM D 3034, PVC with bell ends.
   c. Gaskets: ASTM F 477, elastomeric seals.
5. PVC Gravity Sewer Piping:
   a. Pipe and Fittings: ASTM F 679, T-1 **OR** T-2, **as directed**, wall thickness, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F 477, elastomeric seals for gasketed joints.
6. PVC Pressure Piping:
   a. Pipe: AWWA C900, Class 100 **OR** Class 150 **OR** Class 200, **as directed**, PVC pipe with bell-and-spigot ends for gasketed joints.

b. Fittings: AWWA C900, Class 100 **OR** Class 150 **OR** Class 200, **as directed**, PVC pipe with bell ends
c. Gaskets: ASTM F 477, elastomeric seals.

7. PVC Water-Service Piping:
   a. Pipe: ASTM D 1785, Schedule 40 **OR** Schedule 80, **as directed**, PVC, with plain ends for solvent-cemented joints.
   b. Fittings: ASTM D 2466, Schedule 40 **OR** ASTM D 2467, Schedule 80, **as directed**, PVC, socket type.

J. Fiberglass Pipe And Fittings
1. Fiberglass Sewer Pipe: ASTM D 3262, RTRP for gasketed joints fabricated with Type 2, polyester **OR** Type 4, epoxy, **as directed**, resin.
   a. Liner: Reinforced thermoset **OR** Nonreinforced thermoset **OR** Thermoplastic **OR** No liner, **as directed**.
   b. Grade: Reinforced, surface layer matching pipe resin **OR** Nonreinforced, surface layer matching pipe resin **OR** No surface layer, **as directed**.
   c. Stiffness: 9 psig (62 kPa) **OR** 18 psig (124 kPa) **OR** 36 psig (248 kPa) **OR** 72 psig (496 kPa), **as directed**.
2. Fiberglass Nonpressure Fittings: ASTM D 3840, RTRF for gasketed joints.
   a. Laminating Resin: Type 1, polyester **OR** Type 2, epoxy, **as directed**, resin.
   b. Reinforcement: Grade with finish compatible with resin.
3. Gaskets: ASTM F 477, elastomeric seals.

K. Concrete Pipe And Fittings
1. Nonreinforced-Concrete Sewer Pipe and Fittings: ASTM C 14 (ASTM C 14M), Class 1 **OR** Class 2 **OR** Class 3, **as directed**, with bell-and-spigot **OR** tongue-and-groove, **as directed** ends and gasketed joints with ASTM C 443 (ASTM C 443M), rubber gaskets **OR** sealant joints with ASTM C 990 (ASTM C 990M), bitumen or butyl-rubber sealant, **as directed**.
2. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76 (ASTM C 76M).
   a. Bell-and-spigot **OR** Tongue-and-groove, **as directed**, ends and gasketed joints with ASTM C 443 (ASTM C 443M), rubber gaskets **OR** sealant joints with ASTM C 990 (ASTM C 990M), bitumen or butyl-rubber sealant, **as directed**.
   b. Class I, Wall A **OR** Wall B, **as directed**.
   c. Class II, Wall A **OR** Wall B **OR** Wall C, **as directed**.
   d. Class III, Wall A **OR** Wall B **OR** Wall C, **as directed**.
   e. Class IV, Wall A **OR** Wall B **OR** Wall C, **as directed**.
   f. Class V, Wall B **OR** Wall C, **as directed**.

L. Nonpressure Transition Couplings
1. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
2. Sleeve Materials:
   a. For Concrete Pipes: ASTM C 443 (ASTM C 443M), rubber.
   b. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
   c. For Fiberglass Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
   d. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
   e. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
3. Unshielded, Flexible Couplings:
   a. Description: Elastomeric sleeve, with stainless-steel shear ring, **as directed**, and corrosion-resistant-metal tension band and tightening mechanism on each end.
4. Shielded, Flexible Couplings:

a. Description: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

5. Ring-Type, Flexible Couplings:
   a. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

M. Pressure Pipe Couplings
1. Description: AWWA C219, tubular-sleeve coupling, with center sleeve, gaskets, end rings, and bolt fasteners.
2. Metal, bolted, sleeve-type, reducing or transition coupling, for joining underground pressure piping. Include 150-psig (1035-kPa) **OR** 200-psig (1380-kPa), **as directed**, minimum pressure rating and ends sized to fit adjoining pipes.
3. Center-Sleeve Material: Manufacturer's standard **OR** Carbon steel **OR** Stainless steel **OR** Ductile iron **OR** Malleable iron, **as directed**.
4. Gasket Material: Natural or synthetic rubber.
5. Metal Component Finish: Corrosion-resistant coating or material.

N. Expansion Joints And Deflection Fittings
1. Ductile-Iron Flexible Expansion Joints:
   a. Description: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250-psig (1725-kPa) minimum working pressure and for offset and expansion indicated.
2. Ductile-Iron Expansion Joints:
   a. Description: Three-piece assembly of telescoping sleeve with gaskets and restrained-type, ductile-iron or steel with protective coating, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Include rating for 250-psig (1725-kPa) minimum working pressure and for expansion indicated.
3. Ductile-Iron Deflection Fittings:
   a. Description: Compound-coupling fitting, with ball joint, flexing section, gaskets, and restrained-joint ends, complying with AWWA C110 or AWWA C153. Include rating for 250-psig (1725-kPa) minimum working pressure and for up to 15 degrees of deflection.

O. Backwater Valves
1. Cast-Iron Backwater Valves:
   a. Description: ASME A112.14.1, gray-iron body and bolted cover, with bronze seat.
   b. Horizontal type; with swing check valve and hub-and-spigot ends.
   c. Combination horizontal and manual gate-valve type; with swing check valve, integral gate valve, and hub-and-spigot ends.
   d. Terminal type; with bronze seat, swing check valve, and hub inlet.
2. Plastic Backwater Valves:
   a. Description: Horizontal type; with PVC body, PVC removable cover, and PVC swing check valve.

P. Cleanouts
1. Cast-Iron Cleanouts:
   a. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
   b. Top-Loading Classification(s): Light Duty **OR** Medium Duty **OR** Heavy Duty **OR** Extra-Heavy Duty, **as directed**.
   c. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.
2. Plastic Cleanouts:

a. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

Q. Drains
1. Cast-Iron Area Drains:
a. Description: ASME A112.6.3 gray-iron round body with anchor flange and round secured **OR** non-secured, **as directed**, grate. Include bottom outlet with inside calk or spigot connection, of sizes indicated.
b. Top-Loading Classification(s): Medium Duty **OR** Heavy Duty, **as directed**.
2. Cast-Iron Trench Drains:
a. Description: ASME A112.6.3, 6-inch- (150-mm-) wide top surface, rectangular body with anchor flange or other anchoring device, and rectangular secured **OR** non-secured, **as directed**, grate. Include units of total length indicated and quantity of bottom outlets with inside calk or spigot connections, of sizes indicated.
b. Top-Loading Classification(s): Medium Duty **OR** Heavy Duty **OR** Extra-Heavy Duty **OR** Medium and Heavy Duty **OR** Medium and Extra-Heavy Duty **OR** Heavy and Extra-Heavy Duty **OR** Medium, Heavy, and Extra-Heavy Duty, **as directed**.
3. Steel Trench Drains:
a. Description: Factory fabricated from ASTM A 242/A 242M, welded steel plate, to form rectangular body with uniform bottom downward slope of 2 percent toward outlet, anchor flange, and grate. Include units of total length indicated, bottom outlet of size indicated, outlet strainer, acid-resistant enamel coating on inside and outside surfaces, and grate with openings of total free area at least two times cross-sectional area of outlet.
b. Plate Thicknesses: 1/8 inch (3.2 mm) **OR** 1/4 inch (6.4 mm), **as directed**.
c. Overall Widths: 7-1/2 inches (190 mm) **OR** 12-1/3 inches (313 mm), **as directed**.
1) Grate Openings: 1/4 inch (6.4 mm) circular **OR** 3/8 inch (9.5 mm) circular **OR** 3/8-by-3-inch (9.5-by-76-mm) slots, **as directed**.

R. Encasement For Piping
1. Standard: ASTM A 674 or AWWA C105.
2. Material: Linear low-density polyethylene film of 0.008-inch (0.20-mm) **OR** high-density, cross-laminated polyethylene film of 0.004-inch (0.10-mm), **as directed**, minimum thickness.
3. Form: Sheet **OR** Tube, **as directed**.
4. Color: Black **OR** Natural, **as directed**.

S. Manholes
1. Standard Precast Concrete Manholes:
a. Description: ASTM C 478 (ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.
b. Diameter: 48 inches (1200 mm) minimum unless otherwise indicated.
c. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
d. Base Section: 6-inch (150-mm) minimum thickness for floor slab and 4-inch (102-mm) minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
e. Riser Sections: 4-inch (102-mm) minimum thickness, and lengths to provide depth indicated.
f. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
g. Joint Sealant: ASTM C 990 (ASTM C 990M), bitumen or butyl rubber.
h. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
i. Steps: Individual FRP steps or FRP ladder **OR** Individual FRP steps; FRP ladder; or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP **OR** ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing

rods encased in ASTM D 4101, PP, **as directed**, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches (1500 mm).

j. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.

OR

Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

2. Designed Precast Concrete Manholes:
   a. Description: ASTM C 913; designed according to ASTM C 890 for A-16 (AASHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.
   b. Ballast: Increase thickness of one or more precast concrete sections or add concrete to manhole as required to prevent flotation.
   c. Joint Sealant: ASTM C 990 (ASTM C 990M), bitumen or butyl rubber.
   d. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
   e. Steps: Individual FRP steps or FRP ladder **OR** Individual FRP steps; FRP ladder; or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP **OR** ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP, **as directed**, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches (1500 mm).
   f. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.

   OR

   Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, to match diameter of manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope.
3. Fiberglass Manholes:
   a. Description: ASTM D 3753.
   b. Diameter: 48 inches (1200 mm) minimum unless otherwise indicated.
   c. Ballast: Increase thickness of concrete base as required to prevent flotation.
   d. Base Section: Concrete, 6-inch (150-mm) minimum thickness.
   e. Resilient Pipe Connectors (if required): ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
   f. Steps: Individual FRP steps or FRP ladder, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches (1500 mm).
   g. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.

   OR

   Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.
4. Manhole Frames and Covers:

a. Description: Ferrous; 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser with 4-inch- (102-mm-) minimum width flange and 26-inch- (660-mm-) diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
b. Material: ASTM A 536, Grade 60-40-18 ductile **OR** ASTM A 48/A 48M, Class 35 gray, **as directed**, iron unless otherwise indicated.

T. Concrete
1. General: Cast-in-place concrete according to ACI 318, ACI 350/350R (ACI 350M/350RM), and the following:
a. Cement: ASTM C 150, Type II.
b. Fine Aggregate: ASTM C 33, sand.
c. Coarse Aggregate: ASTM C 33, crushed gravel.
d. Water: Potable.
2. Portland Cement Design Mix: 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio.
a. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
b. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.
3. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
a. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
1) Invert Slope: 1 **OR** 2, **as directed**, percent through manhole.
b. Benches: Concrete, sloped to drain into channel.
1) Slope: 4 **OR** 8, **as directed**, percent.
4. Ballast and Pipe Supports: Portland cement design mix, 3000 psi (20.7 MPa) minimum, with 0.58 maximum water/cementitious materials ratio.
a. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
b. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

U. Polymer-Concrete, Channel Drainage Systems
1. General Requirements for Polymer-Concrete, Channel Drainage Systems: Modular system of precast, polymer-concrete channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling. Include quantity of units required to form total lengths indicated.
2. Sloped-Invert, Polymer-Concrete Systems:
a. Channel Sections:
1) Interlocking-joint, precast, modular units with end caps.
2) 4-inch (102-mm) inside width and deep, rounded bottom, with built-in invert slope of 0.6 percent and with outlets in quantities, sizes, and locations indicated.
3) Extension sections necessary for required depth.
4) Frame: Include gray-iron or steel frame for grate.
b. Grates:
1) Manufacturer's designation "Heavy **OR** “Medium, **as directed**, Duty," with slots or perforations that fit recesses in channels.
2) Material: Fiberglass **OR** Galvanized steel **OR** Gray iron **OR** Stainless steel, **as directed**.
c. Covers: Solid gray iron if indicated.
d. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
3. Narrow-Width, Level-Invert, Polymer-Concrete Systems:
a. Channel Sections:
1) Interlocking-joint, precast, modular units with end caps.

2) 5-inch (127-mm) inside width and 9-3/4-inch- (248-mm-) deep, rounded bottom, with level invert and with NPS 4 (DN 100) outlets in quantities, sizes, and locations indicated.

b. Grates:
1) Slots or perforations that fit recesses in channels.
2) Material: Fiberglass **OR** Galvanized steel **OR** Gray iron **OR** Stainless steel, **as directed**.

c. Covers: Solid gray iron if indicated.

d. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.

4. Wide-Width, Level-Invert, Polymer-Concrete Systems:
a. Channel Sections:
1) Interlocking-joint, precast, modular units with end caps.
2) 8-inch (203-mm) inside width and 13-3/4-inch- (350-mm-) deep, rounded bottom, with level invert and with outlets in quantities, sizes, and locations indicated.

b. Grates:
1) Slots or other openings that fit recesses in channels.
2) Material: Fiberglass **OR** Gray iron, **as directed**.

c. Covers: Solid gray iron if indicated.

d. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.

5. Drainage Specialties: Precast, polymer-concrete units.
a. Large Catch Basins:
1) 24-by-12-inch (610-by-305-mm) polymer-concrete body, with outlets in quantities and sizes indicated.
2) Gray-iron slotted grate.
3) Frame: Include gray-iron or steel frame for grate.

b. Small Catch Basins:
1) 19- to 24-inch by approximately 6-inch (483- to 610-mm by approximately 150-mm) polymer-concrete body, with outlets in quantities and sizes indicated.
2) Gray-iron slotted grate.
3) Frame: Include gray-iron or steel frame for grate.

c. Oil Interceptors:
1) Polymer-concrete body with interior baffle and four steel support channels and two 1/4-inch- (6.4-mm-) thick, steel-plate covers.
2) Steel-plate covers.
3) Capacity: 140 gal. (530 L) **OR** 200 gal. (757 L) **OR** 260 gal. (984 L), **as directed**.
4) Inlet and Outlet: NPS 4 (DN 100) **OR** NPS 6 (DN 150), **as directed**.

d. Sediment Interceptors:
1) 27-inch- (686-mm-) square, polymer-concrete body, with outlets in quantities and sizes indicated.
2) 24-inch- (610-mm-) square, gray-iron frame and slotted grate.

6. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
7. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

V. Plastic, Channel Drainage Systems
1. General Requirements for Plastic, Channel Drainage Systems:
a. Modular system of plastic channel sections, grates, and appurtenances.
b. Designed so grates fit into frames without rocking or rattling.
c. Number of units required to form total lengths indicated.

2. Fiberglass Systems:
a. Channel Sections:
1) Interlocking-joint, fiberglass modular units, with built-in invert slope of approximately 1 percent and with end caps.
2) Rounded or inclined inside bottom surface, with outlets in quantities, sizes, and locations indicated.

3) Width: 6 inches (150 mm) **OR** 6 or 8 inches (150 or 203 mm) **OR** 8 inches (203 mm), **as directed**.

b. Factory- or field-attached frames that fit channel sections and grates.
1) Material: Galvanized steel **OR** Stainless steel **OR** Manufacturer's standard metal, **as directed**.

c. Grates with slots or perforations that fit frames.
1) Material: Fiberglass **OR** Galvanized steel **OR** Gray iron **OR** Stainless steel, **as directed**.

d. Covers: Solid gray iron if indicated.

e. Drainage Specialties:
1) Large Catch Basins: 24-inch- (610-mm-) square plastic body, with outlets in quantities and sizes indicated. Include gray-iron frame and slotted grate.
2) Small Catch Basins: 12-by-24-inch (305-by-610-mm) plastic body, with outlets in quantities and sizes indicated. Include gray-iron frame and slotted grate.

3. PE Systems:
a. Channel Sections: Interlocking-joint, PE modular units, 4 inches (102 mm) wide, with end caps. Include rounded bottom, with level invert and with outlets in quantities, sizes, and locations indicated.

b. Grates: PE, ladder shaped; with stainless-steel screws.

c. Color: Gray unless otherwise indicated.

d. Drainage Specialties: Include the following PE components:
1) Drains: 4-inch- (102-mm-) diameter, round, slotted top; with NPS 4 (DN 100) bottom outlet.
OR
Drains: 8-inch- (203-mm-) diameter, round, slotted top; with NPS 6 (DN 150) bottom outlet.
OR
Drains: 4-inch- (102-mm-) square, slotted top; with NPS 3 (DN 80) bottom outlet.
OR
Drains: 8-inch- (203-mm-) square, slotted top; with NPS 6 (DN 150) bottom outlet.
OR
Catch Basins: 12-inch- (305-mm-) square plastic body, with outlets in quantities and sizes indicated. Include PE slotted grate 11-3/4 inches (298 mm) square by 1-1/8 inches (28.6 mm) thick.

4. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.

5. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

W. Catch Basins
1. Standard Precast Concrete Catch Basins:
a. Description: ASTM C 478 (ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.

b. Base Section: 6-inch (150-mm) minimum thickness for floor slab and 4-inch (102-mm) minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.

c. Riser Sections: 4-inch (102-mm) minimum thickness, 48-inch (1200-mm) diameter, and lengths to provide depth indicated.

d. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.

e. Joint Sealant: ASTM C 990 (ASTM C 990M), bitumen or butyl rubber.

f. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
OR
Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch (150- to 225-mm) total thickness, that match 24-inch- (610-mm-) diameter frame and grate.

g. Steps: Individual FRP steps or FRP ladder **OR** Individual FRP steps; FRP ladder; or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP **OR** ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP, **as directed**, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of catch basin to finished grade is less than 60 inches (1500 mm).

h. Pipe Connectors: ASTM C 923 (ASTM C 923M), resilient, of size required, for each pipe connecting to base section.

2. Designed Precast Concrete Catch Basins: ASTM C 913, precast, reinforced concrete; designed according to ASTM C 890 for A-16 (ASSHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for joint sealants.

a. Joint Sealants: ASTM C 990 (ASTM C 990M), bitumen or butyl rubber.

b. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.

OR

Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch (150- to 225-mm) total thickness, that match 24-inch- (610-mm-) diameter frame and grate.

c. Steps: Individual FRP steps or FRP ladder **OR** Individual FRP steps; FRP ladder; or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP **OR** ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP, **as directed**, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of catch basin to finished grade is less than 60 inches (1500 mm).

d. Pipe Connectors: ASTM C 923 (ASTM C 923M), resilient, of size required, for each pipe connecting to base section.

3. Frames and Grates (for rectangular structures): ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include flat grate with small square or short-slotted drainage openings.

a. Size: 24 by 24 inches (610 by 610 mm) minimum unless otherwise indicated.

b. Grate Free Area: Approximately 50 percent unless otherwise indicated.

4. Frames and Grates (for round, manhole-type structures): ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser with 4-inch (102-mm) minimum width flange, and 26-inch- (660-mm-) diameter flat grate with small square or short-slotted drainage openings.

a. Grate Free Area: Approximately 50 percent unless otherwise indicated.

X. Stormwater Inlets

1. Curb Inlets: Made with vertical curb opening, of materials and dimensions according to utility standards.

2. Gutter Inlets: Made with horizontal gutter opening, of materials and dimensions according to utility standards. Include heavy-duty frames and grates.

3. Combination Inlets: Made with vertical curb and horizontal gutter openings, of materials and dimensions according to utility standards. Include heavy-duty frames and grates.

4. Frames and Grates: Heavy duty, according to utility standards.

Y. Stormwater Detention Structures

1. Cast-in-Place Concrete, Stormwater Detention Structures: Constructed of reinforced-concrete bottom, walls, and top; designed according to ASTM C 890 for A-16 (AASHTO HS20-44), heavy-traffic, structural loading; of depth, shape, dimensions, and appurtenances indicated.

a. Ballast: Increase thickness of concrete as required to prevent flotation.

b. Grade Rings (if required): Include two or three reinforced-concrete rings, of 6- to 9-inch (150- to 229-mm) total thickness, that match 24-inch- (610-mm-) diameter frame and cover.

c. Steps: Individual FRP steps or FRP ladder **OR** Individual FRP steps; FRP ladder; or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP **OR** ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP, **as directed**, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of structure to finished grade is less than 60 inches (1500 mm).

2. Manhole Frames and Covers: ASTM A 536, Grade 60-40-18, ductile-iron castings designed for heavy-duty service. Include 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser with 4-inch (102-mm) minimum width flange, and 26-inch- (660-mm-) diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."

Z. Pipe Outlets
1. Head Walls: Cast-in-place reinforced concrete, with apron and tapered sides.
2. Riprap Basins: Broken, irregularly sized and shaped, graded stone according to NSSGA's "Quarried Stone for Erosion and Sediment Control."
   a. Average Size: NSSGA No. R-3, screen opening 2 inches (51 mm).
   b. Average Size: NSSGA No. R-4, screen opening 3 inches (76 mm).
   c. Average Size: NSSGA No. R-5, screen opening 5 inches (127 mm).
3. Filter Stone: According to NSSGA's "Quarried Stone for Erosion and Sediment Control," No. FS-2, No. 4 screen opening, average-size graded stone.
4. Energy Dissipaters: According to NSSGA's "Quarried Stone for Erosion and Sediment Control," No. A-1, 3-ton (2721-kg) average weight armor stone, unless otherwise indicated.

AA. Dry Wells
1. Description: ASTM C 913, precast, reinforced, perforated concrete rings. Include the following:
   a. Floor: Cast-in-place concrete.
   b. Cover: Liftoff-type concrete cover with cast-in lift rings.
   c. Wall Thickness: 4 inches (102 mm) minimum with 1-inch (25-mm) diameter or 1-by-3-inch-(25-by-76-mm-) maximum slotted perforations arranged in rows parallel to axis of ring.
      1) Total Free Area of Perforations: Approximately 15 percent of ring interior surface.
      2) Ring Construction: Designed to be self-aligning.
   d. Filtering Material: ASTM D 448, Size No. 24, 3/4- to 2-1/2-inch (19- to 63-mm) washed, crushed stone or gravel.

   OR

   Description: Manufactured PE side panels and top cover that assemble into 50-gal. (190-L) storage capacity units.
   a. Side Panels: With knockout ports for piping and seepage holes.
   b. Top Cover: With knockout port for drain.
   c. Filter Fabric: As recommended by unit manufacturer.
   d. Filtering Material: ASTM D 448, Size No. 24, 3/4- to 2-1/2-inch (19- to 63-mm) washed, crushed stone or gravel.

   OR

   Description: Constructed-in-place aggregate type. Include the following:
   a. Lining: Clay or concrete bricks.

      OR

      Lining: Concrete blocks or precast concrete rings with notches or weep holes.
   b. Filtering Material: ASTM D 448, Size No. 24, 3/4- to 2-1/2-inch (19- to 63-mm) washed, crushed stone or gravel.
   c. Cover: Precast, reinforced-concrete slab, designed for structural loading according to ASTM C 890 and made according to ASTM C 913. Include slab dimensions that will extend 12 inches (300 mm) minimum beyond edge of excavation, with bituminous coating over entire surface. Cast cover with opening for manhole in center.
   d. Manhole: 24-inch- (610-mm-) diameter, reinforced-concrete access lid with steel lift rings. Include bituminous coating over entire surface.

BB. Stormwater Disposal Systems

1. Chamber Systems:
   a. Storage and Leaching Chambers: Molded PE with perforated sides and open bottom. Include number of chambers, distribution piping, end plates, and other standard components as required for system total capacity.
   b. Filtering Material: ASTM D 448, Size No. 24, 3/4- to 2-1/2-inch (19- to 63-mm) washed, crushed stone or gravel.
   c. Filter Mat: Geotextile woven or spun filter fabric, in one or more layers, for minimum total unit weight of 4 oz./sq. yd. (135 g/sq. m).

   OR

   Pipe Systems: Perforated manifold, header, and lateral piping complying with AASHTO M 252M for NPS 10 (DN 250) and smaller, AASHTO M 294M for NPS 12 to NPS 60 (DN 300 to DN 1500). Include proprietary fittings, couplings, seals, and filter fabric.

1.3 EXECUTION

1.4 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Division 02 Section "Earthwork".

B. Piping Installation

1. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
2. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
3. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
4. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
5. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.
6. Install gravity-flow, nonpressure drainage piping according to the following:
   a. Install piping pitched down in direction of flow.
   b. Install piping NPS 6 (DN 150) and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
   c. Install piping with 36-inch (915-mm) **OR** 48-inch (1220-mm) **OR** 60-inch (1520-mm) **OR** 72-inch (1830-mm), **as directed**, minimum cover.
   d. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
   e. Install hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
   f. Install ductile-iron piping and special fittings according to AWWA C600 or AWWA M41.
   g. Install corrugated steel piping according to ASTM A 798/A 798M.
   h. Install corrugated aluminum piping according to ASTM B 788/B 788M.
   i. Install ABS sewer piping according to ASTM D 2321 and ASTM F 1668.
   j. Install PE corrugated sewer piping according to ASTM D 2321.
   k. Install PVC cellular-core piping according to ASTM D 2321 and ASTM F 1668.
   l. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
   m. Install PVC profile gravity sewer piping according to ASTM D 2321 and ASTM F 1668.

n. Install PVC water-service piping according to ASTM D 2321 and ASTM F 1668.
o. Install fiberglass sewer piping according to ASTM D 3839 and ASTM F 1668.
p. Install nonreinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
q. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

7. Install force-main pressure piping according to the following:
   a. Install piping with restrained joints at tee fittings and at horizontal and vertical changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
   b. Install piping with 36-inch (915-mm) **OR** 48-inch (1220-mm) **OR** 60-inch (1520-mm) **OR** 72-inch (1830-mm), **as directed**, minimum cover.
   c. Install **ductile**-iron pressure piping according to AWWA C600 or AWWA M41.
   d. Install ductile-iron special fittings according to AWWA C600.
   e. Install PVC pressure piping according to AWWA M23, or ASTM D 2774 and ASTM F 1668.
   f. Install PVC water-service piping according to ASTM D 2774 and ASTM F 1668.
8. Install corrosion-protection piping encasement over the following underground metal piping according to ASTM A 674 or AWWA C105:
   a. Hub-and-spigot, cast-iron soil pipe and fittings.
   b. Hubless cast-iron soil pipe and fittings.
   c. Ductile-iron pipe and fittings.
   d. Expansion joints and deflection fittings.

C. Pipe Joint Construction
1. Join gravity-flow, nonpressure drainage piping according to the following:
   a. Join hub-and-spigot, cast-iron soil piping with gasketed joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
   b. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
   c. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
   d. Join ductile-iron culvert piping according to AWWA C600 for push-on joints.
   e. Join ductile-iron piping and special fittings according to AWWA C600 or AWWA M41.
   f. Join corrugated steel sewer piping according to ASTM A 798/A 798M.
   g. Join corrugated aluminum sewer piping according to ASTM B 788/B 788M.
   h. Join ABS sewer piping according to ASTM D 2321 and ASTM D 2751 for elastomeric-seal joints.
   i. Join corrugated PE piping according to ASTM D 3212 for push-on joints.
   j. Join PVC cellular-core piping according to ASTM D 2321 and ASTM F 891 for solvent-cemented joints.
   k. Join PVC corrugated sewer piping according to ASTM D 2321 for elastomeric-seal joints.
   l. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasketed joints.
   m. Join PVC profile gravity sewer piping according to ASTM D 2321 for elastomeric-seal joints or ASTM F 794 for gasketed joints.
   n. Join fiberglass sewer piping according to ASTM D 3839 for elastomeric-seal joints.
   o. Join nonreinforced-concrete sewer piping according to ASTM C 14 (ASTM C 14M) and ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
   p. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
   q. Join dissimilar pipe materials with nonpressure-type flexible couplings.
2. Join force-main pressure piping according to the following:
   a. Join ductile-iron pressure piping according to AWWA C600 or AWWA M41 for push-on joints.

b. Join ductile-iron special fittings according to AWWA C600 or AWWA M41 for push-on joints.
c. Join PVC pressure piping according to AWWA M23 for gasketed joints.
d. Join PVC water-service piping according to ASTM D 2855 for solvent-cemented joints.
e. Join dissimilar pipe materials with pressure-type couplings.

D. Backwater Valve Installation
1. Install horizontal-type backwater valves in piping where indicated.
2. Install combination horizontal and manual gate-valve type in piping and in manholes where indicated.
3. Install terminal-type backwater valves on end of piping and in manholes where indicated.

E. Cleanout Installation
1. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
a. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
b. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
c. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
d. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.
e. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches (450 by 450 by 300 mm) deep. Set with tops 1 inch (25 mm) above surrounding earth grade.
f. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

F. Drain Installation
1. Install type of drains in locations indicated.
a. Use Light-Duty, top-loading classification drains in earth or unpaved foot-traffic areas.
b. Use Medium-Duty, top-loading classification drains in paved foot-traffic areas.
c. Use Heavy-Duty, top-loading classification drains in vehicle-traffic service areas.
d. Use Extra-Heavy-Duty, top-loading classification drains in roads.
2. Embed drains in 4-inch (102-mm) minimum concrete around bottom and sides.
3. Fasten grates to drains if indicated.
4. Set drain frames and covers with tops flush with pavement surface.
5. Assemble trench sections with flanged joints.
6. Embed trench sections in 4-inch (102-mm) minimum concrete around bottom and sides.

G. Manhole Installation
1. General: Install manholes, complete with appurtenances and accessories indicated.
2. Install precast concrete manhole sections with sealants according to ASTM C 891.
3. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.
4. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches (76 mm) above finished surface elsewhere unless otherwise indicated.

H. Catch Basin Installation
1. Construct catch basins to sizes and shapes indicated.
2. Set frames and grates to elevations indicated.

I. Stormwater Inlet And Outlet Installation
1. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.
2. Construct riprap of broken stone, as indicated.
3. Install outlets that spill onto grade, anchored with concrete, where indicated.
4. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.
5. Construct energy dissipaters at outlets, as indicated.

J. Dry Well Installation
1. Excavate hole to diameter of at least 6 inches (150 mm) greater than outside of dry well. Do not extend excavation into ground-water table.
2. Install precast, concrete-ring dry wells according to the following:
   a. Assemble rings to depth indicated.
   b. Extend rings to height where top of cover will be approximately 8 inches (203 mm) below finished grade.
   c. Backfill bottom of inside of rings with filtering material to level at least 12 inches (300 mm) above bottom.
   d. Extend effluent inlet pipe 12 inches (300 mm) into rings and terminate into side of tee fitting.
   e. Backfill around outside of rings with filtering material to top level of rings.
   f. Install cover over top of rings.
3. Install manufactured, PE dry wells according to manufacturer's written instructions and the following:
   a. Assemble and install panels and cover.
   b. Backfill bottom of inside of unit with filtering material to level at least 12 inches (300 mm) above bottom.
   c. Extend effluent inlet pipe 12 inches (300 mm) into unit and terminate into side of tee fitting.
   d. Install filter fabric around outside of unit.
   e. Install filtering material around outside of unit.
4. Install constructed-in-place dry wells according to the following:
   a. Install brick lining material dry and laid flat, with staggered joints for seepage. Build to diameter and depth indicated.
   b. Install block lining material dry, with staggered joints and 20 percent minimum of blocks on side for seepage. Install precast concrete rings with notches or weep holes for seepage. Build to diameter and depth indicated.
   c. Extend lining material to height where top of manhole will be approximately 8 inches (203 mm) below finished grade.
   d. Backfill bottom of inside of lining with filtering material to level at least 12 inches (300 mm) above bottom.
   e. Extend effluent inlet pipe 12 inches (300 mm) into lining and terminate into side of tee fitting.
   f. Backfill around outside of lining with filtering material to top level of lining.
   g. Install manhole over top of dry well. Support cover on undisturbed soil. Do not support cover on lining.

K. Concrete Placement
1. Place cast-in-place concrete according to ACI 318.

L. Channel Drainage System Installation
1. Install with top surfaces of components, except piping, flush with finished surface.
2. Assemble channel sections to form slope down toward drain outlets. Use sealants, adhesives, fasteners, and other materials recommended by system manufacturer.
3. Embed channel sections and drainage specialties in 4-inch (102-mm) minimum concrete around bottom and sides.
4. Fasten grates to channel sections if indicated.
5. Assemble channel sections with flanged or interlocking joints.
6. Embed channel sections in 4-inch (102-mm) minimum concrete around bottom and sides.

M. Stormwater Disposal System Installation
1. Chamber Systems: Excavate trenches of width and depth, and install system and backfill according to chamber manufacturer's written instructions. Include storage and leaching chambers, filtering material, and filter mat.
   OR

Piping Systems: Excavate trenches of width and depth, and install piping system, filter fabric, and backfill, according to piping manufacturer's written instructions.

N. Connections
1. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Division 15 Section "Storm Drainage Piping".
2. Connect force-main piping to building's storm drainage force mains specified in Division 15 Section "Storm Drainage Piping". Terminate piping where indicated.
3. Make connections to existing piping and underground manholes.
   a. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch (150-mm) overlap, with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
   b. Make branch connections from side into existing piping, NPS 4 to NPS 20 (DN 100 to DN 500). Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
   c. Make branch connections from side into existing piping, NPS 21 (DN 525) or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches (76 mm) of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 inches (150 mm) of concrete for minimum length of 12 inches (300 mm) to provide additional support of collar from connection to undisturbed ground.
      1) Use concrete that will attain a minimum 28-day compressive strength of 3000 psi (20.7 MPa) unless otherwise indicated.
      2) Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
   d. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.
4. Connect to sediment interceptors specified in Division 02 Section "Interceptors".
5. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
   a. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
      1) Unshielded **OR** Shielded, **as directed**, flexible couplings for same or minor difference OD pipes.
      2) Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
      3) Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
   b. Use pressure-type pipe couplings for force-main joints.

O. Closing Abandoned Storm Drainage Systems
1. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
   a. Close open ends of piping with at least 8-inch- (203-mm-) thick, brick masonry bulkheads.
   b. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.
2. Abandoned Manholes and Structures: Excavate around manholes and structures as required and use one procedure below:
   a. Remove manhole or structure and close open ends of remaining piping.

b. Remove top of manhole or structure down to at least 36 inches (915 mm) below final grade. Fill to within 12 inches (300 mm) of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

3. Backfill to grade according to Division 02 Section "Earthwork".

P. Identification

1. Materials and their installation are specified in Division 02 Section "Earthwork". Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.
   a. Use warning tape **OR** detectable warning tape, **as directed**, over ferrous piping.
   b. Use detectable warning tape over nonferrous piping and over edges of underground structures.

Q. Field Quality Control

1. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (610 mm) of backfill is in place, and again at completion of Project.
   a. Submit separate reports for each system inspection.
   b. Defects requiring correction include the following:
      1) Alignment: Less than full diameter of inside of pipe is visible between structures.
      2) Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
      3) Damage: Crushed, broken, cracked, or otherwise damaged piping.
      4) Infiltration: Water leakage into piping.
      5) Exfiltration: Water leakage from or around piping.
   c. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
   d. Reinspect and repeat procedure until results are satisfactory.
2. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
   a. Do not enclose, cover, or put into service before inspection and approval.
   b. Test completed piping systems according to requirements of authorities having jurisdiction.
   c. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
   d. Submit separate report for each test.
   e. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
      1) Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
      2) Option: Test plastic piping according to ASTM F 1417.
      3) Option: Test concrete piping according to ASTM C 924 (ASTM C 924M).
   f. Force-Main Storm Drainage Piping: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than 150 psig (1035 kPa).
      1) Ductile-Iron Piping: Test according to AWWA C600, "Hydraulic Testing" Section.
      2) PVC Piping: Test according to AWWA M23, "Testing and Maintenance" Chapter.
3. Leaks and loss in test pressure constitute defects that must be repaired.
4. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

R. Cleaning

1. Clean interior of piping of dirt and superfluous materials. Flush with potable water **OR** Flush with water, **as directed**.

END OF SECTION 02452

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SECTION 02455 - CONCRETE-FILLED STEEL PILES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for concrete-filled steel piles. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes concrete-filled steel shell and pipe piles.

C. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: For composite piles. Show fabrication and installation details for piles, including splices and tip details.
   a. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
   b. Indicate locations, sizes, type, and arrangement of reinforcement.
   c. Include arrangement of static pile reaction frame, test and anchor piles, equipment, and instrumentation. Submit structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
3. Welding certificates.
4. Design Mixes: For each concrete mix. Include revised mix proportions when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
5. Material Certificates: For steel shell piles and accessories, steel pipe piles and accessories, steel reinforcement and concrete admixtures, from manufacturer.
6. Material Test Reports: For concrete materials.
7. Pile-Driving Equipment Data: Include type, make, and rated energy range; weight of striking part of hammer; weight of drive cap; and, type, size, and properties of hammer cushion.
   a. Include mandrel type and details.
8. Static Pile Test Reports: Submit within three days of completing each test.
9. Pile-Driving Records: Submit within three days of driving each pile.
10. Field quality-control reports.
11. Preconstruction Photographs: Photographs or video of existing conditions of adjacent construction. Submit before the Work begins.

D. Quality Assurance
1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
2. Comply with requirements in ACI 301, "Specifications for Structural Concrete."
3. Welding Qualifications: Qualify procedures and personnel according to the following:
   a. AWS D1.1/D1.1M, "Structural Welding Code - Steel"
   b. AWS D1.3, "Structural Welding Code - Sheet Steel."
4. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
1. Deliver piles to Project site in such quantities and at such times to ensure continuity of installation. Handle and store piles at Project site to prevent physical damage.
   a. Painted Piles: Protect finish and touch up damage before driving piles.

F. Project Conditions

1. Protect structures, underground utilities, and other construction from damage caused by pile driving.
2. Preconstruction Photographs: Inventory and record the condition of adjacent structures, underground utilities, and other construction. Provide photographs **OR** video, **as directed**, of conditions that might be misconstrued as damage caused by pile driving.

1.2 PRODUCTS

A. Steel Shell Piles
1. Fluted Pile Shells: Manufacturer's standard, vertically fluted pile shells; cold formed from steel sheet; 50,000-psi (345-MPa) minimum yield strength after forming. Fabricate watertight, uniformly tapered sections with forged-steel conical nose welded to tip.
   a. Constant Diameter Extensions: Fabricate with splice overlap capable of telescoping into tapered section.
   b. Taper: 0.14 inch in 12 inches (1:86) **OR** 0.25 inch in 12 inches (1:48) **OR** 0.40 inch in 12 inches (1:30), **as directed**.
   c. Thickness: 0.150 inch (3.80 mm) **OR** 0.179 inch (4.55 mm) **OR** 0.209 inch (5.31 mm) **OR** 0.239 inch (6.07 mm), **as directed**.
2. Helically Corrugated Pile Shells: Manufacturer's standard, helically corrugated, uniform-diameter, steel sheet shell piles; of sufficient strength and thickness to remain watertight and resist distortion and buckling due to soil pressure, internal mandrel operation, or redriving. Fabricate in one-piece lengths with 3/16-inch- (4.76-mm-) thick, minimum steel-plate boot continuously welded to tip and as follows:
   a. Nominal Diameter: 8-5/8 inches (219 mm) **OR** 10-5/8 inches (270 mm) **OR** 11-1/8 inches (283 mm) **OR** 12-1/4 inches (311 mm) **OR** 14 inches (350 mm) **OR** 16-1/8 inches (410 mm), **as directed**.
   b. Thickness: 0.048 inch (1.21 mm), minimum **OR** 0.060 inch (1.52 mm), minimum **OR** 0.075 inch (1.90 mm), minimum **OR** 0.105 inch (2.66 mm), **as directed**.

B. Steel Pipe Piles
1. Steel Pipe: ASTM A 252, Grade 2 **OR** Grade 3, **as directed**; seamless or welded.

C. Steel Reinforcement
1. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420); deformed.
2. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M.
3. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized after fabrication and bending, as follows:
   a. Steel Reinforcement: ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**; deformed.
4. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M, as follows:
   a. Steel Reinforcement: ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**; deformed.
5. Plain Steel Wire: ASTM A 82/A 82M, as drawn **OR** galvanized, **as directed**.
6. Deformed-Steel Wire: ASTM A 496/A 496M.
7. Epoxy-Coated-Steel Wire: ASTM A 884/A 884M, Class A coated, plain **OR** deformed, **as directed**.

D. Concrete Materials
1. Portland Cement: ASTM C 150, Type I or II.
   a. Fly Ash: ASTM C 618, Class C or F.
   b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
2. Blended Hydraulic Cement: ASTM C 595, Type IS, portland blast-furnace slag **OR** Type IP, portland-pozzolan **OR** Type I (PM), pozzolan-modified portland **OR** Type I (SM), slag-modified Portland, **as directed**, cement.

3. Normal-Weight Aggregates: ASTM C 33, Class 4S **OR** Class 4M **OR** Class 1N, **as directed**, uniformly graded, 3/4-inch (19-mm) maximum aggregate size. Provide aggregates from a single source.
4. Water: Potable, complying with ASTM C 94/C 94M requirements.
5. Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent chloride ions by mass of cementitious material.
   a. Air-Entraining Admixture: ASTM C 260.
   b. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
   c. Retarding Admixture: ASTM C 494/C 494M, Type B.
   d. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
   e. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
   f. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
   g. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

E. Pile Accessories
1. Driving Points: Manufacturer's standard 60-degree conical driving point, with integral reinforcing ribs, to provide full bearing of pipe pile tip. Fabricate from steel castings as follows:
2. Inside Cutting Shoes: Manufacturer's standard, inside-flanged, open-ended cutting shoe, to provide full bearing of pipe pile tip. Fabricate from steel castings as follows:
3. Outside Cutting Shoes: Manufacturer's standard, outside-flanged, open-ended cutting shoe, to provide full bearing of pipe pile tip. Fabricate from steel castings as follows:
   a. Carbon-Steel Castings: ASTM A 27/A 27M, Grade 65-35 (Grade 450-240), heat treated **OR** Grade N1, **as directed**.
   b. High-Strength Steel Castings: ASTM A 148/A 148M, Grade 80-40 (Grade 550-275) **OR** Grade 90-60 (Grade 620-415), **as directed**.
4. Splice Coupling: Manufacturer's standard splice coupling, rolled from ASTM A 36/A 36M, carbon-steel bar or cast from heat-treated carbon steel, ASTM A 27/A 27M, Grade 65-35 (Grade 450-240), with interior stop and internally tapered for friction fit driving.

F. Paint
1. Paint: SSPC-Paint 16; self-priming, two-component, coal-tar epoxy polyamide, black **OR** red **OR** manufacturer's standard color, **as directed**.

G. Concrete Mixes
1. Prepare concrete design mixes according to ACI 301, determined by either laboratory trial batch or field test data basis.
   a. Use a qualified testing agency for preparing and reporting proposed mix designs determined by laboratory trial batch.
2. Proportion mixes according to ACI 301 to provide normal-weight concrete suitable for piles with the following properties:
   a. Compressive Strength (28 Days): 5000 psi (34.5 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3000 psi (20.7 MPa), **as directed**.
   b. Maximum Water-Cementitious Material Ratio at Point of Placement: 0.45 **OR** 0.50, **as directed**.
   c. Slump Limit: 5 inches (127 mm) **OR** 8 inches (203 mm), **as directed**, plus or minus 1 inch (25 mm).
3. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content of 6.0 percent, plus or minus 1.5 **OR** 2.5 to 4.5, **as directed**, percent.
4. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 limits as if concrete were exposed to deicing chemicals.
5. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 **OR** 0.30, **as directed**, percent by weight of cement.
6. Concrete-mix design adjustments may be considered if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant. Resubmit and obtain approval from the Owner of proposed changes to concrete-mix proportions.

H. Fabrication
1. Fabricate and assemble piles in shop to greatest extent possible.
2. Fabricate full-length piles to eliminate splicing during driving.
OR
Fabricate full-length piles by splicing pile lengths together. Maintain axial alignment of pile lengths. Maintain structural properties of pile across splice.
a. Splice Coupling: Fit splice coupling into position and weld to adjoining steel pipe pile sections according to manufacturer's written instructions and AWS D1.1/D1.1M for procedures, appearance and quality of welds, and methods used in correcting welding work.
b. Welded Splices: Accurately mill meeting ends of steel pipe piles and bevel for welding. Continuously weld pile according to AWS D1.1/D1.1M for procedures, appearance and quality of welds, and methods used in correcting welding work.
c. Welded Splices: Continuously weld steel shell pile according to manufacturer's written instructions and AWS D1.1/D1.1M and AWS D1.3, **as directed**, for procedures, appearance and quality of welds, and methods used in correcting welding work.
d. Splice piles during fabrication or field installation.
3. Fit and weld driving points to tip of pile according to manufacturer's written instructions and AWS D1.1/D1.1M for procedures, appearance and quality of welds, and methods used in correcting welding work.
OR
Fit and weld cutting shoes to tip of pile according to manufacturer's written instructions and AWS D1.1/D1.1M for procedures, appearance and quality of welds, and methods used in correcting welding work.
4. Pile-Length Markings: Mark each pile with horizontal lines at 12-inch (305-mm) intervals; label the distance from pile tip at 60-inch (1.52-m) intervals. Maintain markings on piles until driven.

I. Shop Painting, **as directed**
1. General: Shop paint steel pile surfaces, except for surfaces to be encased in concrete, as follows:
a. Extend painting to a depth of 60 inches (1.52 m) below finished grade **OR** low-tide level, **as directed**, to top of exposed pile.
2. Surface Preparation: Clean surfaces to be painted. Remove loose rust and loose mill scale, and remove spatter, slag, or flux deposits. Prepare surfaces according to SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning."
3. Painting: Immediately after surface preparation, apply coat of paint according to manufacturer's written instructions to provide a dry film thickness of not less than 8 mils (0.2 mm).
a. Apply second coat to provide a dry film thickness of not less than 8 mils (0.2 mm), resulting in a two-coat paint system thickness of not less than 16 mils (0.4 mm).
b. Apply second and third coats with each coat having a dry film thickness of not less than 8 mils (0.2 mm), resulting in a three-coat paint system thickness of not less than 24 mils (0.6 mm).
c. Mark pile lengths after shop painting.

J. Concrete Mixing
1. Ready-Mixed Concrete: Comply with ASTM C 94/C 94M.
a. Do not add water to concrete mix after mixing.
b. Maintain concrete temperature to not exceed 90 deg F (32 deg C).

1.3 EXECUTION

A. Examination

1. Site Conditions: Do not start pile-driving operations until earthwork fills have been completed or excavations have reached an elevation of 6 to 12 inches (152 to 305 mm) above bottom of footing or pile cap.

B. Driving Equipment
   1. Pile Hammer: Air-, steam-, hydraulic-, or diesel-powered type capable of consistently delivering adequate peak-force duration and magnitude to develop the ultimate capacity required for type and size of pile driven and character of subsurface material anticipated.
   2. Hammer Cushions and Driving Caps: Between hammer and top of pile, provide hammer cushion and steel driving cap as recommended by hammer manufacturer and as required to drive pile without damage.
   3. Leads: Use fixed, semifixed, or hanging-type pile-driver leads that will hold full length of pile firmly in position and in axial alignment with hammer.
   4. Mandrel: Expandable mandrel, capable of distributing driving energy throughout length of steel shell pile.

C. Static Pile Tests, **as directed**
   1. General: Static pile tests will be used to verify driving criteria and pile lengths and to confirm allowable load of piles.
      a. Furnish test piles 60 inches (1.52 m) longer than production piles.
      b. Determination of actual length of piles will be based on results of static pile tests.
   2. Pile Tests: Arrange and perform the following pile tests:
      a. Axial Compressive Static Load Test: ASTM D 1143.
      b. Axial Tension Static Load Test: ASTM D 3689.
      c. Lateral Load Test: ASTM D 3966.
   3. Equip each test pile with two telltale rods, according to ASTM D 1143, for measuring deformation during load test.
   4. Provide pile reaction frame, anchor piles, equipment, and instrumentation with sufficient reaction capacity to perform tests. Notify the Owner at least 48 hours in advance of performing tests. On completion of testing, remove testing structure, anchor piles, equipment, and instrumentation.
      a. Allow a minimum of seven days to elapse after driving test piles before starting pile testing.
      b. Number of Test Piles: One pile **OR** As indicated, **as directed**.
   5. Driving Test Piles: Drive test piles at locations indicated to the minimum penetration or driving resistance indicated. Use test piles identical to those required for Project and drive with appropriate pile-driving equipment operating at rated driving energy to be used in driving permanent piles.
      a. Pile Design Load: As indicated **OR as directed**.
   6. Approval Criteria: Allowable load shall be the load acting on the test pile when the lesser of, **as directed**, the following criteria are met, divided by a factor of safety of 2:
      a. Net settlement, after deducting rebound, of not more than 0.01 inch/ton (0.25 mm/907 kg) of test load.
      b. Total settlement exceeds the pile elastic compression by 0.15 inch (4 mm), plus 1.0 percent of the tip diagonal dimension.
      c. A plunging failure or sharp break in the load settlement curve.
   7. Test Pile-Driving Records: Prepare driving records for each test pile, compiled and attested to by a qualified professional engineer, **as directed**. Include same data as required for driving records of permanent piles.
   8. Test piles that comply with requirements, including location tolerances, may be used on Project.

D. Steel Reinforcement
   1. Comply with recommendations in CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
   2. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy bond with concrete.
   3. Fabricate and install reinforcement cages symmetrically about axis of pile shell **OR** pipe, **as directed**, in a single unit.

4. Accurately position, support, and secure reinforcement against displacement during concreting. Maintain minimum cover on reinforcement.
5. Protect exposed ends of extended reinforcement, dowels, or anchor bolts from mechanical damage and exposure to weather.

E. Concrete Placement
1. Do not place concrete until other piles within a radius of 20 feet (6 m) have been driven and approved.
2. Inspection: Before placing concrete, allow testing and inspecting agency to visually inspect and verify that each pile shell **OR** pipe, **as directed**, is clean, watertight, plumb, and free of distortion or other defects.
3. Place concrete in a continuous operation and without segregation immediately after cleaning out pile shell **OR** pipe, **as directed**.
4. Place concrete by means of bottom discharge bucket, flexible drop chute, steep-sided funnel hopper, or tremie or pump concrete into place.
5. Place concrete in a dry pile shell **OR** pipe, **as directed**, unless placement underwater is approved by the Owner.
   a. Place concrete underwater by tremie method or pumping. Control placement operations to ensure tremie is embedded no less than 60 inches (1.52 m) into concrete, and flow of tremied concrete is continuous from bottom to top of pile shell **OR** pipe, **as directed**.
   b. Other methods of depositing concrete may be used if approved by the Owner.
6. Consolidate final 10 feet (3 m) of concrete during placement to ensure that concrete is thoroughly worked around steel reinforcement and into corners.
7. Screed concrete level at cutoff elevation and apply a scoured, rough finish.

F. Driving Piles
1. General: Continuously drive piles to elevations or penetration resistance indicated or established by static load testing of piles, **as directed**. Establish and maintain axial alignment of leads and piles before and during driving.
2. Predrilling, **as directed**: Provide pre-excavated holes where indicated, to depths indicated. Drill holes with a diameter less than the largest cross-section dimension of pile.
   a. Firmly seat pile in predrilled hole by driving with reduced energy before starting final driving.
3. Heaved Piles: Redrive heaved piles to tip elevation at least as deep as original tip elevation with a driving resistance at least as great as original driving resistance.
4. Pile Splices: Splice piles during installation and align pile segments concentrically.
5. Driving Tolerances: Drive piles without exceeding the following tolerances, measured at pile heads:
   a. Location: 4 inches (102 mm) from location indicated after initial driving, and 6 inches (152 mm) after pile driving is completed.
   b. Plumb: Maintain 1 inch (25 mm) in 4 feet (1.2 m) from vertical, or a maximum of 4 inches (102 mm), measured when pile is aboveground in leads.
   c. Batter Angle: Maximum 1 inch (25 mm) in 4 feet (1.2 m) from required angle, measured when pile is aboveground in leads.
6. Excavation: Clean out steel pipe pile by removing soil and debris from inside pile before placing steel reinforcement or concrete.
7. Withdraw damaged or defective piles and piles that exceed driving tolerances and install new piles within driving tolerances.
   a. Fill holes left by withdrawn piles using cohesionless soil material such as gravel, broken stone, and gravel-sand mixtures. Place and compact in lifts not exceeding 72 inches (1.83 m).
      OR
      Fill holes left by withdrawn piles as directed by the Owner.

   OR

Abandon and cut off rejected piles as directed by the Owner. Leave rejected piles in place and install new piles in locations as directed by the Owner.

8. Cutting Off: Cut off tops of driven piles square with pile axis and at elevations indicated.
9. Pile-Driving Records: Maintain accurate driving records for each pile, compiled and attested to by a qualified professional engineer, **as directed**. Include the following data:
    a. Project name and number.
    b. Name of Contractor.
    c. Pile location in pile group and designation of pile group.
    d. Sequence of driving in pile group.
    e. Pile dimensions.
    f. Ground elevation.
    g. Elevation of tips after driving.
    h. Final tip and cutoff elevations of piles after driving pile group.
    i. Records of redriving.
    j. Elevation of splices.
    k. Type, make, model, and rated energy of hammer.
    l. Weight and stroke of hammer.
    m. Type of pile-driving cap used.
    n. Cushion material and thickness.
    o. Actual stroke and blow rate of hammer.
    p. Pile-driving start and finish times, and total driving time.
    q. Time, pile-tip elevation, and reason for interruptions.
    r. Number of blows for every 12 inches (305 mm) of penetration, and number of blows per 1 inch (25 mm) for the last 6 inches (152 mm) of driving.
    s. Pile deviations from location and plumb.
    t. Preboring, jetting, or special procedures used.
    u. Unusual occurrences during pile driving.

G. Field Quality Control
1. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
    a. Pile foundations.
2. Testing Agency: Engage a qualified independent testing agency to perform tests and inspections.
3. Tests and Inspections:
    a. Dynamic Pile Testing: High-strain dynamic monitoring shall be performed and reported according to ASTM D 4945 during initial driving and during restriking on 5 single piles **OR** 3 percent of piles, **as directed**.
    b. Low-strain integrity measurement shall be performed and reported for each pile.
    c. Weld Testing: In addition to visual inspection, welds shall be tested and inspected according to AWS D1.1/D1.1M and the inspection procedures listed in subparagraphs below, at testing agency's option. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.
        1) Liquid Penetrant Inspection: ASTM E 165.
        2) Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
        3) Radiographic Inspection: ASTM E 94; minimum quality level "2-2T."
        4) Ultrasonic Inspection: ASTM E 164.
    d. Concrete: Sampling and testing of concrete for quality control shall include the following:
        1) Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94/C 94M.
            a) Slump: ASTM C 143/C 143M; one test at point of placement for each compressive-strength test, but no fewer than one test for each concrete load.
            b) Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F (5 deg C) and below or when 80 deg F (27 deg C) and above, and one test for each set of compressive-strength specimens.

c) Compression Test Specimens: ASTM C 31/C 31M; one set of four standard cylinders for each compressive-strength test unless otherwise indicated. Mold and store cylinders for laboratory-cured test specimens unless field-cured test specimens are required.

d) Compressive-Strength Tests: ASTM C 39/C 39M; one set for each truck load. One specimen shall be tested at seven days, two specimens shall be tested at 28 days, and one specimen shall be retained in reserve for later testing if required.

2) When frequency of testing will provide fewer than five strength tests for a given class of concrete, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

3) When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing in-place concrete.

4) Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength and no individual strength test result falls below specified compressive strength by more than 500 psi (3.45 MPa).

5) Test results shall be reported in writing to the Owner, concrete manufacturer, and Contractor within 24 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, concrete type and class, location of concrete batch in piles, design compressive strength at 28 days, concrete-mix proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

6) Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as sole basis for acceptance or rejection.

7) Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate concrete strengths or other requirements have not been met.

H. Touchup Painting, a**s directed**

1. Clean field welds, splices, and abraded painted areas and field-apply paint according to SSPC-PA 1. Use same paint and apply same number of coats as specified for shop painting.
   a. Apply touchup paint before driving piles to surfaces that will be immersed or inaccessible after driving.

I. Disposal

1. Remove withdrawn piles and cutoff sections of piles from site and legally dispose of them off Owner's property.

END OF SECTION 02455

SECTION 02455a - WATER DISTRIBUTION

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for water distribution. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes water-distribution piping and related components outside the building for water service **OR** fire-service mains **OR** combined water service and fire-service mains, **as directed**.
2. Utility-furnished products include water meters that will be furnished to the site, ready for installation.

C. Definitions
1. EPDM: Ethylene propylene diene terpolymer rubber.
2. LLDPE: Linear, low-density polyethylene plastic.
3. PA: Polyamide (nylon) plastic.
4. PE: Polyethylene plastic.
5. PP: Polypropylene plastic.
6. PVC: Polyvinyl chloride plastic.
7. RTRF: Reinforced thermosetting resin (fiberglass) fittings.
8. RTRP: Reinforced thermosetting resin (fiberglass) pipe.

D. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.
   a. Wiring Diagrams: Power, signal, and control wiring for alarms.
3. Field quality-control test reports.
4. Operation and Maintenance Data.

E. Quality Assurance
1. Regulatory Requirements:
   a. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
   b. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
   c. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.
2. Piping materials shall bear label, stamp, or other markings of specified testing agency.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
4. Comply with ASTM F 645 for selection, design, and installation of thermoplastic water piping.
5. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.
6. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.
7. NSF Compliance:

a. Comply with NSF 14 for plastic potable-water-service piping. Include marking "NSF-pw" on piping.
b. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

F. Delivery, Storage, And Handling
1. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:
a. Ensure that valves are dry and internally protected against rust and corrosion.
b. Protect valves against damage to threaded ends and flange faces.
c. Set valves in best position for handling. Set valves closed to prevent rattling.
2. During Storage: Use precautions for valves, including fire hydrants, according to the following:
a. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
b. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.
3. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.
4. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.
5. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.
6. Protect flanges, fittings, and specialties from moisture and dirt.
7. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

G. Project Conditions
1. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:
a. Notify Owner no fewer than two days in advance of proposed interruption of service.
b. Do not proceed with interruption of water-distribution service without Owner's written permission.

H. Coordination
1. Coordinate connection to water main with utility company.

1.2 PRODUCTS

A. Copper Tube And Fittings
1. Soft Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B), **as directed,** water tube, annealed temper.
a. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
b. Copper, Pressure-Seal Fittings:
1) NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
2) NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.
2. Hard Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**, water tube, drawn temper.
a. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
b. Copper, Pressure-Seal Fittings:

1) NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
2) NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.

3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.
4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

B. Ductile-Iron Pipe And Fittings
1. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   a. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   b. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
2. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   a. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   b. Gaskets: AWWA C111, rubber.
3. Grooved-Joint, Ductile-Iron Pipe: AWWA C151, with cut, rounded-grooved ends.
   a. Grooved-End, Ductile-Iron Pipe Appurtenances:
      1) Grooved-End, Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.
      2) Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.
4. Flanges: ASME 16.1, Class 125, cast iron.

C. PE Pipe And Fittings
1. PE, ASTM Pipe: ASTM D 2239, SIDR No. 5.3, 7, or 9; with PE compound number required to give pressure rating not less than 160 psig (1100 kPa) **OE** 200 psig (1380 kPa), **as directed**.
   a. Insert Fittings for PE Pipe: ASTM D 2609, made of PA, PP, or PVC with serrated male insert ends matching inside of pipe. Include bands or crimp rings.
   b. Molded PE Fittings: ASTM D 3350, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.
2. PE, AWWA Pipe: AWWA C906, DR No. 7.3, 9, or 9.3; with PE compound number required to give pressure rating not less than 160 psig (1100 kPa) **OR** 200 psig (1380 kPa), **as directed**.
   a. PE, AWWA Fittings: AWWA C906, socket- or butt-fusion type, with DR number matching pipe and PE compound number required to give pressure rating not less than 160 psig (1100 kPa) **OR** 200 psig (1380 kPa), **as directed**.
3. PE, Fire-Service Pipe: ASTM F 714, AWWA C906, or equivalent for PE water pipe; FMG approved, with minimum thickness equivalent to FMG Class 150 and Class 200.
   a. Molded PE Fittings: ASTM D 3350, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.

D. PVC Pipe And Fittings
1. PVC, Schedule 40 Pipe: ASTM D 1785.
   a. PVC, Schedule 40 Socket Fittings: ASTM D 2466.
2. PVC, Schedule 80 Pipe: ASTM D 1785.
   a. PVC, Schedule 80 Socket Fittings: ASTM D 2467.
   b. PVC, Schedule 80 Threaded Fittings: ASTM D 2464.
3. PVC, AWWA Pipe: AWWA C900, Class 150 **OR** Class 200, **as directed**, with bell end with gasket, and with spigot end.
   a. Comply with UL 1285 for fire-service mains if indicated.

b. PVC Fabricated Fittings: AWWA C900, Class 150 **OR** Class 200, **as directed**, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
c. PVC Molded Fittings: AWWA C907, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
d. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   1) Gaskets: AWWA C111, rubber.
e. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   1) Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

E. Fiberglass Pipe And Fittings
1. AWWA RTRP: AWWA C950, Class 150 **OR** Class 200 **OR** Class 250, **as directed**, Type I **OR** II, **as directed**, Grade 1, epoxy **OR** Grade 2, polyester, **as directed**, with bell-and-spigot ends for bonded **OR** with gasket or seal for gasketed, **as directed**, joints. Liner is optional, unless otherwise indicated. Include FMG approval if used for fire-service mains.
   a. RTRF: AWWA C950, similar to pipe in material, pressure class, and joining method.
2. UL RTRP: UL 1713, Class 150 **OR** Class 200 **OR** Class 250, **as directed**, with bell-and-spigot ends with gasket or seal for gasketed joints. Liner is optional, unless otherwise indicated.
   a. RTRF: Similar to pipe in material, pressure class, and joining method.

F. Special Pipe Fittings
1. Ductile-Iron Rigid Expansion Joints:
   a. Description: Three-piece, ductile-iron assembly consisting of telescoping sleeve with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
      1) Pressure Rating: 250 psig (1725 kPa) minimum.
      2) Expansion Required: As directed by the manufacturer or as directed by the Owner.
2. Ductile-Iron Flexible Expansion Joints:
   a. Description: Compound, ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections. Assemble components for offset and expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
      1) Pressure Rating: 250 psig (1725 kPa) minimum.
      2) Offset: As directed by the manufacturer or as directed by the Owner.
      3) Expansion Required: As directed by the manufacturer or as directed by the Owner.
3. Ductile-Iron Deflection Fittings:
   a. Description: Compound, ductile-iron coupling fitting with sleeve and 1 or 2 flexing sections for up to 15-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
      1) Pressure Rating: 250 psig (1725 kPa) minimum.

G. Joining Materials
1. Refer to Division 02 Section "Piped Utilities -basic Materials And Methods" for commonly used joining materials.
2. Brazing Filler Metals: AWS A5.8, BCuP Series.
3. Bonding Adhesive for Fiberglass Piping: As recommended by fiberglass piping manufacturer.
4. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

H. Piping Specialties

1. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
2. Tubular-Sleeve Pipe Couplings:
   a. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners and with ends of same sizes as piping to be joined.
      1) Standard: AWWA C219.
      2) Center-Sleeve Material: Manufacturer's standard **OR** Carbon steel **OR** Stainless steel **OR** Ductile iron **OR** Malleable iron, **as directed**.
      3) Gasket Material: Natural or synthetic rubber.
      4) Pressure Rating: 150 psig (1035 kPa) **OR** 200 psig (1380 kPa), **as directed**, minimum.
      5) Metal Component Finish: Corrosion-resistant coating or material.
3. Split-Sleeve Pipe Couplings:
   a. Description: Metal, bolted, split-sleeve-type, reducing or transition coupling with sealing pad and closure plates, O-ring gaskets, and bolt fasteners.
      1) Standard: AWWA C219.
      2) Sleeve Material: Manufacturer's standard **OR** Carbon steel **OR** Stainless steel, **as directed**.
      3) Sleeve Dimensions: Of thickness and width required to provide pressure rating.
      4) Gasket Material: O-rings made of EPDM rubber, unless otherwise indicated.
      5) Pressure Rating: 150 psig (1035 kPa) **OR** 200 psig (1380 kPa), **as directed**, minimum.
      6) Metal Component Finish: Corrosion-resistant coating or material.
4. Flexible Connectors:
   a. Nonferrous-Metal Piping: Bronze hose covered with bronze wire braid; with copper-tube, pressure-type, solder-joint ends or bronze flanged ends brazed to hose.
   b. Ferrous-Metal Piping: Stainless-steel hose covered with stainless-steel wire braid; with ASME B1.20.1, threaded steel pipe nipples or ASME B16.5, steel pipe flanges welded to hose.
5. Dielectric Fittings: Combination of copper alloy and ferrous; threaded, solder, or plain end types; and matching piping system materials.
   a. Dielectric Unions: Factory-fabricated union assembly, designed for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C). Include insulating material that isolates dissimilar metals and ends with inside threads according to ASME B1.20.1.
   b. Dielectric Flanges: Factory-fabricated companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure to suit system pressures.
   c. Dielectric-Flange Insulation Kits: Field-assembled companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
      1) Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure to suit system pressures.
   d. Dielectric Couplings: Galvanized-steel couplings with inert and noncorrosive thermoplastic lining, with threaded ends and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
   e. Dielectric Nipples: Electroplated steel nipples with inert and noncorrosive thermoplastic lining, with combination of plain, threaded, or grooved end types, and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

I. Corrosion-Protection Piping Encasement
   1. Encasement for Underground Metal Piping:
      a. Standards: ASTM A 674 or AWWA C105.
      b. Form: Sheet **OR** Tube, **as directed**.
      c. Material: LLDPE film of 0.008-inch (0.20-mm) minimum thickness.
      d. Material: LLDPE film of 0.008-inch (0.20-mm) minimum thickness, or high-density, crosslaminated PE film of 0.004-inch (0.10-mm) minimum thickness.

e. Material: High-density, crosslaminated PE film of 0.004-inch (0.10-mm) minimum thickness.
f. Color: Black **OR** Natural, **as directed**.

J. Gate Valves
1. AWWA, Cast-Iron Gate Valves:
a. Nonrising-Stem, Metal-Seated Gate Valves:
1) Description: Gray- or ductile-iron body and bonnet; with cast-iron or bronze double-disc gate, bronze gate rings, bronze stem, and stem nut.
a) Standard: AWWA C500.
b) Minimum Pressure Rating: 200 psig (1380 kPa).
c) End Connections: Mechanical joint.
d) Interior Coating: Complying with AWWA C550.
b. Nonrising-Stem, Resilient-Seated Gate Valves:
1) Description: Gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.
a) Standard: AWWA C509.
b) Minimum Pressure Rating: 200 psig (1380 kPa).
c) End Connections: Mechanical joint.
d) Interior Coating: Complying with AWWA C550.
c. Nonrising-Stem, High-Pressure, Resilient-Seated Gate Valves:
1) Description: Ductile-iron body and bonnet; with bronze or ductile-iron gate, resilient seats, bronze stem, and stem nut.
a) Standard: AWWA C509.
b) Minimum Pressure Rating: 250 psig (1725 kPa).
c) End Connections: Push on or mechanical joint.
d) Interior Coating: Complying with AWWA C550.
d. OS&Y, Rising-Stem, Metal-Seated Gate Valves:
1) Description: Cast- or ductile-iron body and bonnet, with cast-iron double disc, bronze disc and seat rings, and bronze stem.
a) Standard: AWWA C500.
b) Minimum Pressure Rating: 200 psig (1380 kPa).
c) End Connections: Flanged.
e. OS&Y, Rising-Stem, Resilient-Seated Gate Valves:
1) Description: Cast- or ductile-iron body and bonnet, with bronze or gray- or ductile-iron gate, resilient seats, and bronze stem.
a) Standard: AWWA C509.
b) Minimum Pressure Rating: 200 psig (1380 kPa).
c) End Connections: Flanged.
2. UL/FMG, Cast-Iron Gate Valves:
a. UL/FMG, Nonrising-Stem Gate Valves:
1) Description: Iron body and bonnet with flange for indicator post, bronze seating material, and inside screw.
a) Standards: UL 262 and FMG approved.
b) Minimum Pressure Rating: 175 psig (1207 kPa).
c) End Connections: Flanged.
b. OS&Y, Rising-Stem Gate Valves:
1) Description: Iron body and bonnet and bronze seating material.
a) Standards: UL 262 and FMG approved.
b) Minimum Pressure Rating: 175 psig (1207 kPa).
c) End Connections: Flanged.
3. Bronze Gate Valves:
a. OS&Y, Rising-Stem Gate Valves:
1) Description: Bronze body and bonnet and bronze stem.
a) Standards: UL 262 and FMG approved.

b) Minimum Pressure Rating: 175 psig (1207 kPa).
c) End Connections: Threaded.

b. Nonrising-Stem Gate Valves:
1) Description: Class 125, Type 1, bronze with solid wedge, threaded ends, and malleable-iron handwheel.
a) Standard: MSS SP-80.

K. Gate Valve Accessories And Specialties
1. Tapping-Sleeve Assemblies:
a. Description: Sleeve and valve compatible with drilling machine.
1) Standard: MSS SP-60.
2) Tapping Sleeve: Cast- or ductile-iron or stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
3) Valve: AWWA, cast-iron, nonrising-stem, metal **OR** resilient, **as directed**,-seated gate valve with one raised face flange mating tapping-sleeve flange.
2. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches (125 mm) in diameter.
a. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.
3. Indicator Posts: UL 789, FMG-approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

L. Check Valves
1. AWWA Check Valves:
a. Description: Swing-check type with resilient seat. Include interior coating according to AWWA C550 and ends to match piping.
1) Standard: AWWA C508.
2) Pressure Rating: 175 psig (1207 kPa).
2. UL/FMG, Check Valves:
a. Description: Swing-check type with pressure rating; rubber-face checks, unless otherwise indicated; and ends matching piping.
1) Standards: UL 312 and FMG approved.
2) Pressure Rating: 175 psig (1207 kPa) **OR** 250 psig (1725 kPa), **as directed**.

M. Detector Check Valves
1. Detector Check Valves:
a. Description (with water meter): Galvanized cast-iron body, bolted cover with air-bleed device for access to internal parts, and flanged ends. Include one-piece bronze disc with bronze bushings, pivot, and replaceable seat. Include threaded bypass taps in inlet and outlet for bypass meter connection. Set valve to allow minimal water flow through bypass meter when major water flow is required.
1) Standards: UL 312 and FMG approved.
2) Pressure Rating: 175 psig (1207 kPa).
3) Water Meter: AWWA C700, disc type, at least one-fourth size of detector check valve. Include meter, bypass piping, gate valves, check valve, and connections to detector check valve.
b. Description (without water meter): Iron body, corrosion-resistant clapper ring and seat ring material, flanged ends, with connections for bypass and installation of water meter.
1) Standards: UL 312 and FMG approved.
2) Pressure Rating: 175 psig (1207 kPa).

N. Butterfly Valves
1. AWWA Butterfly Valves:

a. Description: Rubber seated.
1) Standard: AWWA C504.
2) Body: Cast or ductile iron.
3) Body Type: Wafer **OR** Flanged, **as directed**.
4) Pressure Rating: 150 psig (1035 kPa).

2. UL Butterfly Valves:
a. Description: Metal on resilient material seating.
1) Standards: UL 1091 and FMG approved.
2) Body: Cast or ductile iron.
3) Body Type: Wafer **OR** Flanged, **as directed**.
4) Pressure Rating: 175 psig (1207 kPa).

O. Plug Valves
1. Plug Valves:
a. Description: Resilient-seated eccentric.
1) Standard: MSS SP-108.
2) Body: Cast iron.
3) Pressure Rating: 175-psig (1207-kPa) minimum CWP.
4) Seat Material: Suitable for potable-water service.

P. Corporation Valves And Curb Valves
1. Service-Saddle Assemblies: Comply with AWWA C800. Include saddle and valve compatible with tapping machine.
a. Service Saddle: Copper alloy with seal and AWWA C800, threaded outlet for corporation valve.
b. Corporation Valve: Bronze body and ground-key plug, with AWWA C800, threaded inlet and outlet matching service piping material.
c. Manifold (if utility company requires multiple connections): Copper fitting with two to four inlets as required, with ends matching corporation valves and outlet matching service piping material.
2. Curb Valves: Comply with AWWA C800. Include bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material.
3. Service Boxes for Curb Valves: Similar to AWWA M44 requirements for cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over curb valve and with a barrel approximately 3 inches (75 mm) in diameter.
a. Shutoff Rods: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve.

Q. Water Meters
1. Water meters will be furnished by utility company.
NOTE: If water meters are specified in this Section, delete paragraph above and retain and edit paragraphs and subparagraphs below.
2. Displacement-Type Water Meters:
a. Description: With bronze main case.
1) Standard: AWWA C700.
2) Registration: Flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.
3. Turbine-Type Water Meters:
a. Description:
1) Standard: AWWA C701.
2) Registration: Flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.
4. Compound-Type Water Meters:
a. Description:
1) Standard: AWWA C702.
2) Registration: Flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.

5. Remote Registration System:
   a. Description: Utility company standard; direct-reading type. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.
      1) Standard: AWWA C706.
      2) Registration: Flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.
6. Remote Registration System:
   a. Description: Utility company standard; encoder type. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.
      1) Standard: AWWA C707.
      2) Registration: Flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.
      3) Data-Acquisition Units: Comply with utility company requirements for type and quantity.
         OR
         Visible Display Units: Comply with utility company requirements for type and quantity.

R. Detector-Type Water Meters
1. Detector-Type Water Meters
2. Description: Main line, proportional meter with second meter on bypass. Register flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.
   a. Standards: AWWA C703, UL listed, and FMG approved.
   b. Pressure Rating: 150 psig (1035 kPa).
   c. Bypass Meter: AWWA C701, turbine **OR** AWWA C702, compound, **as directed**,-type, bronze case.
      1) Size: At least one-half nominal size of main-line meter.
3. Description: Main-line turbine meter with strainer and second meter on bypass. Register flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.
   a. Standards: AWWA C703, UL listed, and FMG approved.
   b. Pressure Rating: 175 psig (1207 kPa).
   c. Bypass Meter: AWWA C701, turbine-type, bronze case.
      1) Size: At least NPS 2 (DN 50).
4. Remote Registration System:
   a. Description: Utility company standard; direct-reading type. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.
      1) Standard: AWWA C706.
      2) Registration: Flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.
5. Remote Registration System:
   a. Description: Utility company standard; encoder type. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.
      1) Standard: AWWA C707.
      2) Registration: Flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.
      3) Data-Acquisition Units: Comply with utility company requirements for type and quantity.
         OR
         Visible Display Units: Comply with utility company requirements for type and quantity.

S. Pressure-Reducing Valves
1. Water Regulators:
   a. Standard: ASSE 1003.
   b. Pressure Rating: Initial pressure of 150 psig (1035 kPa).
   c. Size: As directed by the manufacturer or as directed by the Owner.
   d. Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
   e. Design Inlet Pressure: As directed by the manufacturer or as directed by the Owner.
   f. Design Outlet Pressure Setting: As directed by the manufacturer or as directed by the Owner.

g. Body: Bronze with chrome-plated finish, **as directed**, for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved, **as directed**, for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).
h. Valves for Booster Heater Water Supply: Include integral bypass.
i. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).

2. Water Control Valves:
   a. Description: Pilot-operation, diaphragm-type, single-seated main water control valve with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot control valve, restrictor device, specialty fittings, and sensor piping.
      1) Pressure Rating: Initial pressure of 150 psig (1035 kPa) minimum.
      2) Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.
         a) Size: As directed by the manufacturer or as directed by the Owner.
         b) Pattern: Angle **OR** Globe, **as directed**,-valve design.
         c) Trim: Stainless steel.
      3) Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
      4) Design Inlet Pressure: As directed by the manufacturer or as directed by the Owner.
      5) Design Outlet Pressure Setting: As directed by the manufacturer or as directed by the Owner.
      6) End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged, **as directed**, for NPS 2-1/2 (DN 65) and larger.

T. Relief Valves
1. Air-Release Valves:
   a. Description: Hydromechanical device to automatically release accumulated air.
      1) Standard: AWWA C512.
      2) Pressure Rating: 300 psig (2070 kPa), **as directed**.
      3) Body Material: Cast iron, **as directed**.
      4) Trim Material: Stainless steel, brass, or bronze, **as directed**.
      5) Water Inlet Size: As directed by the manufacturer or as directed by the Owner.
      6) Air Outlet Size: As directed by the manufacturer or as directed by the Owner.
      7) Orifice Size: As directed by the manufacturer or as directed by the Owner.
      8) Design Air-Release Capacity: As directed by the manufacturer or as directed by the Owner.
2. Air/Vacuum Valves:
   a. Description: Direct-acting, float-operated, hydromechanical device with large orifice to automatically release accumulated air or to admit air during filling of piping.
      1) Standard: AWWA C512.
      2) Pressure Rating: 300 psig (2070 kPa), **as directed**.
      3) Body Material: Cast iron, **as directed**.
      4) Trim Material: Stainless steel, brass, or bronze\, **as directed**.
      5) Inlet and Outlet Size: As directed by the manufacturer or as directed by the Owner.
      6) Orifice Size: As directed by the manufacturer or as directed by the Owner.
      7) Design Air Capacity: As directed by the manufacturer or as directed by the Owner.
3. Combination Air Valves:
   a. Description: Float-operated, hydromechanical device to automatically release accumulated air or to admit air.
      1) Standard: AWWA C512.
      2) Pressure Rating: 300 psig (2070 kPa), **as directed**.
      3) Body Material: Cast iron, **as directed**.
      4) Trim Material: Stainless steel, brass, or bronze, **as directed**.
      5) Inlet and Outlet Size: As directed by the manufacturer or as directed by the Owner.
      6) Orifice Size: As directed by the manufacturer or as directed by the Owner.
      7) Design Air Capacity: As directed by the manufacturer or as directed by the Owner.

U. Vacuum Breakers
1. Pressure Vacuum Breaker Assembly:
a. Standard: ASSE 1020.
b. Operation: Continuous-pressure applications.
c. Pressure Loss: 5 psig (35 kPa), **as directed,** maximum, through middle 1/3 of flow range.
d. Size: As directed by the manufacturer or as directed by the Owner.
e. Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
f. Selected Unit Flow Range Limits: As directed by the manufacturer or as directed by the Owner.
g. Pressure Loss at Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
h. Accessories: Ball valves on inlet and outlet.

V. Backflow Preventers
1. Reduced-Pressure-Principle Backflow Preventers:
a. Standard: ASSE 1013 **OR** AWWA C511, **as directed**.
b. Operation: Continuous-pressure applications.
c. Pressure Loss: 12 psig (83 kPa), **as directed,** maximum, through middle 1/3 of flow range.
d. Size: As directed by the manufacturer or as directed by the Owner.
e. Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
f. Selected Unit Flow Range Limits: As directed by the manufacturer or as directed by the Owner.
g. Pressure Loss at Design Flow Rate: As directed by the manufacturer or as directed by the Owner.for NPS 2 (DN 50) and smaller; As directed by the manufacturer or as directed by the Owner.for NPS 2-1/2 (DN 65) and larger.
h. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved **OR** steel with interior lining complying with AWWA C550 or that is FDA approved **OR** stainless steel, **as directed**, for NPS 2-1/2 (DN 65) and larger.
i. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged, **as directed**, for NPS 2-1/2 (DN 65) and larger.
j. Configuration: Designed for horizontal, straight through **OR** vertical inlet, horizontal center section, and vertical outlet **OR** vertical, **as directed**, flow.
k. Accessories:
1) Valves: Ball type with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; OS&Y gate type with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.
2) Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.
2. Double-Check, Backflow-Prevention Assemblies:
a. Standard: ASSE 1015 **OR** AWWA C510, **as directed**.
b. Operation: Continuous-pressure applications, unless otherwise indicated.
c. Pressure Loss: 5 psig (35 kPa), **as directed**, maximum, through middle 1/3 of flow range.
d. Size: As directed by the manufacturer or as directed by the Owner.
e. Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
f. Selected Unit Flow Range Limits: As directed by the manufacturer or as directed by the Owner.
g. Pressure Loss at Design Flow Rate: As directed by the manufacturer or as directed by the Owner.for NPS 2 (DN 50) and smaller; As directed by the manufacturer or as directed by the Owner.for NPS 2-1/2 (DN 65) and larger.
h. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved **OR** steel with interior lining complying with AWWA C550 or that is FDA approved **OR** stainless steel, **as directed**, for NPS 2-1/2 (DN 65) and larger.
i. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged, **as directed**, for NPS 2-1/2 (DN 65) and larger.

j. Configuration: Designed for horizontal, straight through, **as directed**, flow.
k. Accessories: Ball valves with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; OS&Y gate valves with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.

3. Reduced-Pressure-Detector, Fire-Protection Backflow Preventer Assemblies:
   a. Standards: ASSE 1047 and UL listed or FMG approved.
   b. Operation: Continuous-pressure applications.
   c. Pressure Loss: 12 psig (83 kPa), **as directed**, maximum, through middle 1/3 of flow range.
   d. Size: As directed by the manufacturer or as directed by the Owner.Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
   e. Selected Unit Flow Range Limits: As directed by the manufacturer or as directed by the Owner.
   f. Pressure Loss at Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
   g. Body: Cast iron with interior lining complying with AWWA C550 or that is FDA approved **OR** Steel with interior lining complying with AWWA C550 or that is FDA approved **OR** Stainless steel, **as directed**.
   h. End Connections: Flanged.
   i. Configuration: Designed for horizontal, straight through **OR** vertical inlet, horizontal center section, and vertical outlet **OR** vertical, **as directed**, flow.
   j. Accessories:
      1) Valves: UL 262, FMG-approved, OS&Y gate type with flanged ends on inlet and outlet.
      2) Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.
      3) Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.
4. Double-Check, Detector-Assembly Backflow Preventers:
   a. Standards: ASSE 1048 and UL listed or FMG approved.
   b. Operation: Continuous-pressure applications.
   c. Pressure Loss: 5 psig (35 kPa), **as directed**, maximum, through middle 1/3 of flow range.
   d. Size: As directed by the manufacturer or as directed by the Owner.
   e. Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
   f. Selected Unit Flow Range Limits: As directed by the manufacturer or as directed by the Owner.
   g. Pressure Loss at Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
   h. Body: Cast iron with interior lining complying with AWWA C550 or that is FDA approved **OR** Steel with interior lining complying with AWWA C550 or that is FDA approved **OR** Stainless steel, **as directed**.
   i. End Connections: Flanged.
   j. Configuration: Designed for horizontal, straight through **OR** vertical inlet, horizontal center section, and vertical outlet **OR** vertical, **as directed**, flow.
   k. Accessories:
      1) Valves: UL 262, FMG-approved, OS&Y gate type with flanged ends on inlet and outlet.
      2) Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.
5. Backflow Preventer Test Kits:
   a. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

W. Water Meter Boxes
1. Description: Cast-iron body and cover for disc-type water meter, with lettering "WATER METER" in cover; and with slotted, open-bottom base section of length to fit over service piping.

a. Option: Base section may be cast-iron, PVC, clay, or other pipe.

2. Description: Cast-iron body and double cover for disc-type water meter, with lettering "WATER METER" in top cover; and with separate inner cover; air space between covers; and slotted, open-bottom base section of length to fit over service piping.
3. Description: Polymer-concrete body and cover for disc-type water meter, with lettering "WATER" in cover; and with slotted, open-bottom base section of length to fit over service piping. Include vertical and lateral design loadings of 15,000 lb minimum over 10 by 10 inches (6800 kg minimum over 254 by 254 mm) square.
   a. Use of this meter box is permitted in walks or unpaved areas away from traffic; do not use in roadways.

X. Concrete Vaults
1. Description: Precast, reinforced-concrete vault, designed for A-16 load designation according to ASTM C 857 and made according to ASTM C 858.
   a. Ladder: ASTM A 36/A 36M, steel or polyethylene-encased steel steps.
   b. Manhole: ASTM A 48/A 48M Class No. 35A minimum tensile strength, gray-iron traffic frame and cover.
      1) Dimension: 24-inch (610-mm) minimum diameter, unless otherwise indicated.
   c. Manhole: ASTM A 536, Grade 60-40-18, ductile-iron traffic frame and cover.
      1) Dimension: 24-inch- (610-mm-) minimum diameter, unless otherwise indicated.
   d. Drain: ASME A112.6.3, cast-iron floor drain with outlet of size indicated. Include body anchor flange, light-duty cast-iron grate, bottom outlet, and integral or field-installed bronze ball or clapper-type backwater valve.

Y. Protective Enclosures
1. Freeze-Protection Enclosures:
   a. Description: Insulated enclosure designed to protect aboveground water piping, equipment, or specialties from freezing and damage, with heat source to maintain minimum internal temperature of 40 deg F (4 deg C) when external temperatures reach as low as minus 34 deg F (minus 36 deg C).
      1) Standard: ASSE 1060.
      2) Class I: For equipment or devices other than pressure or atmospheric vacuum breakers.
      3) Class I-V: For pressure or atmospheric vacuum breaker equipment or devices. Include drain opening in housing.
         a) Housing: Reinforced-aluminum **OR** -fiberglass, **as directed**, construction.
            i. Size: Of dimensions indicated, but not less than those required for access and service of protected unit.
            ii. Drain opening for units with drain connection.
            iii. Access doors with locking devices.
            iv. Insulation inside housing.
            v. Anchoring devices for attaching housing to concrete base.
         b) Electric heating cable or heater with self-limiting temperature control.
2. Weather-Resistant Enclosures:
   a. Description: Uninsulated enclosure designed to protect aboveground water piping, equipment, or specialties from weather and damage.
      1) Standard: ASSE 1060.
      2) Class III: For equipment or devices other than pressure or atmospheric vacuum breakers.
      3) Class III-V: For pressure or atmospheric vacuum breaker equipment or devices. Include drain opening in housing.
         i. Housing: Reinforced-aluminum **OR** -fiberglass, **as directed**, construction.
         ii. Size: Of dimensions indicated, but not less than those required for access and service of protected unit.
         iii. Drain opening for units with drain connection.

iv. Access doors with locking devices.
v. Anchoring devices for attaching housing to concrete base.

3. Expanded-Metal Enclosures:
   a. Description: Enclosure designed to protect aboveground water piping, equipment, or specialties from damage.
      1) Material: ASTM F 1267, expanded metal side and top panels, of weight and with reinforcement of same metal at edges as required for rigidity.
      2) Type: Type I, expanded **OR** II, expanded and flattened, **as directed**.
      3) Class: Class 1, uncoated carbon steel **OR** 2, hot-dip, zinc-coated carbon steel **OR** 3, corrosion-resisting steel, **as directed**.
      4) Finish: Manufacturer's enamel paint.
      5) Size: Of dimensions indicated, but not less than those required for access and service of protected unit.
      6) Locking device.
      7) Lugs or devices for securing enclosure to base.
4. Enclosure Bases:
   a. Description: 4-inch- (100-mm-) **OR** 6-inch- (150-mm-), **as directed**, minimum thickness precast concrete, of dimensions required to extend at least 6 inches (150 mm) beyond edges of enclosure housings. Include openings for piping.

Z. Fire Hydrants
1. Dry-Barrel Fire Hydrants:
   a. Description (for AWWA dry-barrel fire hydrants): Freestanding, with one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, 5-1/4-inch (133-mm) main valve, drain valve, and NPS 6 (DN 150) mechanical-joint inlet. Include interior coating according to AWWA C550. Hydrant shall have cast-iron body, compression-type valve opening against pressure and closing with pressure.
      1) Standard: AWWA C502.
      2) Pressure Rating: 150 psig (1035 kPa) minimum **OR** 250 psig (1725 kPa), **as directed**.
      3) Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
      4) Operating and Cap Nuts: Pentagon, 1-1/2 inches (38 mm) point to flat.
      5) Direction of Opening: Open hydrant valve by turning operating nut to left or counterclockwise.
      6) Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.
   b. Description (for UL/FMG, dry-barrel fire hydrants): Freestanding, with one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, 5-1/4-inch (133-mm) main valve, drain valve, and NPS 6 (DN 150) mechanical-joint inlet. Hydrant shall have cast-iron body, compression-type valve opening against pressure and closing with pressure.
      1) Standards: UL 246, FMG approved.
      2) Pressure Rating: 150 psig (1035 kPa) minimum **OR** 250 psig (1725 kPa), **as directed**.
      3) Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
      4) Operating and Cap Nuts: Pentagon, 1-1/2 inches (38 mm) point to flat.
      5) Direction of Opening: Open hydrant valve by turning operating nut to left or counterclockwise.
      6) Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.
2. Wet-Barrel Fire Hydrants:
   a. Description (for AWWA wet-barrel fire hydrants): Freestanding, with one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, NPS 6 (DN 150) threaded or flanged inlet, and base section with NPS 6 (DN 150) mechanical-joint inlet. Include interior coating according to AWWA C550.
      1) Standard: AWWA C503.

2) Pressure Rating: 150 psig (1035 kPa) minimum.
3) Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
4) Operating and Cap Nuts: Pentagon, 1-1/2 inches (38 mm) point to flat.
5) Direction of Opening: Open hydrant valves by turning operating nut to left or counterclockwise.
6) Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.

b. Description (for UL/FMG, wet-barrel fire hydrants): Freestanding, with one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, NPS 6 (DN 150) threaded or flanged inlet, and base section with NPS 6 (DN 150) mechanical-joint inlet.
1) Standards: UL 246 and FMG approved.
2) Pressure Rating: 150 psig (1035 kPa) minimum.
3) Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
4) Operating and Cap Nuts: Pentagon, 1-1/2 inches (38 mm) point to flat.
5) Direction of Opening: Open hydrant valves by turning operating nut to left or counterclockwise.
6) Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.

AA. Flushing Hydrants
1. Post-Type Flushing Hydrants:
a. Description: Nonfreeze and drainable, of length required for shutoff valve installation below frost line.
1) Pressure Rating: 150 psig (1035 kPa) minimum.
2) Outlet: One, with horizontal discharge.
3) Hose Thread: NPS 2-1/2 (DN 65), with NFPA 1963 external hose thread for use by local fire department, and with cast-iron cap with brass chain.
4) Barrel: Cast-iron or steel pipe with breakaway feature.
5) Valve: Bronze body with bronze-ball or plunger closure, and automatic draining.
6) Security: Locking device for padlock.
7) Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.
8) Inlet: NPS 2 (DN 50) minimum.
9) Operating Wrench: One for each unit.
2. Ground-Type Flushing Hydrants:
a. Description: Nonfreeze and drainable, of length required for shutoff valve installation below frost line.
1) Pressure Rating: 150 psig (1035 kPa) minimum.
2) Outlet: One, with vertical **OR** angle, **as directed**, discharge.
3) Hose Thread: NPS 2-1/2 (DN 65), with NFPA 1963 external hose thread for use by local fire department, and with cast-iron cap with brass chain.
4) Barrel: Cast-iron or steel pipe.
5) Valve: Bronze body with bronze-ball or plunger closure, and automatic draining.
6) Inlet: NPS 2 (DN 50) minimum.
7) Hydrant Box: Cast iron with cover, for ground mounting.
8) Operating Wrench: One for each unit.
3. Post-Type Sampling Station:
a. Description: Nonfreeze and drainable, of length required for shutoff valve installation below frost line.
1) Pressure Rating: 100 psig (690 kPa) minimum.
2) Sampling Outlet: One unthreaded nozzle with handle.
3) Valve: Bronze body with bronze-ball or plunger closure. Include operating handle.
4) Drain: Tubing with separate manual vacuum pump.
5) Inlet: NPS 3/4 (DN 20) minimum.
6) Housing: Weatherproof material with locking device. Include anchor device.
7) Operating Wrench: One for each unit.

BB. Fire Department Connections
1. Fire Department Connections:
a. Description: Freestanding, with cast-bronze body, thread inlets according to NFPA 1963 and matching local fire department hose threads, and threaded bottom outlet. Include lugged caps, gaskets, and chains; lugged swivel connection and drop clapper for each hose-connection inlet; 18-inch- (460-mm-) high brass sleeve; and round escutcheon plate.
1) Standard: UL 405.
2) Connections: Two NPS 2-1/2 (DN 65) inlets and one NPS 4 (DN 100) **OR** NPS 6 (DN 150), **as directed**, outlet.
3) Connections: Three **OR** Four, **as directed**, NPS 2-1/2 (DN 65) inlets and one NPS 6 (DN 150) outlet.
4) Connections: Six NPS 2-1/2 (DN 65) inlets and one NPS 6 (DN 150) **OR** NPS 8 (DN 200), **as directed**, outlet.
5) Inlet Alignment: Inline, horizontal **OR** Square, **as directed**.
6) Finish Including Sleeve: Polished chrome-plated **OR** Rough chrome-plated **OR** Polished bronze, **as directed**.
7) Escutcheon Plate Marking: "AUTO SPKR" **OR** "STANDPIPE" **OR** "AUTO SPKR & STANDPIPE."

CC. Alarm Devices
1. Alarm Devices, General: UL 753 and FMG approved, of types and sizes to mate and match piping and equipment.
2. Water-Flow Indicators (can be used with wet-barrel fire hydrants): Vane-type water-flow detector, rated for 250-psig (1725-kPa) working pressure; designed for horizontal or vertical installation; with 2 single-pole, double-throw circuit switches to provide isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal when cover is removed.
3. Supervisory Switches: Single pole, double throw; designed to signal valve in other than fully open position. Mount on stem of OS&Y gate valves and on indicator posts.
4. Pressure Switches: Single pole, double throw; designed to signal increase in pressure. Mount on barrel of dry-barrel fire hydrants.

1.3 EXECUTION

A. Earthwork
1. Refer to Division 02 Section "Earthwork" for excavating, trenching, and backfilling.

B. Piping Applications
1. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.
2. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.
3. Do not use flanges or unions for underground piping.
4. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.
5. Underground water-service piping NPS 3/4 to NPS 3 (DN 20 to DN 80), **as directed**, shall be selected from the following, **as directed**:
a. Soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; wrought-copper, solder-joint fittings; and brazed **OR** copper, pressure-seal fittings; and pressure-sealed, **as directed**, joints.
b. PE, ASTM pipe; insert fittings for PE pipe; and clamped **OR** molded PE fittings; and heat-fusion, **as directed**, joints.
c. PVC, Schedule 40 pipe; PVC, Schedule 40 **OR** Schedule 80 pipe; PVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.

d. NPS 1 to NPS 3 (DN 25 to DN 80) fiberglass, AWWA RTRP, Class 150 **OR** 200 **OR** 250, **as directed**; RTRF; and bonded joints.
e. Fiberglass, AWWA RTRP, Class 150 **OR** 200 **OR** 250, **as directed**; RTRF; and bonded joints.

6. Underground water-service piping NPS 4 to NPS 8 (DN 100 to DN 200), **as directed**, shall be selected from the following, **as directed**:
   a. Soft copper tube, ASTM B 88, Type K (ASTM B 88M,Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; wrought-copper, solder-joint fittings; and brazed joints.
   b. Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed **OR** mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical **OR** grooved-end pipe; ductile-iron-pipe appurtenances; and grooved, **as directed**, joints.
   c. PE, AWWA pipe; PE, AWWA fittings; and heat-fusion joints.
   d. PVC, Schedule 40 pipe; PVC, Schedule 40 **OR** Schedule 80 pipe; PVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.
   e. NPS 4 and NPS 6 (DN 100 and DN 150): NPS 6 (DN 150) PVC, AWWA Class 150 pipe; PVC, AWWA Class 150 fabricated **OR** molded, **as directed**, fittings; and gasketed joints.
   f. NPS 8 (DN 200): PVC, AWWA Class 200 pipe; PVC, AWWA Class 200 fabricated **OR** push-on-joint, ductile-iron **OR** mechanical-joint, ductile-iron, **as directed**, fittings; and gasketed joints.
   g. Fiberglass, AWWA RTRP, Class 150 **OR** 200 **OR** 250, **as directed**; RTRF; and bonded joints.
7. Water Meter Box Water-Service Piping NPS 3/4 to NPS 2 (DN 20 to DN 50), **as directed**, shall be same as underground water-service piping.
8. Aboveground and Vault, **as directed**, Water-Service Piping NPS 3/4 to NPS 3 (DN 20 to DN 80), **as directed**, shall be selected from the following:

NOTE: Water-service piping materials listed in subparagraphs below are for potable-water service. They may not be suitable for fire-service mains.

   a. Hard copper tube, ASTM B 88, Type K (ASTM B 88M, Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; wrought-copper, solder-joint fittings; and brazed **OR** copper, pressure-seal fittings; and pressure-sealed, **as directed**, joints.
   b. PVC, Schedule 80 pipe; PVC, Schedule 80 socket fittings; and solvent-cemented **OR** threaded fittings; and threaded, **as directed**, joints.
   c. NPS 1 to NPS 2 (DN 25 to DN 50) fiberglass, AWWA RTRP, Class 150 **OR** 200 **OR** 250, **as directed**; RTRF; and bonded joints.
9. Aboveground and vault, **as directed**, water-service piping NPS 4 to NPS 8 (DN 100 to DN 200), **as directed**, shall be selected from the following:
   a. Hard copper tube, ASTM B 88, Type K (ASTM B 88M, Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; wrought-copper, solder-joint fittings; and brazed joints.
   b. Ductile-iron, grooved-end pipe; ductile-iron, grooved-end appurtenances; and grooved joints.
   c. PVC, Schedule 80 pipe; PVC, Schedule 80 socket fittings; and solvent-cemented **OR** threaded fittings; and threaded, **as directed**, joints.
   d. Fiberglass, AWWA RTRP, Class 150 **OR** 200 **OR** 250, **as directed**; RTRF; and bonded joints.
10. Underground Fire-Service-Main Piping NPS 4 to NPS 12 (DN 100 to DN 300), **as directed**, shall be selected from the following:

NOTE: Fire-service-main piping materials listed in subparagraphs below are for fire-protection water service. They may not be suitable for potable-water service.

   a. Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed **OR** mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical **OR** grooved-end pipe; ductile-iron-pipe appurtenances; and grooved, **as directed**, joints.
   b. PE, Class 150 **OR** 200, **as directed**, fire-service pipe; molded PE fittings; and heat-fusion joints.

c. PVC, AWWA Class 150 pipe listed for fire-protection service; PVC Class 150 fabricated or molded fittings; and gasketed joints.
d. PVC, AWWA Class 200 pipe listed for fire-protection service; PVC Class 200 fabricated fittings; and gasketed joints.
e. Fiberglass, AWWA, FMG-approved RTRP, Class 150 **OR** 200, **as directed**; RTRF; and gasketed joints.
f. Fiberglass, UL RTRP, Class 150 **OR** 200 **OR** 250, **as directed**; RTRF; and gasketed joints.

11. Aboveground and Vault, **as directed**, Fire-Service-Main Piping NPS 4 to NPS 12 (DN 100 to DN 300), **as directed**, shall be ductile-iron, grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints.
12. Underground Combined Water-Service and Fire-Service-Main Piping NPS 6 to NPS 12 (DN 150 to DN 300), **as directed**, shall be selected from the following:
    a. Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed **OR** mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical **OR** grooved-end pipe; ductile-iron-pipe appurtenances; and grooved, **as directed**, joints.
    b. PVC, AWWA Class 150 **OR** 200, **as directed**, pipe listed for fire-protection service; PVC fabricated or molded fittings of same class as pipe; and gasketed joints.
    c. Fiberglass, AWWA, FMG-approved RTRP, Class 150 **OR** 200, **as directed**; RTRF; and gasketed joints.
13. Aboveground and Vault, **as directed**, Combined Water Service and Fire-Service-Main Piping NPS 6 to NPS 12 (DN 150 to DN 300), **as directed**, shall be ductile-iron, grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints.

C. Valve Applications
1. General Application: Use mechanical-joint-end valves for NPS 3 (DN 80) and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 (DN 50) and smaller installation.
2. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
    a. Underground Valves, NPS 3 (DN 80) and Larger: AWWA, cast-iron, nonrising-stem, metal **OR** resilient **OR** high-pressure, resilient, **as directed**,-seated gate valves with valve box.
    b. Underground Valves, NPS 4 (DN 100) and Larger, for Indicator Posts: UL/FMG, cast-iron, nonrising-stem gate valves with indicator post.
    c. Use the following for valves in vaults and aboveground:
        1) Gate Valves, NPS 2 (DN 50) and Smaller: Bronze, nonrising **OR** rising, **as directed**, stem.
        2) Gate Valves, NPS 3 (DN 80) and Larger: AWWA, cast iron, OS&Y rising stem, metal seated **OR** AWWA, cast iron, OS&Y rising stem, resilient seated **OR** UL/FMG, cast iron, OS&Y rising stem, **as directed**.
        3) Check Valves: AWWA C508 **OR** UL/FMG, **as directed**, swing type.
    d. Pressure-Reducing Valves: Use for water-service piping in vaults and aboveground to control water pressure.
    e. Relief Valves: Use for water-service piping in vaults and aboveground.
        1) Air-Release Valves: To release accumulated air.
        2) Air/Vacuum Valves: To release or admit large volume of air during filling of piping.
        3) Combination Air Valves: To release or admit air.
    f. Detector Check Valves: Use for water-service piping in vaults and aboveground to detect unauthorized use of water.

D. Piping Systems - Common Requirements
1. See Division 15 Section "Common Work Results For Plumbing" for piping-system common requirements.

E. Piping Installation

1. Water-Main Connection (if tap is made by utility company): Arrange with utility company for tap of size and in location indicated in water main.
2. Water-Main Connection (if tap is made by Contractor): Tap water main according to requirements of water utility company and of size and in location indicated.
3. Make connections larger than NPS 2 (DN 50) with tapping machine according to the following:
   a. Install tapping sleeve and tapping valve according to MSS SP-60.
   b. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
   c. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
   d. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.
4. Make connections NPS 2 (DN 50) and smaller with drilling machine according to the following:
   a. Install service-saddle assemblies and corporation valves in size, quantity, and arrangement required by utility company standards.
   b. Install service-saddle assemblies on water-service pipe to be tapped. Position outlets for corporation valves.
   c. Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.
   d. Install corporation valves into service-saddle assemblies.
   e. Install manifold for multiple taps in water main.
   f. Install curb valve in water-service piping with head pointing up and with service box.
5. Comply with NFPA 24 for fire-service-main piping materials and installation.
   a. Install PE corrosion-protection encasement according to ASTM A 674 or AWWA C105.
   b. Install copper tube and fittings according to CDA's "Copper Tube Handbook."
6. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.
   a. If required, install PE corrosion-protection encasement according to ASTM A 674 or AWWA C105.
7. Install PE pipe according to ASTM D 2774 and ASTM F 645.
8. Install PVC, AWWA pipe according to ASTM F 645 and AWWA M23.
9. Install fiberglass AWWA pipe according to AWWA M45.
10. Bury piping with depth of cover over top at least 30 inches (750 mm), **as directed**, with top at least 12 inches (300 mm), **as directed**, below level of maximum frost penetration, and according to the following:
    a. Under Driveways: With at least 36 inches (910 mm), **as directed**, cover over top.
    b. Under Railroad Tracks: With at least 48 inches (1220 mm), **as directed**, cover over top.
    c. In Loose Gravelly Soil and Rock: With at least 12 inches (300 mm), **as directed**, additional cover.
11. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.
12. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.
    a. Terminate water-service piping at building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.
13. Sleeves are specified in Division 15 Section "Common Work Results For Plumbing".
14. Mechanical sleeve seals are specified in Division 15 Section "Common Work Results For Plumbing".
15. For piping with gasketed joints: Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.
16. See Division 15 Section "Common Work Results For Fire Suppression" for fire-suppression-water piping inside the building.
17. See Division 15 Section "Common Work Results For Plumbing" for potable-water piping inside the building.

F. Joint Construction
1. See Division 15 Section "Common Work Results For Plumbing" for basic piping joint construction.
2. Make pipe joints according to the following:
   a. Copper-Tubing, Pressure-Sealed Joints: Use proprietary crimping tool and procedure recommended by copper, pressure-seal-fitting manufacturer.
   b. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
   c. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
   d. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with grooved-end, ductile-iron-piping couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.
   e. PE Piping Insert-Fitting Joints: Use plastic insert fittings and fasteners according to fitting manufacturer's written instructions.
   f. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.
   g. Fiberglass Piping Bonded Joints: Use adhesive and procedure recommended by piping manufacturer.
   h. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure. Refer to Division 15 Section "Common Work Results For Plumbing" for joining piping of dissimilar metals.

G. Anchorage Installation
1. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
   a. Concrete thrust blocks.
   b. Locking mechanical joints.
   c. Set-screw mechanical retainer glands.
   d. Bolted flanged joints.
   e. Heat-fused joints.
   f. Pipe clamps and tie rods.
2. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
   a. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
   b. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
   c. Bonded-Joint Fiberglass, Water-Service Piping: According to AWWA M45.
   d. Fire-Service-Main Piping: According to NFPA 24.
3. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

H. Valve Installation
1. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.
2. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.
3. UL/FMG, Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.
4. UL/FMG, Valves Other Than Gate Valves: Comply with NFPA 24.
5. MSS Valves: Install as component of connected piping system.
6. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.
7. Pressure-Reducing Valves: Install in vault or aboveground between shutoff valves. Install full-size valved bypass, **as directed**.
8. Relief Valves: Comply with AWWA C512. Install aboveground with shutoff valve on inlet.

I. Detector-Check Valve Installation

1. Install in vault or aboveground.
2. Install for proper direction of flow. Install bypass with water meter, gate valves on each side of meter, and check valve downstream from meter.
3. Support detector check valves, meters, shutoff valves, and piping on brick or concrete piers.

J. Water Meter Installation
1. If water meters are provided by the Contractor: Install water meters, piping, and specialties according to utility company's written instructions.
2. Water Meters: Install displacement **OR** turbine, **as directed**,-type water meters, NPS 2 (DN 50) and smaller, in meter boxes with shutoff valves on water meter inlets. Include valves on water meter outlets and valved bypass around meters unless prohibited by authorities having jurisdiction.
3. Water Meters: Install compound **OR** turbine, **as directed**,-type water meters, NPS 3 (DN 80) and larger, in meter vaults. Include shutoff valves on water meter inlets and outlets and valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.
4. Water Meters: Install detector-type water meters in meter vault according to AWWA M6. Include shutoff valves on water meter inlets and outlets and full-size valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.

K. Roughing-In For Water Meters
1. If Contractor is to rough-in for water meters to be installed by utility company: Rough-in piping and specialties for water meter installation according to utility company's written instructions.

L. Vacuum Breaker Assembly Installation
1. Install pressure vacuum breaker assemblies of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.
2. Do not install pressure vacuum breaker assemblies in vault or other space subject to flooding.

M. Backflow Preventer Installation
1. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.
2. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.
3. Do not install bypass piping around backflow preventers.
4. Support NPS 2-1/2 (DN 65) and larger backflow preventers, valves, and piping near floor and on brick or concrete piers.

N. Water Meter Box Installation
1. Install water meter boxes in paved areas flush with surface.
2. Install water meter boxes in grass or earth areas with top 2 inches (50 mm), **as directed**, above surface.

O. Concrete Vault Installation
1. Install precast concrete vaults according to ASTM C 891.

P. Protective Enclosure Installation
1. Install concrete base level and with top approximately 2 inches (50 mm), **as directed**, above grade.
2. Install protective enclosure over valves and equipment.
3. Anchor protective enclosure to concrete base.

Q. Fire Hydrant Installation
1. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.

2. Wet-Barrel Fire Hydrants: Install with valve below frost line. Provide for drainage.
3. AWWA Fire Hydrants: Comply with AWWA M17.
4. UL/FMG Fire Hydrants: Comply with NFPA 24.

R. Flushing Hydrant Installation
1. Install post-type flushing hydrants with valve below frost line and provide for drainage. Support in upright position. Include separate gate valve or curb valve and restrained joints in supply piping.
2. Install ground-type flushing hydrants with valve below frost line and provide for drainage. Install hydrant box flush with grade. Include separate gate valve or curb valve and restrained joints in supply piping.
3. Install sampling stations with valve below frost line and provide for drainage. Attach weather-resistant housing and support in upright position. Include separate curb valve in supply piping.

S. Fire Department Connection Installation
1. Install ball drip valves at each check valve for fire department connection to mains.
2. Install protective pipe bollards on two sides of **OR** on three sides of, **as directed**, each fire department connection. Pipe bollards are specified in Division 05 Section "Metal Fabrications".

T. Alarm Device Installation
1. General: Comply with NFPA 24 for devices and methods of valve supervision. Underground valves with valve box do not require supervision.
2. Supervisory Switches: Supervise valves in open position.
   a. Valves: Grind away portion of exposed valve stem. Bolt switch, with plunger in stem depression, to OS&Y gate-valve yoke.
   b. Indicator Posts: Drill and thread hole in upper-barrel section at target plate. Install switch, with toggle against target plate, on barrel of indicator post.
3. Locking and Sealing: Secure unsupervised valves as follows:
   a. Valves: Install chain and padlock on open OS&Y gate valve.
   b. Post Indicators: Install padlock on wrench on indicator post.
4. Pressure Switches: Drill and thread hole in exposed barrel of fire hydrant. Install switch.
5. Water-Flow Indicators: Install in water-service piping in vault. Select indicator with saddle and vane matching pipe size. Drill hole in pipe, insert vane, and bolt saddle to pipe.
6. Connect alarm devices to building fire alarm system. Wiring and fire-alarm devices are specified in Division 13.

U. Connections
1. Piping installation requirements are specified in other Division 02. Drawings indicate general arrangement of piping, fittings, and specialties.
2. See Division 15 Section "Common Work Results For Plumbing" for piping connections to valves and equipment.
3. Connect water-distribution piping to utility water main **OR** existing water main, **as directed**. Use tapping sleeve and tapping valve **OR** service clamp and corporation valve, **as directed**.
4. Connect water-distribution piping to interior domestic water **OR** fire-suppression, **as directed**, piping.
5. Connect waste piping from concrete vault drains to sanitary sewerage system. See Division 02 for connection to sanitary-sewer **OR** storm-drainage system. See Division 02 for connection to storm-sewer, **as directed**, piping.
6. Ground equipment according to Division 16 Section "Grounding And Bonding".
7. Connect wiring according to Division 16 Section "Conductors And Cables".

V. Field Quality Control
1. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.
2. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.

a. Increase pressure in 50-psig (350-kPa) increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig (0 kPa). Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts (1.89 L) per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

3. Prepare reports of testing activities.

W. Identification

1. Install continuous underground detectable, **as directed**, warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Division 02 Section "Earthwork".
2. Permanently attach equipment nameplate or marker indicating plastic water-service piping, on main electrical meter panel. See Division 15 Section "Common Work Results For Plumbing" for identifying devices.

NOTE: Delete paragraph above if metallic water-service piping without electrically insulated fittings will be used.

X. Cleaning

1. Clean and disinfect water-distribution piping as follows:
   a. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
   b. If fire-protection-water piping is not connected to potable-water supply, use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.
   c. If fire-protection-water piping is connected to potable-water supply, use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:
      1) Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours **OR** Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours, **as directed**.
      2) After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
      3) Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.
2. Prepare reports of purging and disinfecting activities.

END OF SECTION 02455a

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SECTION 02455b - SANITARY SEWERAGE

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for sanitary sewerage. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Pipe and fittings.
b. Nonpressure and pressure couplings.
c. Expansion joints and deflection fittings.
d. Backwater valves.
e. Cleanouts.
f. Encasement for piping.
g. Manholes.

C. Definitions
1. FRP: Fiberglass-reinforced plastic.

D. Submittals
1. Product Data: For the following:
a. Expansion joints and deflection fittings.
b. Backwater valves.
2. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.
3. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from sewer system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
4. Profile Drawings: Show system piping in elevation. Draw profiles to horizontal scale of not less than 1 inch equals 50 feet (1:500) and to vertical scale of not less than 1 inch equals 5 feet (1:50). Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.
5. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.
6. Field quality-control reports.

E. Delivery, Storage, And Handling
1. Do not store plastic manholes, pipe, and fittings in direct sunlight.
2. Protect pipe, pipe fittings, and seals from dirt and damage.
3. Handle manholes according to manufacturer's written rigging instructions.

F. Project Conditions
1. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
a. Notify the Owner no fewer than two days in advance of proposed interruption of service.
b. Do not proceed with interruption of service without the Owner written permission.

1.2 PRODUCTS

A. Hub-And-Spigot, Cast-Iron Soil Pipe And Fittings
1. Pipe and Fittings: ASTM A 74, Service class **OR** Service and Extra-Heavy classes **OR** Extra-Heavy class, **as directed**.
2. Gaskets: ASTM C 564, rubber.
3. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

B. Hubless Cast-Iron Soil Pipe And Fittings
1. Pipe and Fittings: ASTM A 888 or CISPI 301.
2. CISPI-Trademark, Shielded Couplings:
a. Description: ASTM C 1277 and CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
3. Heavy-Duty, Shielded Couplings:
a. Description: ASTM C 1277 and ASTM C 1540, with stainless-steel shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
4. Cast-Iron, Shielded Couplings:
a. Description: ASTM C 1277 with ASTM A 48/A 48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.
5. Unshielded Couplings:
a. Description: ASTM C 1277 and ASTM C 1461, rigid, sleeve-type, reducing- or transition-type mechanical coupling, with integral, center pipe stop, molded from ASTM C 1440, TPE material; with corrosion-resistant-metal tension band and tightening mechanism on each end.

C. Ductile-Iron, Gravity Sewer Pipe And Fittings
1. Pipe: ASTM A 746, for push-on joints.
2. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.
3. Compact Fittings: AWWA C153, ductile iron, for push-on joints.
4. Gaskets: AWWA C111, rubber.

D. Ductile-Iron, Pressure Pipe And Fittings
1. Push-on-Joint Piping:
a. Pipe: AWWA C151.
b. Standard Fittings: AWWA C110, ductile or gray iron.
c. Compact Fittings: AWWA C153.
d. Gaskets: AWWA C111, rubber, of shape matching pipe and fittings.
2. Mechanical-Joint Piping:
a. Pipe: AWWA C151, with bolt holes in bell.
b. Standard Fittings: AWWA C110, ductile or gray iron, with bolt holes in bell.
c. Compact Fittings: AWWA C153, with bolt holes in bells.
d. Glands: Cast or ductile iron; with bolt holes and high-strength, cast-iron or high-strength, low-alloy steel bolts and nuts.
e. Gaskets: AWWA C111, rubber, of shape matching pipe, fittings, and glands.

E. ABS Pipe And Fittings
1. ABS Sewer Pipe and Fittings: ASTM D 2751, with bell-and-spigot ends for gasketed joints.
a. NPS 3 to NPS 6 (DN 80 to DN 150): SDR 35.
b. NPS 8 to NPS 12 (DN 200 to DN 300): SDR 42.
2. Gaskets: ASTM F 477, elastomeric seals.

F. PVC Pipe And Fittings

1. PVC Cellular-Core Sewer Piping:
   a. Pipe: ASTM F 891, Sewer and Drain Series, PS 50 minimum stiffness, PVC cellular-core pipe with plain ends for solvent-cemented joints.
   b. Fittings: ASTM D 3034, SDR 35, PVC socket-type fittings.
2. PVC Corrugated Sewer Piping:
   a. Pipe: ASTM F 949, PVC corrugated pipe with bell-and-spigot ends for gasketed joints.
   b. Fittings: ASTM F 949, PVC molded or fabricated, socket type.
   c. Gaskets: ASTM F 477, elastomeric seals.
3. PVC Profile Sewer Piping:
   a. Pipe: ASTM F 794, PVC profile, gravity sewer pipe with bell-and-spigot ends for gasketed joints.
   b. Fittings: ASTM D 3034, PVC with bell ends.
   c. Gaskets: ASTM F 477, elastomeric seals.
4. PVC Type PSM Sewer Piping:
   a. Pipe: ASTM D 3034, SDR 35, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
   b. Fittings: ASTM D 3034, PVC with bell ends.
   c. Gaskets: ASTM F 477, elastomeric seals.
5. PVC Gravity Sewer Piping:
   a. Pipe and Fittings: ASTM F 679, T-1 **OR** T-2, **as directed**, wall thickness, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F 477, elastomeric seals for gasketed joints.
6. PVC Pressure Piping:
   a. Pipe: AWWA C900, Class 100 **OR** Class 150 **OR** Class 200, **as directed**, PVC pipe with bell-and-spigot ends for gasketed joints.
   b. Fittings: AWWA C900, Class 100 **OR** Class 150 **OR** Class 200, **as directed**, PVC pipe with bell ends.
   c. Gaskets: ASTM F 477, elastomeric seals.
7. PVC Water-Service Piping:
   a. Pipe: ASTM D 1785, Schedule 40 **OR** Schedule 80, **as directed**, PVC, with plain ends for solvent-cemented joints.
   b. Fittings: ASTM D 2466, Schedule 40 **OR** ASTM D 2467, Schedule 80, **as directed**, PVC, socket type.

G. Fiberglass Pipe And Fittings
1. Fiberglass Sewer Pipe: ASTM D 3262, RTRP, for gasketed joints fabricated with Type 2, polyester **OR** Type 4, epoxy, **as directed**, resin.
   a. Liner: Reinforced thermoset **OR** Nonreinforced thermoset **OR** Thermoplastic **OR** No liner, **as directed**.
   b. Grade: Reinforced, surface layer matching pipe resin **OR** Nonreinforced, surface layer matching pipe resin **OR** No surface layer, **as directed**.
   c. Stiffness: 9 psig (62 kPa) **OR** 18 psig (124 kPa) **OR** 36 psig (248 kPa) **OR** 72 psig (496 kPa), **as directed**.
2. Fiberglass Nonpressure Fittings: ASTM D 3840, RTRF, for gasketed joints.
   a. Laminating Resin: Type 1, polyester **OR** Type 2, epoxy, **as directed**, resin.
   b. Reinforcement: Grade with finish compatible with resin.
3. Gaskets: ASTM F 477, elastomeric seals.

H. Concrete Pipe And Fittings
1. Nonreinforced-Concrete Sewer Pipe and Fittings: ASTM C 14 (ASTM C 14M), Class 1 **OR** Class 2 **OR** Class 3, **as directed**, with bell-and-spigot **OR** tongue-and-groove, **as directed**, ends for gasketed joints with ASTM C 443 (ASTM C 443M), rubber gaskets.
2. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76 (ASTM C 76M).
   a. Bell-and-spigot **OR** tongue-and-groove, **as directed**, ends for gasketed joints, with ASTM C 443 (ASTM C 443M), rubber gaskets.
   b. Class II, Wall A **OR** Wall B **OR** Wall C, **as directed**.

c. Class III, Wall A **OR** Wall B **OR** Wall C, **as directed**.
d. Class IV, Wall A **OR** Wall B **OR** Wall C, **as directed**.
e. Class V, Wall A **OR** Wall B, **as directed**.

I. Nonpressure-Type Transition Couplings
1. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.
2. Sleeve Materials:
a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
b. For Concrete Pipes: ASTM C 443 (ASTM C 443M), rubber.
c. For Fiberglass Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
d. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
e. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
3. Unshielded, Flexible Couplings:
a. Description: Elastomeric sleeve, with stainless-steel shear ring, **as directed**, and corrosion-resistant-metal tension band and tightening mechanism on each end.
4. Shielded, Flexible Couplings:
a. Description: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
5. Ring-Type, Flexible Couplings:
a. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.
6. Nonpressure-Type, Rigid Couplings:
a. Description: ASTM C 1461, sleeve-type, reducing- or transition-type mechanical coupling, molded from ASTM C 1440, TPE material; with corrosion-resistant-metal tension band and tightening mechanism on each end.

J. Pressure-Type Pipe Couplings
1. Tubular-Sleeve Couplings: AWWA C219, with center sleeve, gaskets, end rings, and bolt fasteners.
2. Metal, bolted, sleeve-type, reducing or transition coupling, for joining underground pressure piping. Include 150-psig (1035-kPa) **OR** 200-psig (1380-kPa), **as directed**, minimum pressure rating and ends of same sizes as piping to be joined.
3. Center-Sleeve Material: Manufacturer's standard **OR** Carbon steel **OR** Stainless steel **OR** Ductile iron **OR** Malleable iron, **as directed**.
4. Gasket Material: Natural or synthetic rubber.
5. Metal Component Finish: Corrosion-resistant coating or material.

K. Expansion Joints And Deflection Fittings
1. Ductile-Iron, Flexible Expansion Joints:
a. Description: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250-psig (1725-kPa) minimum working pressure and for offset and expansion indicated.
2. Ductile-Iron Expansion Joints:
a. Description: Three-piece assembly of telescoping sleeve with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Include rating for 250-psig (1725-kPa) minimum working pressure and for expansion indicated.
3. Ductile-Iron Deflection Fittings:

a. Description: Compound coupling fitting with ball joint, flexing section, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include rating for 250-psig (1725-kPa) minimum working pressure and for up to 15 degrees of deflection.

L. Backwater Valves
1. Cast-Iron Backwater Valves:
a. Description: ASME A112.14.1, gray-iron body and bolted cover, with bronze seat.
b. Horizontal type; with swing check valve and hub-and-spigot ends.
c. Combination horizontal and manual gate-valve type; with swing check valve, integral gate valve, and hub-and-spigot ends.
d. Terminal type; with bronze seat, swing check valve, and hub inlet.
2. PVC Backwater Valves:
a. Description: Horizontal type; with PVC body, PVC removable cover, and PVC swing check valve.

M. Cleanouts
1. Cast-Iron Cleanouts:
a. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
b. Top-Loading Classification(s): Light Duty **OR** Medium Duty **OR** Heavy Duty **OR** Extra-Heavy Duty, **as directed**.
c. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.
2. PVC Cleanouts:
a. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

N. Encasement For Piping
1. Standard: ASTM A 674 or AWWA C105.
2. Material: Linear low-density polyethylene film of 0.008-inch (0.20-mm) **OR** high-density, cross-laminated polyethylene film of 0.004-inch (0.10-mm), **as directed**, minimum thickness.
3. Form: Sheet **OR** Tube, **as directed**.
4. Color: Black **OR** Natural, **as directed**.

O. Manholes
1. Standard Precast Concrete Manholes:
a. Description: ASTM C 478 (ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.
b. Diameter: 48 inches (1200 mm) minimum unless otherwise indicated.
c. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
d. Base Section: 6-inch (150-mm) minimum thickness for floor slab and 4-inch (100-mm) minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.
e. Riser Sections: 4-inch (100-mm) minimum thickness, of length to provide depth indicated.
f. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated; with top of cone of size that matches grade rings.
g. Joint Sealant: ASTM C 990 (ASTM C 990M), bitumen or butyl rubber.
h. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
i. Steps: Individual FRP steps or FRP ladder **OR** Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP **OR** ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP, **as directed**; wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor

steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches (1500 mm).

j. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.

OR

Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.

2. Designed Precast Concrete Manholes:
   a. Description: ASTM C 913; designed according to ASTM C 890 for A-16 (ASSHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.
   b. Ballast: Increase thickness of one or more precast concrete sections or add concrete to manhole as required to prevent flotation.
   c. Joint Sealant: ASTM C 990 (ASTM 990M), bitumen or butyl rubber.
   d. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
   e. Steps: Individual FRP steps or FRP ladder **OR** Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP **OR** ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP, **as directed**; wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches (1500 mm).
   f. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.

      OR

      Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.
3. Fiberglass Manholes:
   a. Description: ASTM D 3753.
   b. Diameter: 48 inches (1200 mm) minimum unless otherwise indicated.
   c. Ballast: Increase thickness of concrete base as required to prevent flotation.
   d. Base Section: Concrete, 6-inch (150-mm) minimum thickness.
   e. Resilient Pipe Connectors (if required): ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
   f. Steps: Individual FRP steps or FRP ladder, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches (1500 mm).
   g. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.

      OR

      Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.
4. Manhole Frames and Covers:

a. Description: Ferrous; 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser, with 4-inch- (100-mm-) minimum-width flange and 26-inch- (660-mm-) diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."
b. Material: ASTM A 536, Grade 60-40-18 ductile **OR** ASTM A 48/A 48M, Class 35 gray, **as directed**, iron unless otherwise indicated.

5. Manhole-Cover Inserts:
a. Description: Manufactured, plastic form, of size to fit between manhole frame and cover and designed to prevent stormwater inflow. Include handle for removal and gasket for gastight sealing.
b. Type: Solid **OR** Drainage with vent holes **OR** Valve, **as directed**.

P. Concrete
1. General: Cast-in-place concrete complying with ACI 318, ACI 350/350R (ACI 350M/350RM), and the following:
a. Cement: ASTM C 150, Type II.
b. Fine Aggregate: ASTM C 33, sand.
c. Coarse Aggregate: ASTM C 33, crushed gravel.
d. Water: Potable.
2. Portland Cement Design Mix: 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio.
a. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
b. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.
3. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
a. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
1) Invert Slope: 1 **OR** 2, **as directed**, percent through manhole.
b. Benches: Concrete, sloped to drain into channel.
1) Slope: 4 **OR** 8, **as directed**, percent.
4. Ballast and Pipe Supports: Portland cement design mix, 3000 psi (20.7 MPa) minimum, with 0.58 maximum water/cementitious materials ratio.
a. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
b. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

1.3 EXECUTION

A. Earthwork
1. Excavating, trenching, and backfilling are specified in Division 02 Section "Earthwork".

B. Piping Installation
1. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
2. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
3. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
4. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

5. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.
6. Install gravity-flow, nonpressure, drainage piping according to the following:
   a. Install piping pitched down in direction of flow, at minimum slope of 1 **OR** 2, **as directed**, percent unless otherwise indicated.
   b. Install piping NPS 6 (DN 150) and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
   c. Install piping with 36-inch (915-mm) **OR** 48-inch (1220-mm) **OR** 60-inch (1520-mm) **OR** 72-inch (1830-mm), **as directed**, minimum cover.
   d. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
   e. Install hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
   f. Install ductile-iron, gravity sewer piping according to ASTM A 746.
   g. Install ABS sewer piping according to ASTM D 2321 and ASTM F 1668.
   h. Install PVC cellular-core sewer piping according to ASTM D 2321 and ASTM F 1668.
   i. Install PVC corrugated sewer piping according to ASTM D 2321 and ASTM F 1668.
   j. Install PVC profile sewer piping according to ASTM D 2321 and ASTM F 1668.
   k. Install PVC Type PSM sewer piping according to ASTM D 2321 and ASTM F 1668.
   l. Install PVC gravity sewer piping according to ASTM D 2321 and ASTM F 1668.
   m. Install fiberglass sewer piping according to ASTM D 3839 and ASTM F 1668.
   n. Install nonreinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
   o. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
7. Install force-main, pressure piping according to the following:
   a. Install piping with restrained joints at tee fittings and at horizontal and vertical changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
   b. Install piping with 36-inch (915-mm) **OR** 48-inch (1220-mm) **OR** 60-inch (1520-mm) **OR** 72-inch (1830-mm), **as directed**, minimum cover.
   c. Install ductile-iron pressure piping according to AWWA C600 or AWWA M41.
   d. Install ductile-iron special fittings according to AWWA C600.
   e. Install PVC pressure piping according to AWWA M23 or to ASTM D 2774 and ASTM F 1668.
   f. Install PVC water-service piping according to ASTM D 2774 and ASTM F 1668.
8. If required to provide protection for metal piping, install corrosion-protection piping encasement over the following underground metal piping according to ASTM A 674 or AWWA C105:
   a. Hub-and-spigot, cast-iron soil pipe.
   b. Hubless cast-iron soil pipe and fittings.
   c. Ductile-iron pipe and fittings.
   d. Expansion joints and deflection fittings.
9. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

C. Pipe Joint Construction
1. Join gravity-flow, nonpressure, drainage piping according to the following:
   a. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
   b. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
   c. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

d. Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on joints.
e. Join ABS sewer piping according to ASTM D 2321 and ASTM D 2751 for elastomeric-seal joints.
f. Join PVC cellular-core sewer piping according to ASTM D 2321 and ASTM F 891 for solvent-cemented joints.
g. Join PVC corrugated sewer piping according to ASTM D 2321.
h. Join PVC profile sewer piping according to ASTM D 2321 for elastomeric-seal joints or ASTM F 794 for gasketed joints.
i. Join PVC Type PSM sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
j. Join PVC gravity sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
k. Join fiberglass sewer piping according to ASTM D 4161 for elastomeric-seal joints.
l. Join nonreinforced-concrete sewer piping according to ASTM C 14 (ASTM C 14M) and ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.
m. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.
n. Join dissimilar pipe materials with nonpressure-type, flexible **OR** rigid, **as directed**, couplings.

2. Join force-main, pressure piping according to the following:
   a. Join ductile-iron pressure piping according to AWWA C600 or AWWA M41 for push-on joints.
   b. Join ductile-iron special fittings according to AWWA C600 or AWWA M41 for push-on joints.
   c. Join PVC pressure piping according to AWWA M23 for gasketed joints.
   d. Join PVC water-service piping according to ASTM D 2855.
   e. Join dissimilar pipe materials with pressure-type couplings.
3. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
   a. Use nonpressure flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
      1) Unshielded **OR** Shielded, **as directed**, flexible **OR** rigid, **as directed**, couplings for pipes of same or slightly different OD.
      2) Unshielded, increaser/reducer-pattern, flexible **OR** rigid, **as directed**, couplings for pipes with different OD.
      3) Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
   b. Use pressure pipe couplings for force-main joints.

D. Manhole Installation
1. General: Install manholes complete with appurtenances and accessories indicated.
2. Install precast concrete manhole sections with sealants according to ASTM C 891.
3. Install FRP manholes according to manufacturer's written instructions.
4. Form continuous concrete channels and benches between inlets and outlet.
5. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches (76 mm) above finished surface elsewhere unless otherwise indicated.
6. Install manhole-cover inserts in frame and immediately below cover.

E. Concrete Placement
1. Place cast-in-place concrete according to ACI 318.

F. Backwater Valve Installation
1. Install horizontal-type backwater valves in piping manholes or pits.
2. Install combination horizontal and manual gate valves in piping and in manholes.
3. Install terminal-type backwater valves on end of piping and in manholes. Secure units to sidewalls.

G. Cleanout Installation
1. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts, and use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
   a. Use Light-Duty, top-loading classification cleanouts in earth **OR** unpaved foot-traffic, **as directed**, areas.
   b. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
   c. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
   d. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.
2. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches (450 by 450 by 300 mm) deep. Set with tops 1 inch (25 mm) above surrounding grade.
3. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

H. Connections
1. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Division 15 Section "Sanitary Waste And Vent Piping".
2. Connect force-main piping to building's sanitary force mains specified in Division 15 Section "Sanitary Waste And Vent Piping". Terminate piping where indicated.
3. Make connections to existing piping and underground manholes.
   a. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch (150-mm) overlap with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
   b. Make branch connections from side into existing piping, NPS 4 to NPS 20 (DN 100 to DN 500). Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
   c. Make branch connections from side into existing piping, NPS 21 (DN 525) or larger, or to underground manholes by cutting opening into existing unit large enough to allow 3 inches (76 mm) of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in 6 inches (150 mm) of concrete for minimum length of 12 inches (300 mm) to provide additional support of collar from connection to undisturbed ground.
      1) Use concrete that will attain a minimum 28-day compressive strength of 3000 psi (20.7 MPa) unless otherwise indicated.
      2) Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
   d. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.
4. Connect to grease **OR** oil **OR** sand, **as directed**, interceptors specified in Division 02 Section "Interceptors".

I. Closing Abandoned Sanitary Sewer Systems
1. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
   a. Close open ends of piping with at least 8-inch- (203-mm-) thick, brick masonry bulkheads.
   b. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.
2. Abandoned Manholes: Excavate around manhole as required and use either procedure below:
   a. Remove manhole and close open ends of remaining piping.

b. Remove top of manhole down to at least 36 inches (915 mm) below final grade. Fill to within 12 inches (300 mm) of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

3. Backfill to grade according to Division 02 Section "Earthwork".

J. Identification

1. Materials and their installation are specified in Division 02 Section "Earthwork". Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.
   a. Use warning tape **OR** detectable warning tape, **as directed**, over ferrous piping.
   b. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

K. Field Quality Control

1. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (600 mm) of backfill is in place, and again at completion of Project.
   a. Submit separate report for each system inspection.
   b. Defects requiring correction include the following:
      1) Alignment: Less than full diameter of inside of pipe is visible between structures.
      2) Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
      3) Damage: Crushed, broken, cracked, or otherwise damaged piping.
      4) Infiltration: Water leakage into piping.
      5) Exfiltration: Water leakage from or around piping.
   c. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
   d. Reinspect and repeat procedure until results are satisfactory.
2. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
   a. Do not enclose, cover, or put into service before inspection and approval.
   b. Test completed piping systems according to requirements of authorities having jurisdiction.
   c. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
   d. Submit separate report for each test.
   e. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
      1) Fill sewer piping with water. Test with pressure of at least 10-foot (3-m) head of water, and maintain such pressure without leakage for at least 15 minutes.
      2) Close openings in system and fill with water.
      3) Purge air and refill with water.
      4) Disconnect water supply.
      5) Test and inspect joints for leaks.

      OR

      Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
      6) Option: Test plastic gravity sewer piping according to ASTM F 1417.
      7) Option: Test concrete gravity sewer piping according to ASTM C 924 (ASTM C 924M).
   f. Force Main: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than 150 psig (1035 kPa).
      1) Ductile-Iron Piping: Test according to AWWA C600, "Hydraulic Testing" Section.
      2) PVC Piping: Test according to AWWA M23, "Testing and Maintenance" Chapter.
   g. Manholes: Perform hydraulic test according to ASTM C 969 (ASTM C 969M).
3. Leaks and loss in test pressure constitute defects that must be repaired.

4. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

L. Cleaning
1. Clean dirt and superfluous material from interior of piping. Flush with potable water.

END OF SECTION 02455b

Task	Specification	Specification Description
02455	02242	Piped Utilities Basic Materials And Methods
02455	02452	Storm Drainage

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SECTION 02456 - WATER SUPPLY WELLS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for water supply wells. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Cable-tool, Rotary drilled, Reverse-rotary drilled, and Driven water supply wells.
b. Jet, Line-shaft, and Submersible well pumps.

C. Definitions
1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. PA: Polyamide (nylon) plastic.
3. PE: Polyethylene plastic.
4. PP: Polypropylene plastic.
5. PVC: Polyvinyl chloride plastic.

D. Submittals
1. Product Data: Submit certified performance curves and rated capacities of selected well pumps and furnished specialties for each type and size of well pump indicated.
2. Shop Drawings: Show layout and connections for well pumps.
a. Wiring Diagrams: Power, signal, and control wiring.
3. Field quality-control reports.
4. Operation and maintenance data.

E. Quality Assurance
1. Well Driller Qualifications: An experienced water supply well driller licensed in the jurisdiction where Project is located.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
3. Comply with AWWA A100 for water supply wells.

F. Project Conditions
1. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
a. Notify Owner no fewer than seven days in advance of proposed interruption of water service.
b. Do not proceed with interruption of water service without Owner's written permission.
2. Well Drilling Water: Provide temporary water and piping for drilling purposes. Provide necessary piping for water supply.

1.2 PRODUCTS

A. Well Casings
1. Steel Casing: AWWA C200, single ply, steel pipe with threaded ends and threaded couplings for threaded joints.

2. ABS Casing: ASTM F 480, ABS, Schedule 40 **OR** 80, **as directed**, bell-and-spigot pipe and couplings for solvent-cemented joints.
3. PVC Casing: ASTM F 480 and NSF 14, **as directed**, PVC, Schedule 40 **OR** 80, **as directed**, bell-and-spigot pipe and couplings for solvent-cemented joints. Include NSF listing mark "NSF wc," **as directed**.
4. Pitless Adapter: Fitting, of shape required to fit onto casing, with waterproof seals.
5. Pitless Unit: Factory-assembled equipment that includes pitless adapter.
6. Well Seals: Casing cap, with holes for piping and cables, that fits into top of casing and is removable, waterproof, and vermin proof.

B. Grout
1. Cement: ASTM C 150, Type II.
2. Aggregates: ASTM C 33, fine and coarse grades.
3. Water: Potable.

C. Water Well Screens
1. Screen Material: Fabricated of ASTM A 666, Type 304 stainless steel, welded; with continuous-slot, V-shaped openings that widen inwardly **OR** tube; with slotted or perforated surface and designed for well-screen applications, **as directed**.
   a. Screen Couplings: Butt-type, stainless-steel coupling rings.
   b. Screen Fittings: Screen, with necessary fittings, closes bottom and makes tight seal between top of screen and well casing.
   c. Maximum Entering Velocity: 0.1 fps (0.03 m/s).

D. Pack Materials
1. Coarse, uniformly graded filter sand, maximum 1/8 inch (3 mm) in diameter.
2. Fine gravel, maximum 1/4 inch (6 mm) in diameter.

E. Jet-Type Well Pumps
1. Description: Shallow **OR** Deep, **as directed**,-well-design, jet well pump; self-priming; centrifugal pump capable of continuous operation; with the following features:
   a. Housing: Cast iron.
   b. Impeller: Single stage **OR** Multistage, **as directed**, centrifugal; fabricated of corrosion-resistant materials.
   c. Seals: Mechanical.
   d. Shaft: Stainless steel.
   e. Motor: Manufacturer's standard, NEMA MG 1 motor, panel, and accessories.
   f. Motor Controls: Electronic; variable speed.
   g. Check valve, ejector, and pressure-control valve.
2. Pump Accessories:
   a. Compression Tanks: Comply with requirements in Division 15 Section "Potable-water Storage Tanks" **OR** Precharged butyl rubber diaphragm, steel shell, fused polymeric lining, and 100-psig (690-kPa) working pressure, **as directed**.
   b. Pressure Switches: For pump control; for installation in piping.
   c. Water Piping: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with threaded ends.
      1) Cast-Iron Fittings: ASME B16.4, threaded, galvanized.
   d. Water Piping: ASTM D 2239, SIDR Numbers 5.3, 7, or 9 PE pipe; made with PE compound number required to give pressure rating not less than 160 psig (1100 kPa) **OR** 200 psig (1380 kPa), **as directed**. Include NSF listing mark "NSF pw."
      1) Fittings for PE Pipe: ASTM D 2609, made of PA, PP, or PVC with serrated, male insert ends matching inside of pipe. Include bands or crimp rings.

F. Line-Shaft Well Pumps
1. Description: Line-shaft, water **OR** oil, **as directed**,-lubricated, vertical-turbine well pump complying with HI 2.1-2.2 and HI 2.3; with the following features:

a. Impeller Material: Stainless steel **OR** Carbon steel **OR** Bronze, **as directed**.
b. Motor: Full-voltage starting, vertical hollow- or solid-shaft, squirrel-cage induction type complying with ANSI C50.10.
c. Pump Base: Cast iron or fabricated steel.
d. Column Pipe: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with threaded ends and cast-iron or steel threaded couplings.

G. Submersible Well Pumps
1. Description: Submersible, vertical-turbine well pump complying with HI 2.1-2.2 and HI 2.3; with the following features:
a. Impeller Material: Stainless steel **OR** Silicon bronze, **as directed**.
b. Motor: Capable of continuous operation under water, with protected submersible power cable.
c. Column Pipe: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with threaded ends and cast-iron or steel threaded couplings.
d. Discharge Piping: ASTM D 2239, SIDR Numbers 5.3, 7, or 9 PE pipe; made with PE compound number required to give pressure rating not less than 160 psig (1100 kPa) **OR** 200 psig (1380 kPa), **as directed**. Include NSF listing mark "NSF pw."
1) Insert Fittings for PE Pipe: ASTM D 2609, made of PA, PP, or PVC with serrated, male insert ends matching inside of pipe. Include bands or crimp rings.

H. Motors
1. General requirements for motors are specified in Division 15 Section "Common Motor Requirements For Plumbing Equipment".
a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
b. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 15.

1.3 EXECUTION

A. Preparation
1. Pilot-Hole Data: Review pilot-hole test analysis furnished by Owner.
2. Neighborhood Well Data: Review operating and test analyses.

B. Installation
1. Construct well using cable-tool **OR** rotary drilling **OR** reverse-rotary drilling **OR** driven, **as directed**, method.
2. Take samples of substrata formation at 10-foot (3-m) intervals and at changes in formation throughout entire depth of each water supply well. Carefully preserve samples on-site in glass jars properly labeled for identification.
3. If selecting rotary drilled or reverse-rotary drilled method, excavate for mud pit or provide aboveground structure, acceptable to authorities having jurisdiction, to allow settlement of cuttings and circulation of drill fluids back to well without discharging to on-site waterways.
4. Enlarge pilot hole and install permanent casing, screen, and grout. Install first section of casing with hardened steel driving shoe of an OD slightly larger than casing couplings if threaded couplings are used.
5. Set casing and liners round, plumb, and true to line.
6. Join casing pipe as follows:
a. Ream ends of pipe and remove burrs.
b. Remove scale, slag, dirt, and debris from inside and outside casing before installation.
c. Cut bevel in ends of steel casing pipe and make threaded joints.
d. Clean and make solvent-cemented joints for ABS and PVC casings.
7. If rotary drilled or reverse-rotary drilled well, mix grout in proportions of 1 cu. ft. (0.03 cu. m) or a 94-lb (42.6-kg) sack of cement with 5 to 6 gal. (19 to 23 L) of water. Bentonite clay may be added

in amounts of 3 to 5 lb/cu. ft. (1.4 to 2.3 kg/0.03 cu. m) for a 94-lb (42.6-kg) sack of cement. If bentonite clay is added, water may be increased to 6.5 gal./cu. ft. (25 L/0.03 cu. m) of cement.

8. If rotary drilled or reverse-rotary drilled well, place grout continuously, from bottom to top surface, to ensure filling of annular space in one operation. Do not perform other operations in well within 72 hours after grouting of casing. When quick-setting cement is used, this period may be reduced to 24 hours.
9. Provide permanent casing with temporary well cap. Install with top of casing 36 inches (910 mm) above finished grade, **as directed**.
10. Develop wells to maximum yield per foot (meter) of drawdown.
    a. Extract maximum practical quantity of sand, drill fluid, and other fine materials from water-bearing formation.
    b. Avoid settlement and disturbance of strata above water-bearing formation.
    c. Do not disturb sealing around well casings.
    d. Continue developing wells until water contains no more than 2 ppm of sand by weight when pumped at maximum testing rate.
11. Install jet well pumps with ejector in or attached to pump housing. Place check valve on suction line to prevent drainage of compression tank.
12. Install jet well pumps and pressure and suction lines. Install ejector where pressure and suction lines connect above well screen. Install check valve in suction line, or install foot valve below ejector, to prevent drainage of compression tank.
13. Install line-shaft **OR** submersible, **as directed**, well pumps according to HI 2.1-2.4 and provide access for periodic maintenance.
    a. Before lowering permanent pump into well, lower a dummy pump that is slightly longer and wider than permanent pump to determine that permanent pump can be installed. Correct alignment problems.
    b. Before lowering permanent pump into well, start pump to verify correct rotation.
    c. Securely tighten discharge piping joints.
    d. Locate line-shaft well pump near well bottom; locate motor above grade. Install driver plate to correctly align motor and pump.
    e. Connect motor to submersible pump and locate near well bottom.
        1) Connect power cable while connection points are dry and undamaged.
        2) Do not damage power cable during installation; use cable clamps that do not have sharp edges.
        3) Install water-sealed surface plate that will support pump and piping.

C. Connections
1. Piping installation requirements are specified in Division 02 Section "Water Distribution". Drawings indicate general arrangement of piping, fittings, and specialties.
    a. Connect piping between well pump and water piping.
    b. Connect water distribution system in trench to well pipe at pitless adapter **OR** unit, **as directed**.
    c. Connect building water distribution to well pipe inside well house.
2. Ground equipment according to Division 16 Section "Grounding And Bonding".
3. Connect wiring according to Division 16 Section "Conductors And Cables".

D. Well Abandonment
1. Comply with AWWA A100 when abandoning water supply wells. Fill and seal holes and casings and restore ground surface to finished grade.
   OR
   Follow well-abandonment procedures of authorities having jurisdiction. Restore ground surface to finished grade.

E. Field Quality Control
1. Plumbness and Alignment Testing: Comply with AWWA A100.

2. Furnish samples of water-bearing formation to testing laboratory and well-screen manufacturer for mechanical sieve analysis.
3. Prepare reports on static level of ground water, level of water for various pumping rates, and depth to water-bearing strata.
4. Performance Testing: Conduct final pumping tests after wells have been constructed, cleaned, and tested for plumbness and alignment.
   a. Provide discharge piping to conduct water to locations where disposal will not create a nuisance or endanger adjacent property. Comply with requirements of authorities having jurisdiction.
   b. Measure elevation to water level in wells.
   c. Perform two bailer or air-ejection tests to determine expected yield. Test at depths with sufficient quantity of water to satisfy desired yields.
   d. Test Pump: Variable capacity test pump with capacity equal to maximum expected yields at pressure equal to drawdown in wells, plus losses in pump columns and discharge pipes.
   e. Start and adjust test pumps and equipment to required pumping rates.
   f. Record readings of water levels in wells and pumping rates at 30-minute maximum intervals throughout 24-hour minimum period.
   g. Record maximum yields when drawdown is 60 inches (1500 mm) above top of suction screens after designated times.
   h. Operate pumping units continuously for eight hours after maximum drawdown is reached.
   i. Record returning water levels in wells and plot curves of well recovery rates.
   j. Remove sand, stones, and other foreign materials that may become deposited in wells after completing final tests.
5. Water Analysis Testing:
   a. Engage] a qualified testing agency to make bacteriological, physical, and chemical analyses of water from each finished well and report the results. Make analyses according to requirements of authorities having jurisdiction.

      OR

      Analyze water sample from each finished well for bacteriological, physical, and chemical quality and report the results. Make analyses according to requirements of authorities having jurisdiction.

F. Cleaning
1. Disinfect water supply wells according to AWWA A100 and AWWA C654 before testing well pumps.

   OR

   Follow water supply well disinfection procedures required by authorities having jurisdiction before testing well pumps.

G. Protection
1. Water Quality Protection: Prevent well contamination, including undesirable physical and chemical characteristics.
2. Ensure that mud pit will not leak or overflow into streams or wetlands. When well is accepted, remove mud and solids in mud pit from Project site and restore site to finished grade.
3. Provide casings, seals, sterilizing agents, and other materials to eliminate contamination; shut off contaminated water.
4. Exercise care to prevent breakdown or collapse of strata overlaying that from which water is to be drawn.
5. Protect water supply wells to prevent tampering and introducing foreign matter. Retain temporary well cap until installation is complete.

END OF SECTION 02456

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SECTION 02456a - HYDRONIC DISTRIBUTION

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for hydronic distribution. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes underground piping outside the building for distribution of heating hot and chilled water.

C. Performance Requirements
1. Provide components and installation capable of producing hydronic piping systems with the following minimum working-pressure ratings:
   a. Hot-Water Piping: 100 psig (690 kPa) **OR** 150 psig (1035 kPa), **as directed**.
   b. Chilled-Water Piping: 100 psig (690 kPa) **OR** 150 psig (1035 kPa), **as directed**.
   c. Condenser-Water Piping: 100 psig (690 kPa) **OR** 150 psig (1035 kPa), **as directed**.

D. Submittals
1. Product Data
2. Shop Drawings
3. Welding certificates.
4. Source quality-control test reports.
5. Field quality-control test reports.

E. Quality Assurance
1. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.
2. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

F. Project Conditions
1. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
   a. Notify the Owner no fewer than two days in advance of proposed utility interruptions.
   b. Do not proceed with utility interruptions without the Owner‘s written permission.

1.2 PRODUCTS

A. Piping Materials
1. Refer to Part 1.3 "Piping Application" Article for applications of pipes, tubes, fittings, and joining methods.
2. Refer to Division 02 Section "Piped Utilities -basic Materials And Methods" for commonly used joining materials.

B. Steel Pipes And Fittings
1. Steel Pipe: ASTM A 53/A 53M, Type E, Grade B, Standard Weight; with plain ends.
2. Nipples: ASTM A 733, Standard Weight, seamless, carbon-steel pipe complying with ASTM A 53/A 53M.

3. Malleable-Iron, Threaded Fittings: ASME B16.3, Classes 150 **OR** 300, **as directed**, with threads according to ASME B1.20.1.
4. Cast-Iron, Threaded Fittings: ASME B16.4, Classes 125 **OR** 250, **as directed**, standard pattern, with threads according to ASME B1.20.1.
5. Steel Welding Fittings: ASME B16.9 **OR** ASTM A 234/A 234M, **as directed**, seamless or welded.
6. Ductile-Iron, Grooved-End Fittings: ASTM A 536, ductile-iron casting with dimensions matching piping.
7. Steel-Pipe, Keyed Couplings: AWWA C606 for steel-pipe dimensions. Include ferrous housing sections, gasket suitable for hot water, and bolts and nuts.

C. Conduit Piping
1. Description: Factory-fabricated and -assembled, airtight and watertight, drainable, pressure-tested piping with conduit, inner pipe supports, and insulated carrier piping. Fabricate so insulation can be dried in place by forcing dry air through conduit.
2. Carrier Pipe: Steel pipe complying with ASTM A 53/A 53M, Type E, Grade B with beveled **OR** socket, **as directed**, ends for welded joints.
3. Carrier Pipe Insulation:
   a. Mineral-Wool Pipe Insulation: ASTM C 547, Type I, molded.
      1) Apparent Thermal Conductivity (k-Value): 0.31 at 200 deg F (0.044 at 93 deg C) mean temperature.
      2) Density: Maximum 10 lb/cu. ft. (160 kg/cu. m) average.
      3) Compressive Strength: 10 psig (69 kPa) minimum at 5 percent deformation.
      4) Bands: ASTM A 666, Type 304, stainless steel, 3/4 inch (19 mm) wide, 0.020 inch (0.5 mm) thick.
   b. Calcium Silicate Pipe Insulation: ASTM C 533, Type I; preformed, incombustible, inorganic, with non-asbestos fibrous reinforcement.
      1) Thermal Conductivity (k-Value): 0.60 at 500 deg F (0.087 at 260 deg C).
      2) Dry Density: 15 lb/cu. ft. (240 kg/cu. m) maximum.
      3) Compressive Strength: 60 psig (414 kPa) minimum at 5 percent deformation.
      4) Bands: ASTM A 666, Type 304, stainless steel, 3/4 inch (19 mm) wide, 0.020 inch (0.5 mm) thick.
   c. Polyisocyanurate Foam Pipe Insulation: ASTM C 591, preformed, rigid, cellular.
      1) Thermal Conductivity (k-Value): 0.14 at 75 deg F (0.020 at 24 deg C).
      2) Service Temperature: Minus 250 to plus 400 deg F (Minus 156 to plus 204 deg C).
      3) Moisture Absorption: ASTM D 2842, maximum 0.054 percent by volume.
      4) Minimum 90 percent closed cell.
      5) Dry Density: 2 lb/cu. ft. (32 kg/cu. m) maximum.
      6) Compressive Strength: 35 psig (242 kPa) minimum at 5 percent deformation.
      7) Water-Vapor Transmission: 1.26 perm inches (1.83 ng/Pa x s x m) according to ASTM E 96.
   d. Polyurethane Foam Pipe Insulation: ASTM C 591, preformed, rigid, cellular.
      1) Thermal Conductivity (k-Value): 0.13 at 75 deg F (0.019 at 24 deg C).
      2) Service Temperature: Minus 250 to plus 200 deg F (Minus 156 to plus 93 deg C).
      3) Moisture Absorption: ASTM D 2842, maximum 0.054 percent by volume.
      4) Minimum 90 percent closed cell.
      5) Dry Density: 2 lb/cu. ft. (32 kg/cu. m) maximum.
      6) Compressive Strength: 35 psig (242 kPa) minimum at 5 percent deformation.
      7) Water-Vapor Transmission: 1.26 perm inches (1.83 ng/Pa x s x m) according to ASTM E 96.
4. Minimum Clearance:
   a. Between Carrier Pipe Insulation and Conduit: 1 inch (25 mm).
   b. Between Insulation of Multiple Carrier Pipes: 3/16 inch (4.75 mm).
   c. Between Bottom of Carrier Pipe Insulation and Conduit: 1 inch (25 mm).
   d. Between Bottom of Bare, Carrier Pipe and Casing: 1-3/8 inches (35 mm).

5. Conduit: Spiral wound, steel. Finish conduit with 2 coats of fusion-bonded epoxy, minimum 20 mils (0.50 mm) thick. Cover with polyurethane foam insulation with a high-density polyethylene jacket; thickness indicated in Part 1.3 “Piping Application" Article, **as directed**.
   OR
   Conduit: Spiral wound, bare steel. Cover with polyurethane foam insulation with a high-density polyethylene jacket; thickness indicated in Part 1.3 "Piping Application" Article.
6. Carrier Piping Supports within Conduit: Corrugated galvanized steel with a maximum spacing of 10 feet (3 m).
7. Fittings: Factory-fabricated and -insulated elbows and tees. Elbows may be bent pipe equal to carrier pipe. Tees shall be factory fabricated and insulated, and shall be compatible with the carrier pipe.
8. Expansion Offsets and Loops: Size casing to contain piping expansion.
9. Conduit accessories include the following:
   a. Water Shed: Terminal end protector for carrier pipes entering building through floor, 3 inches (75 mm) deep and 2 inches (50 mm) larger than casing; terminate casing 20 inches (500 mm) above the floor level.
   b. Guides and Anchors: Steel plate welded to carrier pipes and to casing, complete with vent and drainage openings inside casing.
   c. End Seals: Steel plate welded to carrier pipes and to casing, complete with drain and vent openings on vertical centerline.
   d. Gland Seals: Packed stuffing box and gland follower mounted on steel plate, welded to end of casing, permitting axial movement of carrier piping, with drain and vent connections on vertical centerline.
   e. Joint Kit: Half-shell, pourable or split insulation and shrink-wrap sleeve.
10. Source Quality Control: Factory test the conduit to 15 psig (105 kPa) for a minimum of 2 minutes with no change in pressure. Factory test the carrier pipe to 150 percent of the operating pressure of system. Furnish test certificates.

D. Cased Piping
   1. Description: Factory-fabricated piping with carrier pipe, insulation, and casing.
   2. Carrier Pipe: Steel pipe complying with ASTM A 53/A 53M, Type E, Grade B with beveled **OR** socket, **as directed**, ends for welded joints.
   3. Carrier Pipe Insulation:
      a. Polyurethane Foam Pipe Insulation: ASTM C 591, preformed, rigid, cellular.
         1) Thermal Conductivity (k-Value): 0.13 at 75 deg F (0.019 at 24 deg C).
         2) Service Temperature: Minus 250 to plus 200 deg F (Minus 156 to plus 93 deg C).
         3) Moisture Absorption: ASTM D 2842, maximum 0.054 percent by volume.
         4) Minimum 90 percent closed cell.
         5) Dry Density: 2 lb/cu. ft. (32 kg/cu. m) maximum.
         6) Compressive Strength: 35 psig (242 kPa) minimum at 5 percent deformation.
         7) Water-Vapor Transmission: 1.26 perm inches (1.83 ng/Pa x s x m) according to ASTM E 96.
   4. Casing: High-density polyethylene **OR** Filament-wound, fiberglass-reinforced polyester resin **OR** PVC, **as directed**.
   5. Casing accessories include the following:
      a. Joint Kit: Half-shell, pourable or split insulation, casing sleeve, and shrink-wrap sleeve.
      b. Expansion Blanket: Elastomeric foam, formed to fit over piping.
      c. End Seals: Shrink wrap the casing material to seal watertight around casing and carrier pipe.
   6. Source Quality Control: Factory test the carrier pipe to 150 percent of the operating pressure of system. Furnish test certificates.

E. Loose-Fill Insulation
   1. Granular, Loose-Fill Insulation: Inorganic, nontoxic, nonflammable, sodium potassium aluminum silicate with calcium carbonate filler. Include chemical treatment that renders insulation hydrophobic.

a. Thermal Conductivity (k-Value): 0.60 at 175 deg F (0.087 at 79 deg C) and 0.65 at 300 deg F (0.094 at 149 deg C).
b. Application Temperature Range: 35 to 800 deg F (2 to 426 deg C).
c. Dry Density: 40 to 42 lb/cu. ft. (640 to 672 kg/cu. m).
d. Strength: 12,000 lb/sq. ft. (58 600 kg/sq. m).

2. Powder, Loose-Fill Insulation: Inert, nontoxic, nonflammable, calcium carbonate particles. Include chemical treatment that renders insulation hydrophobic.
   a. Thermal Conductivity (k-Value): ASTM C 177, 0.58 at 100 deg F (0.084 at 37 deg C) and 0.68 at 300 deg F (0.098 at 149 deg C).
   b. Application Temperature Range: Minus 273 to plus 480 deg F (Minus 169 to plus 250 deg C).
   c. Dry Density: Approximately 60 lb/cu. ft. (960 kg/cu. m).
   d. Strength: 12,000 lb/sq. ft. (58 600 kg/sq. m).

1.3 EXECUTION

A. Earthwork: Refer to Division 02 Section "Earthwork" for excavating, trenching, and backfilling.

B. Piping Application
1. Hot-Water Piping: Schedule 40 **OR** Schedule 80, **as directed**, steel pipe with cast-iron, threaded fittings and threaded **OR** steel fittings and welded **OR** ductile-iron, grooved-end fittings and mechanical, **as directed**, joints; granular **OR** powder, loose-fill insulation.
   OR
   Hot-Water Piping: Conduit piping with mineral-wool **OR** calcium silicate **OR** polyisocyanurate **OR** polyurethane, **as directed**, carrier-pipe insulation and with coated **OR** coated and insulated, **as directed**, conduit.
   a. Insulation Thickness: 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**.
   OR
   Hot-Water Piping: Cased piping with polyurethane carrier-pipe insulation.
2. Chilled-Water Piping: Schedule 40 **OR** Schedule 80, **as directed**, steel pipe with cast-iron, threaded fittings and threaded **OR** steel welding fittings and welded **OR** ductile-iron, grooved-end fittings and mechanical, **as directed**, joints; granular **OR** powder, **as directed**, loose-fill insulation.
   OR
   Chilled-Water Piping: Conduit piping with mineral-wool **OR** calcium silicate **OR** polyisocyanurate **OR** polyurethane, **as directed**, carrier-pipe insulation and with coated **OR** coated and insulated, **as directed**, conduit.
   a. Insulation Thickness: 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**.
   OR
   Chilled-Water Piping: Cased piping with polyurethane carrier-pipe insulation.
3. Condenser-Water Piping: Schedule 40 **OR** Schedule 80, **as directed**, steel pipe with cast-iron, threaded fittings and threaded **OR** steel welding fittings and welded **OR** ductile-iron, grooved-end fittings and mechanical, **as directed**, joints; granular **OR** powder, **as directed**, loose-fill insulation.
   OR
   Condenser-Water Piping: Conduit piping with mineral-wool **OR** calcium silicate **OR** polyisocyanurate **OR** polyurethane, **as directed**, carrier-pipe insulation and with coated **OR** coated and insulated, **as directed**, conduit.
   a. Insulation Thickness: 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**.
   OR
   Condenser-Water Piping: Cased piping with polyurethane carrier-pipe insulation.

C. Piping Installation

1. General Locations and Arrangements: Drawings indicate general location and arrangement of piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, unless deviations to layout are approved.
2. Remove any standing water in the bottom of trench.
3. Bed the pipe on a minimum 6-inch (150-mm) layer of granular fill material with a minimum 6-inch (150-mm) clearance between the pipes.
4. Do not insulate piping or backfill piping trench until field quality-control testing has been completed and results approved.
5. Install piping at uniform grade of 0.2 percent upward in direction of flow or as indicated.
6. Install components with pressure rating equal to or greater than system operating pressure.
7. Install piping free of sags and bends.
8. Install fittings for changes in direction and branch connections.
9. Refer to Division 15 Section "Common Work Results For Hvac" for sleeves and mechanical sleeve seals through exterior building walls.
10. Secure anchors with concrete thrust blocks. Concrete is specified in Division 03 Section "Cast-in-place Concrete".
11. Connect to hydronic piping where it passes through the building wall. Hydronic piping inside the building is specified in Division 15 Section "Hydronic Piping".

D. Loose-Fill Insulation Installation
1. Do not disturb the bottom of trench, or compact and stabilize it to ensure proper support.
2. Remove any standing water in the bottom of trench.
3. Form insulation trench by excavation or by installing drywall side forms to establish required height and width of the insulation.
4. Support piping with proper pitch, separation, and clearance to backfill or side forms using temporary supporting devices that can be removed after back filling with insulation.
5. Place insulation and backfill after field quality-control testing has been completed and results approved.
6. Apply bitumastic coating to carbon-steel anchors and guides. Pour concrete thrust blocks and anchors. Refer to Division 03 Section "Cast-in-place Concrete" for concrete and reinforcement.
7. Wrap piping at expansion loops and offsets with mineral-wool insulation of thickness appropriate for calculated expansion amount.
8. Pour loose-fill insulation to required dimension agitating insulation to eliminate voids around piping.
9. Remove temporary hangers and supports.
10. Cover loose-fill insulation with polyethylene sheet a minimum of 4 mils (0.10 mm) thick, and empty loose-fill insulation bags on top.
11. Manually backfill 6 inches (150 mm) of clean backfill. If mechanical compaction is required, manually backfill to 12 inches (300 mm) before using mechanical-compaction equipment.

E. Joint Construction
1. Refer to Division 02 Section "Piped Utilities -basic Materials And Methods" for basic piping joint construction.
2. Keyed-Coupling Joints: Cut- or roll-groove pipes. Assemble joints with keyed couplings, gaskets, lubricant, and bolts.
3. Conduit and Cased Piping Joints: Assemble sections and finish joints with pourable or split insulation, exterior jacket sleeve, and apply shrink-wrap seals as required by manufacturer's written installation instructions.

F. Identification: Install continuous plastic underground warning tapes during back filling of trenches for underground hydronic distribution piping. Locate 6 to 8 inches (150 to 200 mm) below finished grade, directly over piping. Refer to Division 02 Section "Earthwork" for warning-tape materials and devices and their installation.

G. Field Quality Control

1. Prepare hydronic piping for testing according to ASME B31.9 and as follows:
   a. Leave joints, including welds, uninsulated and exposed for examination during test.
   b. Isolate equipment. Do not subject equipment to test pressure.
   c. Install relief valve set at pressure no more than one-third higher than test pressure.
   d. Fill system with water. Where there is risk of freezing, air or a safe, compatible liquid may be used.
   e. Use vents installed at high points to release trapped air while filling system.
2. Test hydronic piping as follows:
   a. Subject hydronic piping to hydrostatic test pressure that is not less than 1.5 times the design pressure.
   b. After hydrostatic test pressure has been applied for 10 minutes, examine joints for leakage. Remake leaking joints using new materials and repeat hydrostatic test until no leaks exist.
3. Test conduit as follows:
   a. Seal vents and drains and subject conduit to 15 psig (105 kPa) for 4 hours with no loss of pressure. Repair leaks and retest as required.
4. Prepare a written report of testing.

END OF SECTION 02456a

SECTION 02456b - STEAM DISTRIBUTION

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for steam distribution. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes underground piping outside the building for distribution of steam and condensate.

C. Performance Requirements
1. Provide components and installation capable of producing steam piping systems with the following minimum working-pressure ratings:
   a. Steam Piping: 15 psig (104 kPa) **OR** 125 psig (860 kPa), **as directed**.
   b. Condensate Piping: 100 psig (690 kPa).

D. Submittals
1. Product Data:
2. Shop Drawings:
3. Welding certificates.
4. Source quality-control test reports.
5. Field quality-control test reports.

E. Quality Assurance
1. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.
2. ASME Compliance: Comply with ASME B31.1, "Power Piping" **OR** ASME B31.9, "Building Services Piping," **as directed**, for materials, products, and installation.
3. ASME Compliance: Safety valves and pressure vessels shall bear appropriate ASME labels.

F. Project Conditions
1. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
   a. Notify the Owner no fewer than two days in advance of proposed utility interruptions.
   b. Do not proceed with utility interruptions without written permission.

1.2 PRODUCTS

A. Piping Materials
1. Refer to Article 1.3 "Piping Application" for applications of pipes, tubes, fittings, and joining methods.
2. Refer to Division 02 Section "Piped Utilities -basic Materials And Methods" for commonly used joining materials.

B. Steel Pipes And Fittings
1. Steel Pipe: ASTM A 53/A 53M, Type E, Grade A, Standard Weight; with plain ends.
2. Nipples: ASTM A 733, Standard Weight, seamless, carbon-steel pipe complying with ASTM A 53/A 53M.

3. Malleable-Iron, Threaded Fittings: ASME B16.3, Classes 150 and 300, with threads according to ASME B1.20.1.
4. Cast-Iron, Threaded Fittings: ASME B16.4, Classes 125 and 250, standard pattern, with threads according to ASME B1.20.1.
5. Steel Welding Fittings: ASME B16.9 and ASTM A 234/A 234M, seamless or welded.

C. Conduit Piping
1. Description: Factory-fabricated and -assembled, airtight and watertight, drainable, pressure-tested piping with conduit, inner pipe supports, and insulated carrier piping. Fabricate so insulation can be dried in place by forcing dry air through conduit.
2. Carrier Pipe: Steel pipe complying with ASTM A 53/A 53M, Type E, Grade A with beveled **OR** socket, **as directed**, ends for welded joints.
3. Carrier Pipe Insulation:
   a. Mineral-Wool Pipe Insulation: ASTM C 547, Type I, molded.
      1) Apparent Thermal Conductivity (k-Value): 0.31 at 200 deg F (0.044 at 93 deg C) mean temperature.
      2) Density: Maximum 10 lb/cu. ft. (160 kg/cu. m) average.
      3) Compressive Strength: 10 psig (69 kPa) minimum at 5 percent deformation.
      4) Bands: ASTM A 666, Type 304, stainless steel, 3/4 inch (19 mm) wide, 0.020 inch (0.5 mm) thick.
   b. Calcium Silicate Pipe Insulation: ASTM C 533, Type I; preformed, incombustible, inorganic, with non-asbestos fibrous reinforcement.
      1) Thermal Conductivity (k-Value): 0.60 at 500 deg F (0.087 at 260 deg C).
      2) Dry Density: 15 lb/cu. ft. (240 kg/cu. m) maximum.
      3) Compressive Strength: 60 psig (414 kPa) minimum at 5 percent deformation.
      4) Bands: ASTM A 666, Type 304, stainless steel, 3/4 inch (19 mm) wide, 0.020 inch (0.5 mm) thick.
   c. Polyisocyanurate Foam Pipe Insulation: ASTM C 591, preformed, rigid, cellular.
      1) Thermal Conductivity (k-Value): 0.14 at 75 deg F (0.020 at 24 deg C).
      2) Service Temperature: Minus 250 to plus 400 deg F (Minus 156 to plus 204 deg C).
      3) Moisture Absorption: ASTM D 2842, maximum 0.054 percent by volume.
      4) Minimum 90 percent closed cell.
      5) Dry Density: 2 lb/cu. ft. (32 kg/cu. m) maximum.
      6) Compressive Strength: 35 psig (242 kPa) minimum at 5 percent deformation.
      7) Water-Vapor Transmission: 1.26 perm inches (1.83 ng/Pa x s x m) according to ASTM E 96.
   d. Polyurethane Foam Pipe Insulation: ASTM C 591, preformed, rigid, cellular.
      1) Thermal Conductivity (k-Value): 0.13 at 75 deg F (0.019 at 24 deg C).
      2) Service Temperature: Minus 250 to plus 200 deg F (Minus 156 to plus 93 deg C).
      3) Moisture Absorption: ASTM D 2842, maximum 0.054 percent by volume.
      4) Minimum 90 percent closed cell.
      5) Dry Density: 2 lb/cu. ft. (32 kg/cu. m) maximum.
      6) Compressive Strength: 35 psig (242 kPa) minimum at 5 percent deformation.
      7) Water-Vapor Transmission: 1.26 perm inches (1.83 ng/Pa x s x m) according to ASTM E 96.
4. Minimum Clearance:
   a. Between Carrier Pipe Insulation and Conduit: 1 inch (25 mm).
   b. Between Insulation of Multiple Carrier Pipes: 3/16 inch (4.75 mm).
   c. Between Bottom of Carrier Pipe Insulation and Conduit: 1 inch (25 mm).
   d. Between Bottom of Bare, Carrier Pipe and Casing: 1-3/8 inches (35 mm).
5. Conduit: Spiral wound, steel. Finish conduit with 2 coats of fusion-bonded epoxy, minimum 20 mils (0.50 mm) thick. Cover with polyurethane foam insulation with a high-density polyethylene jacket; thickness indicated in Part 1.3 "Piping Application" Article, **as directed**.
6. Conduit: Spiral wound, bare steel. Cover with polyurethane foam insulation with a high-density polyethylene jacket; thickness indicated in Part 1.3 "Piping Application" Article.

7. Carrier Piping Supports within Conduit: Corrugated galvanized steel with a maximum spacing of 10 feet (3 m).
8. Fittings: Factory-fabricated and -insulated elbows and tees. Elbows may be bent pipe equal to carrier pipe. Tees shall be factory fabricated and insulated, and shall be compatible with the carrier pipe.
9. Expansion Offsets and Loops: Size casing to contain piping expansion.
10. Conduit accessories include the following:
    a. Water Shed: Terminal end protector for carrier pipes entering building through floor, 3 inches (75 mm) deep and 2 inches (50 mm) larger than casing; terminate casing 20 inches (500 mm) above the floor level.
    b. Guides and Anchors: Steel plate welded to carrier pipes and to casing, complete with vent and drainage openings inside casing.
    c. End Seals: Steel plate welded to carrier pipes and to casing, complete with drain and vent openings on vertical centerline.
    d. Gland Seals: Packed stuffing box and gland follower mounted on steel plate, welded to end of casing, permitting axial movement of carrier piping, with drain and vent connections on vertical centerline.
    e. Joint Kit: Half-shell, pourable or split insulation and shrink-wrap sleeve.
11. Source Quality Control: Factory test the conduit to 15 psig (105 kPa) for a minimum of 2 minutes with no change in pressure. Factory test the carrier pipe to 150 percent of the operating pressure of system. Furnish test certificates.

D. Cased Piping
1. Description: Factory-fabricated piping with carrier pipe, insulation, and casing.
2. Carrier Pipe: Steel pipe complying with ASTM A 53/A 53M, Type E, Grade A with beveled **OR** socket, **as directed**, ends for welded joints.
3. Carrier Pipe Insulation:
    a. Polyurethane Foam Pipe Insulation: ASTM C 591, preformed, rigid, cellular.
        1) Thermal Conductivity (k-Value): 0.13 at 75 deg F (0.019 at 24 deg C).
        2) Service Temperature: Minus 250 to plus 200 deg F (Minus 156 to plus 93 deg C).
        3) Moisture Absorption: ASTM D 2842, maximum 0.054 percent by volume.
        4) Minimum 90 percent closed cell.
        5) Dry Density: 2 lb/cu. ft. (32 kg/cu. m) maximum.
        6) Compressive Strength: 35 psig (242 kPa) minimum at 5 percent deformation.
        7) Water-Vapor Transmission: 1.26 perm inches (1.83 ng/Pa x s x m) according to ASTM E 96.
4. Casing: High-density polyethylene **OR** Filament-wound, fiberglass-reinforced polyester resin **OR** PVC, **as directed**.
5. Casing accessories include the following:
    a. Joint Kit: Half-shell, pourable or split insulation, casing sleeve, and shrink-wrap sleeve.
    b. Expansion Blanket: Elastomeric foam, formed to fit over piping.
    c. End Seals: Shrink wrap the casing material to seal watertight around casing and carrier pipe.
6. Source Quality Control: Factory test the carrier pipe to 150 percent of the operating pressure of system. Furnish test certificates.

E. Loose-Fill Insulation
1. Granular, Loose-Fill Insulation: Inorganic, nontoxic, nonflammable, sodium potassium aluminum silicate with calcium carbonate filler. Include chemical treatment that renders insulation hydrophobic.
    a. Thermal Conductivity (k-Value): 0.60 at 175 deg F (0.087 at 79 deg C) and 0.65 at 300 deg F (0.094 at 149 deg C).
    b. Application Temperature Range: 35 to 800 deg F (2 to 426 deg C).
    c. Dry Density: 40 to 42 lb/cu. ft. (640 to 672 kg/cu. m).
    d. Strength: 12,000 lb/sq. ft. (58 600 kg/sq. m).

2. Powder, Loose-Fill Insulation: Inert, nontoxic, nonflammable, calcium carbonate particles. Include chemical treatment that renders insulation hydrophobic.
   a. Thermal Conductivity (k-Value): ASTM C 177, 0.58 at 100 deg F (0.084 at 37 deg C) and 0.68 at 300 deg F (0.098 at 149 deg C).
   b. Application Temperature Range: Minus 273 to plus 480 deg F (Minus 169 to plus 250 deg C).
   c. Dry Density: Approximately 60 lb/cu. ft. (960 kg/cu. m).
   d. Strength: 12,000 lb/sq. ft. (58 600 kg/sq. m).

1.3 EXECUTION

A. Earthwork: Refer to Division 02 Section "Earthwork" for excavating, trenching, and backfilling.

B. Piping Application
1. Steam Piping: Schedule 40 **OR** Schedule 80, **as directed**, steel pipe with cast-iron, threaded fittings and threaded **OR** steel fittings and welded **OR** ductile-iron, grooved-end fittings and mechanical, **as directed**, joints; granular **OR** powder, **as directed**, loose-fill insulation.
2. Steam Piping: Conduit piping with mineral-wool **OR** calcium silicate **OR** polyisocyanurate **OR** polyurethane, **as directed**, carrier-pipe insulation and with coated, **unless directed otherwise to be** coated and insulated, conduit.
   a. Insulation Thickness: 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**.
3. Condensate Piping: Schedule 40 **OR** Schedule 80, **as directed**, steel pipe with cast-iron, threaded fittings and threaded **OR** steel welding fittings and welded **OR** ductile-iron, grooved-end fittings and mechanical, **as directed**, joints; granular **OR** powder, **as directed**, loose-fill insulation.
4. Condensate Piping: Conduit piping with mineral-wool **OR** calcium silicate **OR** polyisocyanurate **OR** polyurethane, **as directed**, carrier-pipe insulation and with coated **OR** coated and insulated, **as directed**, conduit.
   a. Insulation Thickness: 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**.
5. Condensate Piping: Cased piping with polyurethane carrier-pipe insulation.

C. Piping Installation
1. General Locations and Arrangements: Drawings indicate general location and arrangement of piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, unless deviations to layout are approved.
2. Remove any standing water in the bottom of trench.
3. Bed the pipe on a minimum 6-inch (150-mm) layer of granular fill material with a minimum 6-inch (150-mm) clearance between the pipes.
4. Do not insulate piping or backfill piping trench until field quality-control testing has been completed and results approved.
5. Install piping at uniform grade of 0.2 percent downward in direction of flow or as indicated.
6. Install condensate piping at uniform grade of 0.4 percent downward in direction of flow.
7. Install components with pressure rating equal to or greater than system operating pressure.
8. Install piping free of sags and bends.
9. Install fittings for changes in direction and branch connections.
10. Refer to Division 15 Section "Common Work Results For Hvac" for sleeves and mechanical sleeve seals through exterior building walls.
11. Secure anchors with concrete thrust blocks. Concrete is specified in Division 03 Section "Cast-in-place Concrete".
12. Connect to steam and condensate piping where it passes through the building wall. Steam and condensate piping inside the building is specified in Division 15 Section "Steam And Condensate Piping".

D. Loose-Fill Insulation Installation
   1. Do not disturb the bottom of trench, or compact and stabilize it to ensure proper support.
   2. Remove any standing water in the bottom of trench.
   3. Form insulation trench by excavation or by installing drywall side forms to establish the required height and width of the insulation.
   4. Support piping with proper pitch, separation, and clearance to backfill or side forms using temporary supporting devices that can be removed after back filling with insulation.
   5. Place insulation and backfill after field quality-control testing has been completed and results approved.
   6. Apply bitumastic coating to carbon-steel anchors and guides. Pour concrete thrust blocks and anchors. Refer to Division 03 Section "Cast-in-place Concrete" for concrete and reinforcement.
   7. Wrap piping at expansion loops and offsets with mineral-wool insulation of thickness appropriate for calculated expansion amount.
   8. Pour loose-fill insulation to required dimension agitating insulation to eliminate voids around piping.
   9. Remove temporary hangers and supports.
   10. Cover loose-fill insulation with polyethylene sheet a minimum of 4 mils (0.10 mm) thick, and empty loose-fill insulation bags on top.
   11. Manually backfill 6 inches (150 mm) of clean backfill. If mechanical compaction is required manually backfill to 12 inches (300 mm) before using mechanical-compaction equipment.

E. Joint Construction
   1. Refer to Division 02 Section "Piped Utilities -basic Materials And Methods" for basic piping joint construction.
   2. Keyed-Coupling Joints: Cut- or roll-groove pipes. Assemble joints with keyed couplings, gaskets, lubricant, and bolts.
   3. Conduit and Cased Piping Joints: Assemble sections and finish joints with pourable or split insulation, exterior jacket sleeve, and apply shrink-wrap seals as required by manufacturer's written installation instructions.

F. Identification: Install continuous plastic underground warning tapes during back filling of trenches for underground steam and condensate distribution piping. Locate 6 to 8 inches (150 to 200 mm) below finished grade, directly over piping. Refer to Division 02 Section "Earthwork" for warning-tape materials and devices and their installation.

G. Field Quality Control
   1. Prepare steam and condensate piping for testing according to ASME B31.1 and ASME B31.9 and as follows:
      a. Leave joints, including welds, uninsulated and exposed for examination during test.
      b. Isolate equipment. Do not subject equipment to test pressure.
      c. Install relief valve set at pressure no more than one-third higher than test pressure.
      d. Fill system with temperature water. Where there is risk of freezing, air or a safe, compatible liquid may be used.
      e. Use vents installed at high points to release trapped air while filling system. Use drip legs installed at low points for complete removal of liquid.
   2. Test steam and condensate piping as follows:
      a. Subject steam and condensate piping to hydrostatic test pressure that is not less than 1.5 times the design pressure.
      b. After hydrostatic test pressure has been applied for 10 minutes, examine joints for leakage. Remake leaking joints using new materials and repeat hydrostatic test until no leaks exist.
   3. Test conduit as follows:
      a. Seal vents and drains and subject conduit to 15 psig (105 kPa) for 4 hours with no loss of pressure. Repair leaks and retest as required.
   4. Prepare a written report of testing.

END OF SECTION 02456b

Task	Specification	Specification Description
02456	02242	Piped Utilities Basic Materials And Methods

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SECTION 02459 - GROUND-LOOP HEAT-PUMP PIPING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for ground-loop, heat-pump piping. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes piping for horizontal or vertical, direct-buried, ground-loop, heat-pump systems that operate between 23 and 104 deg F (minus 5 and plus 40 deg C).

C. Performance Requirements
1. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
   a. Ground-Loop, Heat-Pump Piping: 160 psig (1100 kPa) **OR** 200 psig (1380 kPa), **as directed**

D. Submittals
1. Product Data: For the following:
   a. Pipe and fittings.
   b. Joining method and equipment.
   c. Propylene glycol solution.
2. Field quality-control test reports.

1.2 PRODUCTS

A. Pipes And Fittings
1. PE Pipe: ASTM D 2239, SIDR Numbers 5.3, 7, 9, or 11.5; with PE compound number required to achieve required system working pressure.
   a. Molded PE Fittings: ASTM D 2683 or ASTM D 3261, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.
2. U-Bend Assembly: Factory fabricated with embossed depth stamp every 24 inches (600 mm) **OR** 36 inches (900 mm), **as directed** from U-bend.

B. Borehole Backfill
1. Surface Seal: Bentonite **OR** Cement, **as directed,** with thermal conductivity greater than 1.2 Btu/h x sq. ft. x deg F (0.7 W/sq. m x K).
2. Backfill below Surface Seal: Natural or manufactured sand specified in Division 02 Section "Earthwork".

C. Antifreeze Solution
1. Propylene Glycol: Minimum 99 percent propylene glycol with corrosion inhibitors and environmental stabilizer additives to be mixed with water to protect the piping circuit and connected equipment from physical damage from freezing or corrosion.
2. Quantity: Sufficient solution for initial system startup and for preventive maintenance for one year from date of Substantial Completion.
3. Dilution Water: Chloride content shall be less than 25 ppm, sulfate less than 25 ppm, and hardness less than 100 ppm.

1.3 EXECUTION

A. Earthwork
1. Excavating, trenching, warning tape, and backfilling are specified in Division 02 Section "Earthwork".

B. Horizontal Piping Installation
1. Separate trenches by 10 feet (3 m) minimum, unless otherwise indicated. Remove rocks in trenches that could contact pipe.
2. Backfill to 24 inches (600 mm) above pipe with mud developed from excavated rock-free soil or with sand, pea gravel, or fly ash. Backfill from slurry level to grade with excavated soil, compacting as specified for pipe burial in Division 02 Section "Earthwork".
3. Extend pipe from trench onto the bottom of the body of water at an elevation that is at least 12 inches (300 mm) below frost line. Seal membrane or impervious liner under the body of water after installing piping.
4. Install PE piping in trenches according to ASTM D 2774 or ASTM F 645.
   a. Clean PE pipe and fittings and make heat-fusion joints according to ASTM D 2657. Minimize number of joints.
5. Purge, flush, and pressure test piping before backfilling trenches.
6. Install continuous detectable warning tape for underground piping. Locate tape a minimum of 24 inches (600 mm) below finished grade, directly over piping. Underground warning tapes are specified in Division 02 Section "Earthwork".
7. Common piping installation requirements are specified in Division 15 Section "Common Work Results For Hvac".

C. Vertical Piping Installation
1. Install PE piping in boreholes according to ASTM D 2774 or ASTM F 645.
   a. Clean PE pipe and fittings and make heat-fusion joints according to ASTM D 2657. Minimize number of joints.
2. Purge, flush, and pressure test piping before backfilling boreholes.
3. After installation of loop pipe in borehole, fill piping loop with water or antifreeze solution, and pump backfill into borehole to discharge at base of borehole.
4. Fill borehole with backfill to a point at least 60 inches (1524 mm) below grade and backfill remainder with surface seal material.
5. Extend piping and connect to water-source, ground-loop, heat-pump piping systems at outside face of building wall in locations and pipe sizes indicated.
   a. Terminate water-service piping at building wall until building water-source, ground-loop, heat-pump piping systems are installed. Terminate piping with caps. Make connections to building water-source, ground-loop, heat-pump piping systems when those systems are installed.
6. Wall sleeves are specified in Division 15 Section "Common Work Results For Hvac".
7. Mechanical sleeve seals are specified in Division 15 Section "Common Work Results For Plumbing".

D. Antifreeze Solution Fill
1. Fill system with required quantity of propylene glycol and water to provide minus 10 deg F (minus 23 deg C) freezing temperature.
2. Test the dilute solution using gas chromatography to verity concentration of propylene glycol, and forward report to the Owner.

E. Connections
1. Drawings indicate general arrangement of piping, fittings, and specialties.

F. Field Quality Control

1. Piping Tests: Fill piping 24 hours before testing and apply test pressure to stabilize piping. Use potable water only.
2. Hydrostatic Tests: Test at not less than 1-1/2 times the pipe working-pressure rating allowing for static pressure of borehole depth.
   a. Increase pressure in 50-psig (345-kPa) increments and inspect each joint between increments. Hold at test pressure for 30 minutes. Slowly increase to next test pressure increment and hold for 30 minutes. After testing at maximum test pressure, reduce pressure to 30 psig (207 kPa). Hold for 90 minutes, and measure pressure at 30-minute intervals. Repair leaks and retest until no leaks exist.
3. Prepare reports of testing activity.

END OF SECTION 02459

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Task	Specification	Specification Description
02459	02242	Piped Utilities Basic Materials And Methods
02459	02455a	Water Distribution
02459	02213	Subdrainage
02459	02452	Storm Drainage
02460	02455b	Sanitary Sewerage
02462	01352	No Specification Required
02462	02242	Piped Utilities Basic Materials And Methods
02462	02455b	Sanitary Sewerage
02462	02452	Storm Drainage
02463	02455b	Sanitary Sewerage

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SECTION 02464 - SAND DRAINS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of sand drains. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Galvanized Perforated Corrugated Metal Pipe: AASHTO M36.

B. Perforated Polyvinyl Chloride (PVC) Plastic Pipe: ASTM D 1784.

C. Aggregate shall be sand, gravel, crushed rock, or chat that is clean, sound, and of a good quality. Gradation shall conform to the following table:
Retained on the 1-inch sieve 0%
Retained on the 3/8-inch sieve 0-15%
Retained on the No. 8 sieve 40-60%
Retained on the No. 30 sieve 70-95%
Retained on the No. 100 sieve 98-100%

1.3 EXECUTION

A. Pipe Bedding: Aggregate shall be placed in uniform layers on level excavation.

B. Perforated Pipe shall be installed with securely aligned joints to lines and grades, which will allow proper drainage.

C. Perforated Pipe shall be embedded with a minimum coverage of two feet of aggregate or as directed.

END OF SECTION 02464

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SECTION 02464a - MONITORING WELLS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for monitoring wells including drilling, casing, well screen, gravel packing, grouting, development, monitoring device, and incidental related work complete and ready for operation. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. General Requirements
1. Each system, including equipment, materials, installation, and performance, shall be in accordance with local, State, and Federal regulations, ASTM D 5092, and EPA 600-4-89-034 except as modified herein. Consider the advisory or recommended provisions to be mandatory, as though the word "shall" has been substituted for the word "should" wherever it appears. Reference to the "Project Representative" and the "Owner" shall be interpreted to mean the Owner. Additional requirements are included under Division 01 Section "Temporary Facilities And Controls". Mark and secure monitoring wells to avoid unauthorized access and tampering.

C. Submittals:
1. Shop Drawings: Well construction.
2. Product Data
   a. Well casing
   b. Well screen
   c. Filter pack
   d. Neat cement grout
   e. Bentonite seal
3. Certificates
   a. Well Drilling/Development Material Handling Plan
   b. Health and Safety Plan
   c. Field Sampling and Laboratory Testing Plan
   d. Treatment facility permit
   e. Installation Survey Report
   f. Well Development Report
   g. Borehole Analysis Report
4. Closeout Submittals
   a. Well Construction Permit
   b. Shipment manifests
   c. Delivery certificates
   d. Treatment and disposal certificates

D. Delivery, Storage, And Handling
1. Deliver materials in an undamaged condition. Unload and store with minimal handling. Store materials in on-site enclosures or under protective coverings. Store plastic piping and jointing materials, and rubber gaskets under cover, out of direct sunlight. Store materials off the ground. Keep insides of pipes and fittings free of dirt and debris. Replace defective or damaged materials with new materials.

E. Quality Assurance
1. Required Drawings: Submit well construction drawings showing components and details of well casing, well screen, filter pack, annular seal, and associated items. Drawings shall be prepared by a State certified professional geologist or hydrogeologist, or by a State registered professional

civil engineer, hereafter referred to as the Contractor's Professional Consultant (CPC). Drawings shall be sealed.

2. Well Drilling/Development Material Handling Plan: A material handling plan shall be furnished by the Contractor 15 days prior to initiation of the work that describes phases of dealing with the potentially contaminated soil and groundwater, including the following: a schedule to be employed in the well drilling and development stages, a sequence of operations, the method of drilling and development, material hauling, proposed equipment, handling of the contaminated materials, soil and water testing requirements, and safety precautions and requirements.
3. Health and Safety Plan (HASP): Describe safety precautions for each phase of the project as specifically related to handling of soil and water removed during well drilling and development operations. Identify appropriate requirements of 29 CFR 1910 and COE EM-385-1-1. Identify safety equipment and procedures to be available and used during the project. Furnish the name and qualifications based on education, training, and work experience of the proposed Health and Safety Officer (HASO) and the members of the drill crew. The CPC may perform the responsibilities of the HASO if properly qualified.
4. Field Sampling and Laboratory Testing Plan: Describe field sampling methods and quality control procedures. Identify laboratory and laboratory methods to be used for contamination testing. Sample reports shall show sample identification for location, date, time, sample method, contamination level, name of individual sampler, identification of laboratory, and quality control procedures.
5. Treatment Facility Permit: Verification that the proposed treatment facility is permitted to accept the contaminated materials specified, prior to the start of excavation.
6. Well Development Report: Provide report, containing the following data for each well: project name and location, well designation, date and time of well installation, date and time of well development, static water level from top of well casing before development and 24 hours after development, field measurements of pH, temperature, and specific conductivity, depth of well from top of casing to bottom of well, screen length, description of development methodology size/capacity of pump or bailer, pumping rate, and recharge rate.
7. Well Construction Permit: Submit a completed permit application and a proposed method of construction to the appropriate state agency prior to construction of the well. Construction of the wells will not be allowed until an approved Well Construction Permit has been submitted to the Owner.
8. Shipment Manifests: Copies of manifests and other documentation required for shipment of waste materials within 24 hours after removal of waste from the site. Shipment manifests shall be signed by the Owner.
9. Delivery Certificates: Verification that the wastes were actually delivered to the approved treatment facility, within 7 days of shipment.
10. Treatment and Disposal Certificates: Verification that the wastes were successfully treated and remediated to the levels specified herein.

1.2 PRODUCTS

A. Well Casing
   1. Stainless Steel Piping: ASTM A 312/A 312M, Type 304, Schedule 40S, with flush threaded joint end fittings. Threaded joints shall be wrapped with fluoropolymer tape, and provided with nitrile O-ring gaskets.
   2. PVC Piping: ASTM F 480, Type 1, Grade 1, PVC 12454, NSF wc or NSF pw, Schedule 40 **OR** 80, **as directed**, with flush threaded joint fittings. Threaded joints shall be wrapped with fluoropolymer tape, and provided with nitrile O-ring gaskets.

B. Well Screen: Well screens shall be located as directed. The length of each screen shall be as directed. Slot size shall be as required to meet project requirements. Slotted openings shall be distributed uniformly around the circumference of the screen. Open area shall approach the formation's natural porosity.

1. Stainless Steel Screens: ASTM A 312/A 312M, Type 304, Schedule 40S, continuous slot construction, wire wound, with flush threaded joint ends.
2. PVC Screens: ASTM D 1785, PVC 1120, NSF wc or NSF pw, Schedule 40 **OR** 80, **as directed**, screen, Schedule 80, machine-slotted construction, flush threaded joint ends. Slots shall be even in width, length, and separation.

C. Primary Filter Pack: Provide clean, durable, well-rounded, and washed quartz or granite, with less than 5 percent non-siliceous material. The filter pack shall not contain organic matter or friable materials. The filter pack shall allow free flow of water in the well, and shall prevent the infiltration of aquifer materials. Filter pack shall have a 30 percent finer than (d-30) grain size size as required to meet project requirements, and a uniformity coefficient less than 2.5, in accordance with ASTM C 117 and ASTM C 136.

D. Secondary Filter Pack: Gradation in accordance with ASTM D 5092. Provide clean, durable, well-rounded, and washed quartz or granite. Pack shall not contain organic matter or friable materials.

E. Annular Sealants
1. Bentonite Seal: Provide powdered, granular, pelletized, or chipped sodium **OR** calcium, **as directed**, montmorillonite in sealed containers from a commercial source, free of impurities. Diameter of pellets shall be less than one fifth the diameter of the borehole annular space to prevent bridging. Bentonite base grout shall be in accordance with ASTM D 5092.
2. Neat Cement Grout: Provide neat cement grout in accordance with ASTM D 5092. Cement shall be in accordance with ASTM C 150. Quick setting admixtures shall not be allowed. Drilling mud or cuttings shall not be used as a sealing material.

F. Bottom Plugs: Provide flush threaded solid plug at the bottom of the well. Plug shall be the same material as the well casing **OR** screen to which it is attached, **as directed**. Joints shall be wrapped with fluoropolymer tape and provided with nitrile O-ring gaskets.

G. Locking Well Cap: Provide flush threaded, weatherproof, and non-removable locking well cap on the top of the well. Well cap shall be of the same material as the well casing to which it is attached. Well cap shall accommodate padlock. Provide a long shackled padlock in accordance with ASTM F 883. Provide two keys for the padlock, and turn them over to the Owner. Locks at the well site shall be keyed alike.

H. Well Head Completions: Clearly mark and secure the well to avoid unauthorized access and tampering. Cast the words "MONITORING WELL" on the well head cover. Provide a sign reading, "WELL IS FOR MONITORING AND IS NOT SAFE FOR DRINKING." Provide stamped metal identification tag as follows:

DO NOT DISTURB
ID #: Date:
Installed By:
Total Depth:
Screened Interval:
TOC Elevation:
Other:
For Information, Call:

1. Aboveground Completions: Provide protective outer casing around the well casing extending above grade. The diameter of the protective outer casing shall be a minimum of 4 in. (100 mm) larger than the well casing diameter. The top of the protective outer casing shall extend a minimum of 6 in. (150 mm) above the top of the well casing cap. The protective outer casing shall be set in cement grout and the bottom of the protective well casing shall extend below the depth of the frost line **OR** to the depth indicated, **as directed**. A 1/4 in. (6 mm) diameter weep hole shall be drilled in the protective outer casing 3 in. (75 mm) above the ground surface. The annular space between the protective outer casing and the well casing shall be filled with pea gravel or coarse sand to just below the level of the cap on the well casing. The locking well cap

shall be provided on top of the protective outer casing. Provide 6 in. (150 mm) diameter steel pipe bollards, filled with concrete as indicated to protect the exposed well head.

a. Protective Outer Casing and Bollards: ASTM A 53, Type E or S, Grade B.

b. Well Casing Cap: Provide cap on top of the protective outer casing. Cap shall be flush threaded and of the same material as the protective outer casing. Threaded joints shall be wrapped with fluoropolymer tape and provided with nitrile O-ring gaskets.

2. At-Grade Completions: Provide cast iron **OR** aluminum, **as directed**, vault box, 30 by 30 in. (750 by 750 mm) **OR** 12 in. (300 mm) diameter, **as directed**, with watertight frame and cover. Vault shall support H-20 loading for traffic areas **OR** a 100,000 lb. (45,360 kg) loading for airfield locations, **as directed**. The frame shall be 6 in. (150 mm) deep, and shall be set in a concrete collar a minimum of 8 in. (200 mm) thick, and extending 4 in. (100 mm) beyond the edge of the frame in all directions. Frame and concrete collar shall be set flush with the level of the existing pavement **OR** set 3 in. (75 mm) above the existing grade, **as directed**. Locking well cap shall be provided on top of the well casing, which will terminate inside the vault as indicated.

I. Polyethylene Sheeting: ASTM D 4397.

1.3 EXECUTION

A. General: Notify the Owner at least 15 days prior to commencement of work. Locations of wells shall be as indicated. Drilling, installation, and development of the monitoring wells shall be supervised, directed, and monitored by the CPC. Drilling, sampling, and well development equipment introduced to the well shall be decontaminated before and after each use in accordance with ASTM D 5088.

B. Drilling: Borehole shall be advanced using conventional 10 in. (250 mm) hollow-stem auger **OR** solid auger **OR** rotary wash, **as directed**, drilling methods. If it is the opinion of the CPC that an alternate drilling method is required, justification for a boring method change shall be submitted to the Owner, and approval for the change granted prior to drilling. Drill crew shall be experienced and trained in drilling and safety requirements for contaminated sites.

1. Sampling: Obtain samples in accordance with ASTM D 1586 or ASTM D 1587. Perform standard penetration tests at the following depths 0.0 to 1.5 ft (0 to 450 mm); 1.5 to 3.0 ft (450 to 900 mm); 3.0 to 4.5 ft (900 to 1350 mm); and 5 ft (1500 mm) centers or at changes in soil formation thereafter. Each soil sample shall be screened in the field with an organic vapor analyzer/flame ionization device (OVA/FID) capable of detecting vapors to a minimum of one ppm. Log boring in accordance with ASTM D 2487 and ASTM D 2488. Groundwater elevation shall be indicated.

2. Analysis: The CPC shall review the log data from each borehole and compare the data with the well design requirements. The CPC shall verify the adequacy of the well design, or shall offer a proposed modification to the design based on the geologic and hydrogeologic data obtained from the borehole. This review and analysis shall be conducted for each borehole **OR** for one borehole considered representative of the entire project, **as directed**. The CPC shall submit the borehole boring logs, the analysis of the well design, and any proposed design modifications to the Owner in a Borehole Analysis Report. Any modifications to the well design approved by the Owner shall be considered a change to the contract documents and shall be negotiated in accordance with the "CHANGES" clause.

3. Alignment: Verify that the well is straight by lowering a 10 ft (3 m) section of steel pipe 1/4 in. (6 mm) smaller in diameter than the inside diameter of the casing in to the well. For wells deeper than 200 ft (60 m), Contractor shall verify that the well is plumb.

C. Soil Removed From The Borehole

1. Temporary Containment of Soil Removed from the Borehole: Soil removed from the borehole shall be placed in a temporary containment area. Provide a temporary containment area near the well site. Cover containment area with 10 mil (0.25 mm) reinforced polyethylene sheeting. Place soil removed from the borehole[s] on the impervious barrier and cover with 6 mil (0.15 mm) reinforced polyethylene sheeting. Provide a straw bale berm around the outer limits of the

containment area and cover with polyethylene sheets. Secure edges of sheets with weights to keep the polyethylene sheeting in place. Water runoff shall be diverted from the stockpiled material. As an option, soil may be stockpiled in trucks suitable for transporting contaminated soils as specified herein.

2. Testing Requirements for Stockpiled Soils
   a. Sampling: A minimum of one composite sample shall be developed and analyzed for each required test for every 100 cu. yds. (76.4 cu. m) or fraction thereof from a composite stockpile of soil removed from all well sites. To develop a composite sample of the size necessary to run the required tests, the Contractor shall take several samples from different areas along the surface and in the center of the stockpile. These samples shall be combined and thoroughly mixed to develop the composite sample.
   b. Testing
      1) The soil shall contain no free liquid as demonstrated by EPA SW-846, Method 9095, paint filter liquids test.
      2) The sum of benzene, toluene, ethyl benzene, and xylene (BTEX) concentrations shall be determined by using EPA SW-846, Method 5030/8020.
      3) TPH (total petroleum hydrocarbons) concentrations shall be determined by using EPA SW-846, Method 8015, which has been modified for use with soil.
      4) Material shall be tested for TOX (total organic halogens) in accordance with EPA SW-846, Method 9020.
      5) Material shall be analyzed for full TCLP in accordance with EPA SW-846, Method 1311 and for ignitability, corrosivity, and reactivity.
      6) Material shall be tested for polychlorinated biphenyls (PCB's) in accordance with EPA SW-846, Method 8080.
      7) Moisture content of the sample shall be determined in accordance with EPA Method 160.3.
   c. Disposal of Stockpiled Soils
      1) Soils exhibiting TPH less than 100 ppm, BTEX less than 10 ppm, TOX less than 100 ppm, passing TCLP tests, and testing negative for PCB's shall be considered clean as shall be disposed of on-site, as directed by the Owner.
      2) Soils failing the TCLP test or exhibiting TOX greater than 100 ppm shall be managed in accordance with applicable State and local regulations. Payment for disposal of materials failing the TCLP metals test or TOX test shall be made in accordance with the "CHANGES" clause of the General Conditions.
      3) If the concentration of total BTEX is greater than 10 ppm or TPH greater than 100 ppm, the soil shall be treated and disposed of at a permitted soil recycling facility.

D. Well Installation: Well installation shall be in accordance with ASTM D 5092 and EPA 600-4-89-034, and as indicated on the well construction drawings submitted by the CPC and approved by the Owner. Borehole shall be stable and shall be verified straight before beginning installation.
   1. Casings and Screens: Well casings, screens, plugs, and caps shall be decontaminated prior to delivery by the manufacturer and shall be certified clean. Materials shall be delivered, stored, and handled in such manner as to ensure that grease, oil, or other contaminants do not contact any portion of the well screen and casing assembly prior to installation. If directed by the Owner, the well screen and casing assembly shall be cleaned with high pressure water prior to installation. Personnel shall wear clean cotton or surgical gloves while handling the assembly. Centralizers shall be used to ensure that the well screen and casing assembly is installed concentrically in the borehole. When the assembly has been installed at the appropriate elevation, it shall be adequately secured to preclude movement during placement of the filter packs and annular seals. The top of the well casing shall be capped during filter pack placement.
   2. Primary and Secondary Filter Packs: Primary and secondary filter packs shall be placed as indicated on the approved well construction drawings to fill the entire annular space between the screen and casing assembly and the outside wall of the borehole. Place both the primary and secondary filters with a tremie pipe in accordance with EPA 600-4-89-034 and ASTM D 5092. Placement of the primary and secondary filters by gravity or free fall methods is not allowed. Control speed of filter placement to prevent bridging and to allow for settlement. Prior to

commencement of work, equipment and methods required to place filters shall be approved by the Owner.

3. Bentonite Seal: Bentonite shall be placed as a slurry through a tremie pipe. Control speed of bentonite placement to prevent bridging or segregation of slurry. Additional water shall be added to the annular space as directed by the CPC to ensure complete hydration of the bentonite. Bentonite shall cure a minimum of 48 hours before the placement of cement grout to ensure complete hydration and expansion of the bentonite.
4. Neat Cement Grout: Cement grout shall be placed in the annular space above the bentonite seal as indicated on the well construction drawings. Cement grout shall be placed as a slurry through a tremie pipe, and injected under pressure to reduce chance of voids. Grout shall be injected in one continuous operation until full strength grout flows out at the ground surface without evidence of drilling cuttings or fluid. Cement grout shall cure a minimum of 48 hours before beginning well development operations.
5. Well Head Completions: Well head completions shall be as indicated and as specified herein.

E. Well Development: Well development shall be in accordance with EPA 600-4-89-034 and ASTM D 5092 except as modified herein. Bailing, surging, and pumping/overpumping/backwashing are acceptable development methods. Air surging and jetting are prohibited. Method of development shall be chosen by the CPC and approved by the Owner. Well development shall not begin until the well installation is complete and accepted by the Owner. Well development operations shall be conducted continuously until development water flows clear and free of drilling fluids, cuttings, or other materials. At such time representative water samples shall be tested for pH, temperature, and specific conductivity in accordance with EPA 600-4-79-20. Samples shall be taken every 3 hours. When stabilized readings of these parameters, as accepted by the Owner, have been achieved for 12 consecutive hours, well development operations shall cease.

F. Water From Well Development Operations: Water from the well development operations shall be containerized in accordance with State and local regulations. One sample shall be taken and analyzed for each required test for every 1000 gallons (3780 liters) of stored water from well development operations.

1. Testing
   a. The sum of benzene, toluene, ethyl benzene, and xylene (BTEX) concentrations shall be determined by using EPA SW-846, Method 8020.
   b. TPH (total petroleum hydrocarbons) concentrations shall be determined by using EPA SW-846, Method 8015.
2. Disposal of Containerized Water
   a. Water exhibiting TPH less than 0.5 ppm and BTEX less than 1 ppb shall be considered clean and shall be disposed of on-site as directed by the Owner.
   b. If the concentration of total BTEX is greater than 1 ppb or TPH greater than 0.5 ppm, the water shall be treated and disposed of at a permitted facility.

G. Transportation Of Contaminated Soil And Water: The Contractor shall be solely responsible for complying with Federal, State, and local requirements for transporting contaminated materials through the applicable jurisdictions and shall bear responsibility and cost for any noncompliance. In addition to those requirements, the Contractor shall do the following:

1. Inspect and document vehicles and containers for proper operation and covering.
2. Inspect vehicles and containers for proper markings, manifest documents, and other requirements for waste shipment.
3. Perform and document decontamination procedures prior to leaving the worksite and again before leaving the disposal site.

H. Disposal Of Contaminated Soil And Water: Contaminated materials removed from the site shall be disposed of in a treatment/disposal facility permitted to accept such materials.

I. Installation Survey: Upon completion of well installation and development and acceptance by the Owner therefor, the Contractor vertical and horizontal position of each well shall be determined by a registered land surveyor licensed in the State where the work is located . The survey shall document the vertical elevations of the top of the casing pipe and the ground surface elevation adjacent to each well. Survey shall be accurate to the nearest 0.01 ft (3 mm). This data shall be submitted with a well location map as the Installation Survey Report.

J. Cleanup: Upon completion of the well construction, remove debris and surplus materials from the jobsite.

END OF SECTION 02464a

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SECTION 02464b - SEPTIC TANK SYSTEMS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for septic tank systems. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
   a. Septic tanks and septic tank filters.
   b. Dosing tanks and siphons or effluent pumps.
   c. Distribution boxes.
   d. Pipe and fittings, including cleanouts.
   e. Leaching chambers.
   f. Trench or Bed or Mound absorption fields.
   g. Seepage pits.

C. Definitions
1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. FRP: Fiberglass-reinforced plastic.
3. HDPE: High-density-polyethylene plastic.
4. PE: Polyethylene plastic.
5. PVC: Polyvinyl chloride plastic.

D. Submittals
1. Product Data: For the following:
   a. Plastic septic tanks.
   b. Septic tank filters.
   c. Automatic siphons **OR** Effluent pumps, **as directed**.
   d. Plastic distribution boxes.
   e. Leaching chambers.
   f. Pipe and fittings, including cleanouts.
2. Shop Drawings: Include manhole openings, covers, pipe connections, and accessories for the following precast concrete structures:
   a. Septic tanks.
   b. Dosing tanks.
   c. Distribution boxes.
   d. Wiring diagram for power, signal, and control wiring.
3. Coordination Drawings: Show piping, underground structures, and other utilities. Indicate size and invert elevations of piping and structures.
4. Operation and Maintenance Data: For effluent pumps to include in emergency, operation, and maintenance manuals.

E. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Project Conditions

1. Interruption of Existing Septic Tank System Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   a. Notify Owner no fewer than two days in advance of proposed interruption of service.
   b. Do not proceed with interruption of service without Owner's written permission.

1.2 PRODUCTS

A. Septic Tanks
   1. Precast Concrete Septic Tanks: ASTM C 1227, single-chamber **OR** two-chamber, **as directed**, precast, reinforced-concrete tank with internal baffle, **as directed**, and covers.
      a. Design: For A-8 (H10-44) **OR** A-12 (HS15-44) **OR** A-16 (HS20-44), **as directed,** traffic loading according to ASTM C 890.
      b. Manholes: 20-inch- (508-mm-) **OR** 22-inch- (559-mm-) **OR** 24-inch- (610-mm-), **as directed,** minimum diameter opening with reinforced-concrete risers to grade and access lid with steel lift rings. Include manhole in center of each septic tank compartment top.
      c. Filter Access: Reinforced-concrete access hole, large enough to remove filter, over filter position.
      d. Inlet and Outlet Access: 12-inch- (300-mm-) minimum diameter, reinforced-concrete access lids with steel lift rings. Include access centered over inlet and outlet.
      e. Resilient Connectors: ASTM C 923 (ASTM C 923M), of size required for piping, fitted into inlet and outlet openings.
   2. Fiberglass Septic Tanks: UL 1316, single-chamber, FRP construction; fabricated for septic tank application with at least one access riser and manhole.
      a. Manholes: 22-inch- (559-mm-) **OR** 24-inch- (610-mm-), **as directed,** minimum diameter opening with FRP access risers to grade and cover.
      b. Filter Access: Include access hole, large enough to remove filter, over filter position.
      c. Resilient Connectors: ASTM C 923 (ASTM C 923M) or other watertight seal, of size required for piping, fitted into inlet and outlet openings.
   3. Polyethylene Septic Tanks: Single-chamber, molded, HDPE or PE construction; fabricated for septic tank application, with baffle, **as directed**, and at least one access riser and manhole.
   4. Polyethylene Septic Tanks: Two-chamber, molded, HDPE or PE construction; fabricated for septic tank application, with access risers and manholes.
      a. Manholes: 18-inch- (457-mm-) **OR** 20-inch- (508-mm-) **OR** 22-inch- (559-mm-), **as directed,** minimum diameter opening with HDPE or PE access risers to grade and cover.
      b. Filter Access: Include access hole, large enough to remove filter, over filter position.
      c. Resilient Connectors: ASTM C 923 (ASTM C 923M) or other watertight seal, of size required for piping, fitted into inlet and outlet openings.

B. Filters
   1. Description: Removable, septic-tank-outlet filter that restricts discharge solids to 1/8 inch (3.2 mm).
      a. Housing: HDPE or PVC.
      b. Outlet Size: NPS 4 (DN 100) **OR** NPS 6 (DN 150), **as directed.**

C. Insulation
   1. Description: Rigid, cellular polystyrene intended for use as thermal insulation. Comply with ASTM C 578, Type IV or XIII.
      a. Thickness: 2-1/2 inches (65 mm) minimum.
      b. Recycled Content: Not less than 50 percent blend of postconsumer and recovered polystyrene resins.

D. Dosing Tanks

1. Dosing Tanks: Comply with ASTM C 913 for precast, reinforced-concrete tank and cover; designed for structural loading according to ASTM C 890.
   a. Design: For effluent pump, **OR** automatic siphon, **as directed,** installation and A-8 (H10-44) **OR** A-12 (HS15-44) **OR** A-16 (HS20-44), **as directed,** traffic loading according to ASTM C 890.
   b. Manholes: 20-inch- (508-mm-) **OR** 22-inch- (559-mm-) **OR** 24-inch- (610-mm-), **as directed,** minimum diameter opening with reinforced-concrete risers to grade and access lid with steel lift rings. Include manhole in center of each septic tank compartment top.
   c. Resilient Connectors: ASTM C 923 (ASTM C 923M), of size required for piping, fitted into inlet and outlet openings.

E. Automatic Siphons
1. Description: Manufactured siphon assembly of molded-HDPE trap, pipe, and bell, with PVC vent piping and stainless-steel bolts.

F. Effluent Pumps
1. Description: Single-stage, centrifugal, end-suction, submersible, direct-connected effluent pump complying with UL 778 and with HI 1.1-1.2 and HI 1.3 for submersible sewage pumps.
   a. Pumps: Simplex **OR** Duplex, **as directed,** arrangement.
      1) Casing: Cast iron, with open inlet and legs or base that elevate pump to permit flow into impeller, and discharge companion flange arranged for vertical discharge.
      2) Impeller: ASTM A 48/A 48M, Class No. 25 A or higher cast iron **OR** ASTM A 532/A 532M, abrasion-resistant cast iron **OR** ASTM B 584, cast bronze, **as directed**; statically and dynamically balanced, closed or semiopen design, overhung, single suction, and keyed and secured to shaft.
      3) Pump and Motor Shaft: Stainless steel **OR** Stainless steel or steel **OR** Steel, **as directed**, with factory-sealed, grease-lubricated ball bearings and mechanical seals.
   b. General requirements for motors are specified in Division 15 Section "Common Motor Requirements For Plumbing Equipment".
      1) Motors: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor waterproof power cable of length required, with grounding plug and cable-sealing assembly for connection at pump.
      2) Moisture-Sensing Probe: Internal moisture sensor, moisture alarm, and waterproof cable of length required, with cable-sealing assembly for connection at pump.
      3) Motor Housing Fluid: Air or oil.
      4) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
      5) Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 15.
   c. Pump Discharge Piping: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe; ASME B16.4, Class 125, gray-iron fittings; and threaded joints.
   d. Controls For Simplex Pump Units: NEMA 250, Type 4X wall-mounting enclosure with two mechanical- float **OR** mercury-float **OR** micropressure, **as directed**, switches in NEMA 250, Type 6 enclosures; mounting rod; and electric cables.
   e. Controls For Duplex Pump Units: NEMA 250, Type 4X wall-mounting enclosure with three mechanical- float **OR** mercury-float **OR** micropressure, **as directed**, switches in NEMA 250, Type 6 enclosures; mounting rod; and electric cables. Include automatic alternator to alternate operation of pump units on successive cycles and to operate both units if one pump cannot handle load.

G. Distribution Boxes
1. Description: Precast concrete, single-chamber box and cover.
   a. Design: Made according to ASTM C 913, and for A-8 (H10-44) **OR** A-12 (HS15-44) **OR** A-16 (HS20-44), **as directed,** traffic loading according to ASTM C 890. Include baffle opposite inlet.

b. Manholes: 20-inch- (508-mm-) **OR** 22-inch- (559-mm-) **OR** 24-inch- (610-mm-), **as directed,** minimum diameter opening with reinforced-concrete risers to grade and cover with steel lift rings in center of distribution box cover.
c. Pipe Connections: ASTM C 923 (ASTM C 923M) resilient connectors, of size required for piping, fitted into inlet and outlet openings. Include watertight plugs in outlets not required.

2. Description: Molded-HDPE or -PE, single-chamber box and cover.
a. Manholes: 18-inch- (457-mm-) **OR** 20-inch- (508-mm-) **OR** 22-inch- (559-mm-), **as directed,** minimum diameter opening with HDPE or PE access risers to grade and cover. Access for PE distribution boxes may be a removable plastic cover and is usually small.
OR
Manufacturer's standard cover or other access opening of size that permits access to distribution-box inlet and outlets.
b. Pipe Connections: With seal that prevents leakage. Include watertight plugs in outlets not required.

H. Distribution Pipes And Fittiings
1. Refer to Part 1.3 "Piping Applications" Article for identification of systems where piping materials specified below are used.
2. Sewer Pipe and Fittings: ABS, complying with ASTM D 2751, SDR 35, for solvent-cement or elastomeric gasket joints.
a. Solvent Cement: ASTM D 2235.
b. Gaskets: ASTM F 477, elastomeric seal.
3. Sewer Pipe and Fittings: PVC, complying with ASTM D 3034, SDR 35, nonperforated, for solvent-cement or elastomeric gasket joints.
a. Solvent Cement: ASTM D 2564.
b. Gaskets: ASTM F 477, elastomeric seal.
4. Sewer Pipe and Fittings: Nonreinforced concrete, complying with ASTM C 14 (ASTM C 14M), Class 2 pipe and matching concrete fittings, for rubber gasket joints.
a. Gaskets: ASTM C 443 (ASTM C 443M), rubber.
5. Sewer Pipe and Fittings: Vitrified clay, complying with ASTM C 700, Standard Strength, unglazed pipe and matching clay fittings, for gasket joints.
a. Gaskets: ASTM C 425, rubber sealing element.

I. Leaching Pipes And Fittings
1. Pipe: PE, complying with ASTM F 810, perforated.
a. Fittings: ASTM D 2729 PVC for loose joints; ASTM D 3034, PVC for gasketed joints; or ASTM D 2751, ABS for gasketed joints.
2. Tube and Fittings: PE, complying with ASTM F 405, perforated corrugated tube with solid-wall fittings.
a. Couplings: PE band, matching tube and fitting dimensions.
3. Pipe and Fittings: PVC, complying with ASTM D 2729, perforated, for solvent-cement joints.
a. Solvent Cement: ASTM D 2564.
4. Drainage Tile: Clay drain tile, complying with ASTM C 4, Standard class, drain tile with regular and smooth ends, for open joints.

J. Nonpressure-Type Pipe Couplings
1. Description: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.
a. Sleeve Materials:
1) For Concrete Pipes: ASTM C 443 (ASTM C 443M), rubber.
2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
3) For Vitrified-Clay Pipes: ASTM C 425, rubber.
4) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

K. Cleanouts
1. Cast-Iron Cleanouts: ASME A112.36.2M; with round, flanged, cast-iron housing and secured, scoriated, heavy-duty **OR** medium-duty, **as directed,** loading class, cast-iron cover, cast-iron ferrule, and countersunk brass cleanout plug.
2. PVC Cleanouts: PVC pipe fitting for solvent-cement or elastomeric gasket joint with PE or PVC threaded cleanout plug.

L. Leaching Chambers
1. Description: Arched, molded-PE structures with solid top, perforated sides, open ends, and open bottom.
   a. End Pieces: Solid and solid with pipe opening types.
   b. Effluent Distribution Piping: PE or PVC pipe, with holes or slots along pipe, attached to underside of top of chambers.

M. Trench **OR** Bed, **as directed,** Absorption-Field Materials
1. Filtering Material: ASTM D 448, Size No. 24, 3/4 to 2-1/2 inches (19 to 63 mm), washed, crushed stone or gravel; or broken, hard-burned clay brick.
2. Filter Mat: Geotextile woven or spun filter fabric, in 1 or more layers, for minimum total unit weight of 3 oz./sq. yd. (101 g/sq. m) **OR** Untreated building paper or similar porous material, **as directed**.
3. Joint Covers for Open-Joint Pipe: Geotextile woven filter fabric, in 1 or more layers, for minimum total unit weight of 3 oz./sq. yd. (101 g/sq. m); copper mesh screening; or commercial corrosion-resistant metal clips made for this application.
4. Fill Material: Soil removed from trench.

N. Mound Absorption-Field Materials
1. Sand Filtering Material: 25 percent or more of very coarse, coarse, or medium sand or combination; maximum of 50 percent fine or very fine sand or combination; and silt and clay combination not to exceed 25 percent. If clay exceeds 60 percent in combination with silt, mixture cannot exceed 15 percent of sand filtering material.
2. Aggregate Filtering Material: Coarse, 1/2 to 2-1/2 inches (13 to 63 mm).
3. Cap: Clay, silt, or combination of clay and silt.
4. Topsoil: Good quality, free of stones, metal, and glass.
5. Vegetation Cover: Grass compatible with adjacent ground cover. No shrubs or trees.
6. Filter Mat: Geotextile woven or spun filter fabric, in 1 or more layers, for minimum total unit weight of 3 oz./sq. yd. (101 g/sq. m) **OR** Untreated building paper or similar porous material, **as directed**.
7. Joint Covers for Open-Joint Pipe: Geotextile woven filter fabric, in 1 or more layers, for minimum total unit weight of 3 oz./sq. yd. (101 g/sq. m); copper mesh screening; or commercial corrosion-resistant metal clips made for this application.

O. Seepage Pit Materials
1. Constructed-in-Place-Type Seepage Pit: Include the following materials.
   a. Pit Lining: ASTM C 62, Type SW, clay bricks; ASTM C 55, concrete bricks; ASTM C 90, hollow, concrete masonry units; or precast concrete rings with notches or weep holes.
   b. Filtering Material: ASTM D 448, Size No. 24, 3/4 to 2-1/2 inches (19 to 63 mm), washed, crushed stone or gravel; or broken, hard-burned clay brick.
   c. Cover: Precast concrete slab; designed for A-8 (H10-44) **OR** A-12 (HS15-44) **OR** A-16 (HS20-44), **as directed,** traffic loading according to ASTM C 890 and made according to ASTM C 913. Include slab dimensions that will extend minimum of 12 inches (300 mm) beyond edge of excavation. Cast cover with opening for manhole in center.
   d. Manholes: 20-inch- (508-mm-) **OR** 22-inch- (559-mm-) **OR** 24-inch- (610-mm-), **as directed,** minimum diameter opening with reinforced-concrete risers to grade and access lid with steel lift rings.

1.3 EXECUTION

A. Earthwork
1. Excavating, trenching, and backfilling for piping and seepage pits are specified in Division 02 Section "Earthwork".
a. Stockpile topsoil for reuse in finish grading without intermixing with other excavated material. Stockpile materials away from edge of excavation and do not store within drip line of remaining trees.
b. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
2. Excavating and Backfilling for Septic and Dosing Tanks:
a. Excavate sufficient width and length for tanks to depth determined by tank inlet elevation. Provide level bottom.
b. Backfill with excavated soil, mounding soil above original grade without compacting.
3. Excavating and Backfilling for Trench **OR** Bed, **as directed,** Absorption Fields:
a. Excavate for trench absorption fields 30 inches (760 mm) wide and 24 inches (600 mm) deep, minimum.
b. Backfill trench absorption fields with excavated soil, mounding soil above original grade without compacting.
c. Excavate for bed absorption fields of width indicated and 24 inches (600 mm) deep, minimum.
d. Backfill bed absorption fields with excavated soil, mounding soil above original grade without compacting.

B. Septic Tank Installation
1. Install precast concrete septic tanks level according to ASTM C 891.
2. Install septic tanks level.
3. Connect septic tank to concrete ballast pad.
4. Install filter in septic tank outlet. Secure filter to septic tank wall. Make direct connections to distribution piping.
5. Install insulation on exterior sides and top of septic tank.
6. Fill septic tank with water.

C. Dosing Tank Installation
1. Install dosing tanks level and according to ASTM C 891.
2. Install automatic siphons embedded in precast concrete dosing tank. Make direct connections to distribution piping.
3. Set submersible effluent pumps on dosing tank floor. Make direct connections to distribution piping.
4. Fill dosing tanks with water.

D. Distribution Box Installation
1. Install precast concrete distribution boxes according to ASTM C 891 and at invert elevations indicated. Set level and plumb.
2. Install PE distribution boxes at invert elevations indicated and according to manufacturer's written instructions. Set level and plumb.

E. Piping Installation
1. Install distribution piping according to the following:
a. PVC Sewer Pipe and Fittings: ASTM D 2321.
b. ABS Sewer Pipe and Fittings: ASTM D 2321.
c. Nonreinforced-Concrete Sewer Pipe and Fittings: ACPA's "Concrete Pipe Installation Manual."
d. Vitrified-Clay Sewer Pipe and Fittings: ASTM C 12.
2. Install leaching piping according to the following:

a. Use perforated pipe and fittings for trench **OR** bed **OR** mound, **as directed,** absorption fields with perforations at bottom.
b. PE Sewer Pipe: ASTM F 481.
c. PE Tube and Fittings: ASTM F 481.
d. PVC Sewer Pipe and Fittings: ASTM F 481.
e. Clay Drain Tile: ASTM C 12.

F. Pipe Joint Construction
1. Basic piping joint construction is specified in Division 02 Section "Piped Utilities -basic Materials And Methods". Where specific joint construction is not indicated, follow piping manufacturer's written instructions.
2. Join distribution piping according to or with the following:
a. Install distribution pipe and fittings to connect septic tank, dosing tank, **as directed**, distribution box, and headers for absorption fields **OR** seepage pits, **as directed,** with closed joints.
b. PVC Sewer Pipe and Fittings: ASTM F 402 and ASTM D 2855 for solvent-cemented joints, or ASTM D 3212 and ASTM D 3034 for gasketed joints.
c. ABS Sewer Pipe and Fittings: ASTM F 402 and ASTM D 2751 for solvent-cemented joints, or ASTM D 2751 and ASTM D 3212 for gasketed joints.
d. Nonreinforced-Concrete Sewer Pipe and Fittings: ACPA's "Concrete Pipe Installation Manual" for gasketed joints.
e. Vitrified-Clay Sewer Pipe and Fittings: ASTM C 425 for gasketed joints.
3. Join leaching piping with or according to the following:
a. Install leaching pipe and fittings for trench **OR** bed **OR** mound, **as directed,** absorption fields with closed joints, unless otherwise indicated.
b. PE Sewer Pipe: With PVC socket fittings and loose joints, with ABS gasketed fittings according to ASTM D 2751, or with PVC gasketed fittings and gasketed joints according to ASTM D 3034.
c. PE Tube and Fittings: With PE band couplings.
d. PVC Sewer Pipe and Fittings: With solvent-cemented joints according to ASTM F 402 and ASTM D 2321.
e. Clay Drain Tile: With loose (open) joints.
4. Join dissimilar pipe materials according to ASTM D 5926, with couplings and gaskets compatible with pipe materials being joined.

G. Cleanout Applications
1. Use cleanouts according to the following:
a. Inlet and Outlet of Septic Tanks: Cast-iron cleanouts.
b. Inlet and Outlet of Dosing Tanks: Cast-iron cleanouts.
c. Inlet and Outlets of Distribution Boxes: Cast-iron **OR** PVC, **as directed,** cleanouts.
d. At Each Change in Direction of Distribution Piping: Cast-iron **OR** PVC, **as directed,** cleanouts.
e. At Ends of Each Row of Leaching Piping: Cast-iron **OR** PVC, **as directed,** cleanouts.

H. Cleanout Installation
1. Cast-Iron Cleanouts: Install with PVC fitting riser from distribution and leaching piping to cast-iron cleanout housing at grade. Use NPS 4 (DN 100) PVC sewer pipe and fittings with solvent-cemented joints for risers. Attach riser to cleanout housing with rubber gasket or coupling.
2. PVC Cleanouts: Install with PVC riser from distribution and leaching piping to PVC cleanout at grade. Use NPS 4 (DN 100) PVC sewer pipe and fittings with solvent-cemented joints for risers and cleanout fitting.
3. Cleanout Support: Set cleanouts in concrete blocks 18 by 18 by 12 inches (450 by 450 by 300 mm) deep, unless location is in concrete pavement. Formwork, reinforcement, and concrete are specified in Division 03 Section "Cast-in-place Concrete".
4. Set top of cleanout 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed,** above surrounding rough grade, or set flush with grade if installed in pavement.

I. Trench **OR** Bed **OR** Absorption-Field, **as directed,** Installation
   1. Filtering Material: Place supporting layer of filtering material over the compacted trench **OR** bed, **as directed,** base to a compacted depth not less than 6 inches (150 mm) below bottom of pipe.
   2. Refer to Part 1.3 "Piping Installation" and "Pipe Joint Construction" articles for specific piping material installation.
   3. Install distribution piping at minimum slope of 1 percent and maximum slope of 2 percent.
   4. Install leaching piping solidly bedded in filtering material, with full bearing for each pipe section throughout its length. Maintain pipe alignment with no slope.
      a. Install perforated pipe with perforations down and joints tightly closed. Install collars and couplings as required.
      b. Install open-joint pipe with 1/2-inch (13-mm) space, maximum, between ends, unless otherwise indicated. Cover top two-thirds of joint opening with joint cover, and tie with corrosion-resistant wire. Commercial joint-cover assemblies may be provided.
      c. Install elbow fittings with tight joints.
      d. Place additional filtering material around sides to a minimum compacted depth of 8 inches (200 mm) above the top of leaching piping.
   5. Install filter mat over filter material before backfilling.
   6. Install leaching chambers with no slope in bottom of trench **OR** bed, **as directed**.
      a. Install leaching chamber distribution piping with tight joints throughout chambers.
   7. Backfill according to Part 1.3 "Earthwork" Article.

J. Mound Absorption-Field Installation
   1. Plow top 6 inches (150 mm) of surface.
   2. Place layers of sand, aggregate, **as directed**, cap, and topsoil above plowed area. Provide grass topping to match adjacent vegetation. Provide side slope not steeper than 3:1. Tie slope toe smoothly into existing grade.
   3. Refer to Part 1.3 "Piping Installation" and "Pipe Joint Construction" articles for specific piping material installation.
   4. Provide solid vent pipe with vent cap extending 12 inches (300 mm) above top of mounds.
   5. Install distribution piping with no slope for pressurized effluent system.
   6. Install distribution piping at a minimum slope of 1 percent and a maximum slope of 2 percent for gravity effluent system.
   7. Install leaching piping solidly bedded in filtering material, with full bearing for each pipe section throughout its length. Maintain pipe alignment with no slope.
      a. Install perforated pipe with perforations down and joints tightly closed. Install collars and couplings as required.
      b. Install open-joint pipe with 1/2-inch (13-mm) space, maximum, between ends, unless otherwise indicated. Cover top two-thirds of joint opening with joint cover, and tie with corrosion-resistant wire. Commercial joint-cover assemblies may be provided.
      c. Install elbow fittings with tight joints.
   8. Install leaching chambers with no slope above plowed area.
      a. Install leaching chamber distribution piping with tight joints throughout chambers.
   9. Provide adequate grading around mound absorption field to prevent storm runoff from washing away a portion of mound absorption field and to prevent exposing pipes.

K. Seepage Pit Installation
   1. Excavate hole to minimum diameter of 6 inches (150 mm) greater than outside of pit lining.
   2. Do not extend pit depth into ground-water table.
   3. Install constructed-in-place seepage pits according to the following procedure if no requirements of authorities having jurisdiction apply:
      a. Install brick pit lining material dry and laid flat with staggered joints for seepage.
      b. Install block pit lining material dry with staggered joints and a minimum of 20 percent of blocks on side for seepage. Install precast concrete rings with notches or weep holes for seepage.

c. Extend pit lining material so top of manhole will be approximately 8 inches (200 mm) below finished grade.
d. Backfill bottom of inside of pit with filtering material at least 12 inches (300 mm) above bottom of lining material.
e. Extend effluent inlet pipe 12 inches (300 mm) into seepage pit and terminate into side of tee fitting.
f. Backfill around outside of pit lining with filtering material to top of lining.
g. Install manhole risers from top of pit to grade. Support cover on undisturbed soil. Do not support cover on pit lining.

L. Identification
1. Identification materials and their installation are specified in Division 02 Section "Earthwork". Arrange for installation of green warning tape directly over piping (including absorption-field piping), at outside edges of underground structures, and at outside edges of absorption fields.
2. Use detectable warning tape over piping, over edges of underground structures, and over edges of absorption fields.

M. Connections
1. Piping installation requirements are specified in other Division 02. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Ground effluent pumps according to Division 16 Section "Grounding And Bonding".
3. Connect wiring according to Division 16 Section "Conductors And Cables".

N. Field Quality Control
1. System Tests: Perform testing of completed septic tank system piping and structures according to authorities having jurisdiction.
2. Additional Tests: Fill underground structures with water and let stand overnight. If water level recedes, locate and repair leaks and retest. Repeat tests and repairs until no leaks exist.

O. Cleaning
1. Clear interior of piping and structures of dirt and other superfluous material as work progresses.
2. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of workday or when work stops.

END OF SECTION 02464b

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Task	Specification	Specification Description
02464	01352	No Specification Required
02464	02242	Piped Utilities Basic Materials And Methods
02464	02455a	Water Distribution
02464	02456	Water Supply Wells
02464	02455b	Sanitary Sewerage
02464	02456a	Hydronic Distribution
02464	02213	Subdrainage
02464	02452	Storm Drainage
02511	01352	No Specification Required
02511	02242	Piped Utilities Basic Materials And Methods
02511	02455b	Sanitary Sewerage
02511	02464b	Septic Tank Systems
02511	02213	Subdrainage
02511	02452	Storm Drainage
02512	02242	Piped Utilities Basic Materials And Methods
02512	02213	Subdrainage
02520	02242	Piped Utilities Basic Materials And Methods
02520	02452	Storm Drainage
02520	02242b	Sewage Treatment Lagoons
02522	02242	Piped Utilities Basic Materials And Methods
02522	02464	Sand Drains
02522	02452	Storm Drainage

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SECTION 02525 - CULVERTS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for culverts. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

C. Delivery, Storage, And Handling
1. Delivery and Storage: Materials delivered to site shall be inspected for damage, unloaded, and stored with a minimum of handling. Materials shall not be stored directly on the ground. The inside of pipes and fittings shall be kept free of dirt and debris. Before, during, and after installation, plastic pipe and fittings shall be protected from any environment that would result in damage or deterioration to the material. The Contractor shall have a copy of the manufacturer's instructions available at the construction site at all times and shall follow these instructions unless directed otherwise by the the Owner. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install plastic pipe shall be stored in accordance with the manufacturer's recommendations and shall be discarded if the storage period exceeds the recommended shelf life. Solvents in use shall be discarded when the recommended pot life is exceeded.
2. Handling: Materials shall be handled in a manner that ensures delivery to the trench in sound, undamaged condition. Pipe shall be carried to the trench, not dragged.

1.2 PRODUCTS

A. Pipe For Culverts
1. Pipe for culverts and storm drains shall be of the sizes indicated and shall conform to the requirements specified.
2. Concrete Pipe
a. ASTM C76/ASTM C76M, Class I **OR** II **OR** III **OR** IV **OR** V, **as directed**, or ASTM C655 D-Load. Note: D-load is defined as the minimum required three-edge test load on a pipe to produce a 0.01 inch crack and/or ultimate failure in pounds per linear foot per foot (no metric definition) of inside diameter.
b. Reinforced Arch Culvert and Storm Drainpipe: ASTM C506/ASTM C506M, Class A-II **OR** A-III **OR** A-IV, **as directed**.
c. Reinforced Elliptical Culvert and Storm Drainpipe: ASTM C507/ASTM C507M. Horizontal elliptical pipe shall be Class HE-A **OR** HE-I **OR** HE-II **OR** HE-III **OR** HE-IV, **as directed**. Vertical elliptical pipe shall be Class VE-II **OR** VE-III **OR** VE-IV **OR** VE-V **OR** VE-VI, **as directed**.
d. Nonreinforced Pipe: ASTM C14/ASTM C14M, Class 1 **OR** 2 **OR** 3, **as directed**.
1) Cast-In-Place Nonreinforced Conduit: ACI 346, except that testing shall be the responsibility of and at the expense of the Contractor. In the case of other conflicts between ACI 346 and project specifications, requirements of ACI 346 shall govern.
NOTE: This type conduit should not be used beneath structures, for drain crossings, adjacent to paved areas, or under high fills.
3. Clay Pipe: Standard or extra strength, as indicated, conforming to ASTM C700.
NOTE: "Bell-and-spigot piping only" in areas where corrosion problems may be anticipated with the stainless steel parts of the couplings used for plain-end piping.

4. Corrugated Steel Pipe
   a. ASTM A760/A760M, zinc or aluminum (Type 2) coated pipe of either:
      1) Type I **OR** II, **as directed**, pipe with annular **OR** helical, **as directed**, 2-2/3 by 1/2 inch (68 by 13 mm) corrugations.
      2) Type IR **OR** IIR, **as directed**, pipe with helical 3/4 by 3/4 by 7-1/2 inch (19 by 19 by 190 mm) corrugations.
   b. Fully Bituminous Coated
      1) AASHTO M190 Type A and ASTM A760/A 760M zinc or aluminum (Type 2) coated pipe of either:
         a) Type I **OR** II, **as directed**, pipe with annular **OR** helical, **as directed**, 2-2/3 by 1/2 inch (68 by 13 mm) corrugations.
         b) Type IR **OR** IIR, **as directed**, pipe with helical 3/4 by 3/4 by 7-1/2 inch (19 by 19 by 190 mm) corrugations.
   c. Half Bituminous Coated, Part Paved: AASHTO M190 Type B and ASTM A760/A 760M zinc or aluminum (Type 2) coated Type I **OR** II, **as directed**, pipe with annular **OR** helical, **as directed**, 2-2/3 by 1/2 inch (68 by 13 mm) corrugations.
   d. Fully Bituminous Coated, Part Paved: AASHTO M190 Type C and ASTM A760/A 760M zinc or aluminum (Type 2) coated Type I **OR** II, **as directed**, pipe with annular **OR** helical, **as directed**, 2-2/3 by 1/2 inch (68 by 13 mm) corrugations.
   e. Fully Bituminous Coated, Fully Paved: AASHTO M190 Type D and ASTM A760/A 760M zinc or aluminum (Type 2) coated Type I **OR** II, **as directed**, pipe with annular **OR** helical, **as directed**, 2-2/3 by 1/2 inch (68 by 13 mm) corrugations.
   f. Concrete-Lined: ASTM A760/A760M zinc coated Type I corrugated steel pipe with annular **OR** helical, **as directed**, 2-2/3 by 1/2 inch (68 by 13 mm) corrugations and a concrete lining in accordance with ASTM A849.
   g. Polymer Precoated: ASTM A 762/A 762M corrugated steel pipe fabricated from ASTM A742/A742M Grade 250/250 10/10 polymer precoated sheet of either:
      1) Type I **OR** II, **as directed**, pipe with annular **OR** helical, **as directed**, 2-2/3 by 1/2 inch (68 by 13 mm) corrugations.
      2) Type IR **OR** IIR, **as directed**, pipe with helical 3/4 by 3/4 by 7-1/2 inch (19 by 19 by 190 mm) corrugations.
   h. Polymer Precoated, Part Paved: ASTM A762/A762M Type I **OR** II, **as directed**, corrugated steel pipe and AASHTO M190 Type B (modified) paved invert only, fabricated from ASTM A742/A742M Grade 250/250 10/10 polymer precoated sheet with annular **OR** helical, **as directed**, 2-2/3 by 1/2 inch (68 by 13 mm) corrugations.
   i. Polymer Precoated, Fully Paved: ASTM A762/A762M Type I **OR** II, **as directed**, corrugated steel pipe and AASHTO M190 Type D (modified), fully paved only, fabricated from ASTM A 742/A 742M Grade 250/250 10/10 polymer precoated sheet with annular **OR** helical, **as directed**, 2-2/3 by 1/2 inch (68 by 13 mm) corrugations.
5. Corrugated Aluminum Alloy Pipe: ASTM B745/B745M corrugated aluminum alloy pipe of either:
   1) Type I **OR** II, **as directed**, pipe with annular **OR** helical, **as directed**, corrugations.
   2) Type IA **OR** IR **OR** IIA **OR** IIR, **as directed**, pipe with helical corrugations.
   b. Aluminum Fully Bituminous Coated: Bituminous coating shall conform to ASTM A849. Piping shall conform to AASHTO M190 Type A and ASTM B745/B745M corrugated aluminum alloy pipe of either:
      1) Type I **OR** II, **as directed**, pipe with annular **OR** helical, **as directed**, corrugations.
      2) Type IA **OR** IR **OR** IIA **OR** IIR, **as directed**, pipe with helical corrugations.
   c. Aluminum Fully Bituminous Coated, Part Paved: Bituminous coating shall conform to ASTM A849. Piping shall conform to AASHTO M190 Type C and ASTM B 745/B 745M corrugated aluminum alloy pipe of either:
      1) Type I **OR** II, **as directed**, pipe with annular **OR** helical, **as directed**, corrugations.
      2) Type IR **OR** IIR, **as directed**, pipe with helical corrugations.
6. Structural Plate, Steel Pipe, Pipe Arches and Arches

a. Assembled with galvanized steel nuts and bolts, from galvanized corrugated steel plates conforming to AASHTO M167. Pipe coating, when required, shall conform to the requirements of AASHTO M190 Type A **OR** AASHTO M243, **as directed**.
b. Thickness of plates shall be as indicated.

7. Structural Plate, Aluminum Pipe, Pipe Arches and Arches
   a. Assembled with either aluminum alloy, aluminum coated steel, stainless steel or zinc coated steel nuts and bolts. Nuts and bolts, and aluminum alloy plates shall conform to AASHTO M219. Pipe coating, when required, shall conform to the requirements of AASHTO M190, Type A **OR** AASHTO M 243, **as directed**.
   b. Thickness of plates shall be as indicated.
8. Ductile Iron Culvert Pipe: ASTM A716.
9. Cast-Iron Soil Piping: Cast-Iron Soil Pipe shall conform to ASTM A74, service-weight; gaskets shall be compression-type rubber conforming to ASTM C564.
10. PVC Pipe
    a. The pipe manufacturer's resin certification, indicating the cell classification of PVC used to manufacture the pipe, shall be submitted prior to installation of the pipe.
    b. Type PSM PVC Pipe: ASTM D3034, Type PSM, maximum SDR 35, produced from PVC certified by the compounder as meeting the requirements of ASTM D1784, minimum cell class 12454-B.
    c. Profile PVC Pipe: ASTM F794, Series 46, produced from PVC certified by the compounder as meeting the requirements of ASTM D1784, minimum cell class 12454-B.
    d. Smooth Wall PVC Pipe: ASTM F679 produced from PVC certified by the compounder as meeting the requirements of ASTM D1784, minimum cell class 12454-B.
    e. Corrugated PVC Pipe: ASTM F949 produced from PVC certified by the compounder as meeting the requirements of ASTMD 1784, minimum cell class 12454-B.
11. PE Pipe
    a. The pipe manufacturer's resin certification indicating the cell classification of PE used to manufacture the pipe shall be submitted prior to installation of the pipe. The minimum cell classification for polyethylene plastic shall apply to each of the seven primary properties of the cell classification limits in accordance with ASTM D3350.
    b. Smooth Wall PE Pipe: ASTM F714, maximum DR of 21 for pipes 3 to 24 inches (80 to 600 mm) in diameter and maximum DR of 26 for pipes 26 to 48 inches (650 to 1200 mm) in diameter. Pipe shall be produced from PE certified by the resin producer as meeting the requirements of ASTM D3350, minimum cell class 335434C.
    c. Corrugated PE Pipe: AASHTO M294, Type S or D, for pipes 12 to 48 inches (300 to 1200 mm) and AASHTO MP 7, Type S or D, for pipes 54 to 60 inches (1350 to 1500 mm) produced from PE certified by the resin producer as meeting the requirements of ASTM D3350, minimum cell class in accordance with AASHTO M294. Pipe walls shall have the following properties:
       NOTE: Corrugated PE pipe culverts and storm drains shall not be installed beneath airfield pavements, Class A, B, or C roads, or road pavements with a design index of 6 or greater. Type S pipe has a full circular cross-section, with an outer corrugated pipe wall and a smooth inner liner. Type C pipe has a full circular cross-section, with a corrugated surface both inside and outside. Corrugations may be either annular or helical.

Nominal Size (in.)	Minimum Wall Area (square in/ft)	Minimum Moment of Inertia of Wall Section (in to the 4th/in)
12	1.50	0.024
15	1.91	0.053
18	2.34	0.062
24	3.14	0.116
30	3.92	0.163
36	4.50	0.222
42	4.69	0.543

48	5.15	0.543
54	5.67	0.800
60	6.45	0.800

Nominal Size (mm)	Minimum Wall Area (square mm/m)	Minimum Moment of Inertia of Wall Section (mm to the 4th/mm)
300	3200	390
375	4000	870
450	4900	1020
600	6600	1900
750	8300	2670
900	9500	3640
1050	9900	8900
1200	10900	8900
1350	12000	13110
1500	13650	13110

d. Profile Wall PE Pipe: ASTM F894, RSC 160, produced from PE certified by the resin producer as meeting the requirements of ASTM D3350, minimum cell class 334433C. Pipe walls shall have the following properties:

Nominal Size (in.)	Minimum Wall Area (square in/ft)	Minimum Moment Of Inertia of Wall Section (in to the 4th/in) Cell Class 334433C	Minimum Moment Of Inertia of Wall Section (in to the 4th/in) Cell Class 335434C
18	2.96	0.052	0.038
21	4.15	0.070	0.051
24	4.66	0.081	0.059
27	5.91	0.125	0.091
30	5.91	0.125	0.091
33	6.99	0.161	0.132
36	8.08	0.202	0.165
42	7.81	0.277	0.227
48	8.82	0.338	0.277

Nominal Size (mm)	Minimum Wall Area (square mm/m)	Minimum Moment Of Inertia of Wall Section (mm to the 4th/mm) Cell Class 334433C	Minimum Moment Of Inertia of Wall Section (mm to the 4th/mm) Cell Class 335434C
450	6300	850	620
525	8800	1150	840
600	9900	1330	970
675	12500	2050	1490
750	12500	2050	1490

825	14800	2640	2160
900	17100	3310	2700
1050	16500	4540	3720
1200	18700	5540	4540

B. Drainage Structures
   1. Flared End Sections: Sections shall be of a standard design fabricated from zinc coated steel sheets meeting requirements of ASTM A929/A929M.
   2. Precast Reinforced Concrete Box: Four-sided box section with open ends to be monolithically cast of reinforced concrete, smooth inside surfaces. Each box section shall be manufactured with chamfered inside corners. Design and manufacture shall conform to ASTM C890.
      a. Design References: ACI 318.
         1) Boxes subjected to highway loadings shall conform to requirements of AASHTO M259 or M273, as applicable, and ASTM C789, C850, C1433, and PS62.
         2) Boxes subjected to aircraft loadings shall conform to requirements of FAA specifications.
         3) Boxes subjected to railway loadings shall conform to requirements of AREMA specifications.
      b. Concrete: 5,000 psi @ 30 days, unless otherwise directed.
      c. Entrained Air: 5 to 9 percent.
      d. Steel Reinforcing: ASTM A185, A615, A616, Grade 60, 60 ksi.
      e. Design Loading: AASHTO HS-20-44 or HS-25-44 with 30 percent impact and equivalent soil pressure of 130 psf. Floatation forces not accounted for.
      f. Joints: Each section shall have a male and female end with no less than 1-1/2-inch of concrete overlap and shall include a 1-inch square neoprene gasket, cemented to male surface of section during manufacture.
      g. End Sections: As required for the individual installation, provide:
         1) Doweled end for 1-inch diameter x 12-inch deep steel dowels, keyway slot.
         2) Keyway slot, a shear connection between the precast and field cast sections.
         3) Plain end, for use where wing and end walls act independently of precast box.
      h. Lifting Pins: Each section shall be equipped with 4 OSHA approved lifting pins.
      i. For multi-cell installations, fill 1-inch spacing between cells with granular material to assume proper load distribution.
   3. Three-Sided Structures for Culverts or Short Span Bridge System
      a. Structures shall conform to requirements of ASTM C1504 and ACI 318. For structures subjected to roadway loadings, conform to requirements of AASHTO specifications.

C. Miscellaneous Materials
   1. Concrete
      a. Unless otherwise specified, concrete and reinforced concrete shall conform to the requirements concrete under Division 03 Section "Cast-in-place Concrete". The concrete mixture shall have air content by volume of concrete, based on measurements made immediately after discharge from the mixer, of 5 to 7 percent when maximum size of coarse aggregate exceeds 1-1/2 inches (37.5 mm).
      b. Air content shall be determined in accordance with ASTM C231. The concrete covering over steel reinforcing shall not be less than 1 inch (25 mm) thick for covers and not less than 1-1/2 inches (40 mm) thick for walls and flooring. Concrete covering deposited directly against the ground shall have a thickness of at least 3 inches (75 mm) between steel and ground.
      c. Expansion-joint filler material shall conform to ASTM D1751, or ASTM D1752, or shall be resin-impregnated fiberboard conforming to the physical requirements of ASTM D1752.
   2. Mortar: Mortar for pipe joints, connections to other drainage structures, and brick or block construction shall conform to ASTM C270, Type M, except that the maximum placement time shall be 1 hour. The quantity of water in the mixture shall be sufficient to produce a stiff workable mortar. Water shall be clean and free of harmful acids, alkalies, and organic impurities. The mortar shall be used within 30 minutes after the ingredients are mixed with water. The inside of

the joint shall be wiped clean and finished smooth. The mortar head on the outside shall be protected from air and sun with a proper covering until satisfactorily cured.

3. Precast Concrete Segmental Blocks: Precast concrete segmental block shall conform to ASTM C139, not more than 8 inches (200 mm) thick, not less than 8 inches (200 mm) long, and of such shape that joints can be sealed effectively and bonded with cement mortar.
4. Brick
   a. Brick shall conform to ASTM C62, Grade SW; ASTM C55, Grade S-I or S-II; or ASTM C32, Grade MS. Mortar for jointing and plastering shall consist of one part portland cement and two parts fine sand. Lime may be added to the mortar in a quantity not more than 25 percent of the volume of cement.
   b. The joints shall be filled completely and shall be smooth and free from surplus mortar on the inside of the structure. Brick structures shall be plastered with 1/2 inch (10 mm) of mortar over the entire outside surface of the walls. For square or rectangular structures, brick shall be laid in stretcher courses with a header course every sixth course. For round structures, brick shall be laid radially with every sixth course a stretcher course.
5. Precast Reinforced Concrete Manholes
   a. Precast reinforced concrete manholes shall conform to ASTM C478/ASTM C478M.
   b. Joints between precast concrete risers and tops shall be full-bedded in cement mortar and shall be smoothed to a uniform surface on both interior and exterior of the structure **OR** made with flexible watertight, rubber-type gaskets meeting the requirements of paragraph JOINTS, **as directed**.
6. Prefabricated Corrugated Metal Manholes
   a. Manholes shall be of the type and design recommended by the manufacturer.
   b. Manholes shall be complete with frames and cover, or frames and gratings.
7. Frame and Cover for Gratings
   a. Frame and cover for gratings shall be cast gray iron, ASTM A48/A48M,
   b. Class 35B; cast ductile iron, ASTM A536, Grade 65-45-12; or cast aluminum, ASTM B26M/B26, Alloy 356.OT6. Weight, shape, size, and waterway openings for grates and curb inlets shall be as indicated on the plans.
8. Joints
   a. Flexible Watertight Joints
      1) Materials: Flexible watertight joints shall be made with plastic or rubber-type gaskets for concrete pipe and with factory-fabricated resilient materials for clay pipe. The design of joints and the physical requirements for plastic gaskets shall conform to AASHTO M198, and rubber-type gaskets shall conform to ASTM C443/ASTM C443M. Factory-fabricated resilient joint materials shall conform to ASTM C425. Gaskets shall have not more than one factory-fabricated splice, except that two factory-fabricated splices of the rubber-type gasket are permitted if the nominal diameter of the pipe being gasketed exceeds 54 inches (1.35 m).
      2) Test Requirements: Watertight joints shall be tested and shall meet test requirements of paragraph HYDROSTATIC TEST ON WATERTIGHT JOINTS. Rubber gaskets shall comply with the oil resistant gasket requirements of ASTM C443/ASTM C443M. Certified copies of test results shall be delivered to the the Owner before gaskets or jointing materials are installed. Alternate types of watertight joint may be furnished, if specifically approved.
   b. External Sealing Bands: Requirements for external sealing bands shall conform to ASTM C877/ASTM C877M.
   c. Flexible Watertight, Gasketed Joints
      1) Gaskets: When infiltration or exfiltration is a concern for pipe lines, the couplings may be required to have gaskets. The closed-cell expanded rubber gaskets shall be a continuous band approximately 7 inches (178 mm) wide and approximately 3/8 inch (10 mm) thick, meeting the requirements of ASTM D1056, Type 2 A1 **OR** B3, **as directed**, and shall have a quality retention rating of not less than 70 percent when tested for weather resistance by ozone chamber exposure, Method B of ASTM D1171. Rubber O-ring gaskets shall be 13/16 inch (21 mm) in diameter for pipe

diameters of 36 inches (914 mm) or smaller and 7/8 inch (22 mm) in diameter for larger pipe having 1/2 inch (13 mm) deep end corrugation. Rubber O-ring gaskets shall be 1-3/8 inches (35 mm) in diameter for pipe having 1 inch (25 mm) deep end corrugations. O-rings shall meet the requirements of AASHTO M198 or ASTM C443/ASTM C443M. Flexible plastic gaskets shall conform to requirements of AASHTO M198, Type B.

2) Connecting Bands: Connecting bands shall be of the type, size and sheet thickness of band, and the size of angles, bolts, rods and lugs as indicated or where not indicated as specified in the applicable standards or specifications for the pipe. Exterior rivet heads in the longitudinal seam under the connecting band shall be countersunk or the rivets shall be omitted and the seam welded. Watertight joints shall be tested and shall meet the test requirements of paragraph HYDROSTATIC TEST ON WATERTIGHT JOINTS.

d. PVC Plastic Pipes: Joints shall be solvent cement or elastomeric gasket type in accordance with the specification for the pipe and as recommended by the pipe manufacturer.

e. Smooth Wall PE Plastic Pipe: Pipe shall be joined using butt fusion method as recommended by the pipe manufacturer.

f. Corrugated PE Plastic Pipe: Water tight joints shall be made using a PVC or PE coupling and rubber gaskets as recommended by the pipe manufacturer. Rubber gaskets shall conform to ASTM F477. Soil tight joints shall conform to the requirements in AASHTO HB-17, Division II, Section 26.4.2.4.(e) for soil tightness and shall be as recommended by the pipe manufacturer.

g. Profile Wall PE Plastic Pipe: Joints shall be gasketed or thermal weld type with integral bell in accordance with ASTM F894.

h. Ductile Iron Pipe: Couplings and fittings shall be as recommended by the pipe manufacturer.

D. Steel Ladder

1. Steel ladder shall be provided where the depth of the manhole exceeds 12 feet (3.66 m). These ladders shall be not less than 16 inches (406 mm) in width, with 3/4 inch (19 mm) diameter rungs spaced 12 inches (305 mm) apart. The two stringers shall be a minimum 3/8 inch (10 mm) thick and 2-1/2 inches (63 mm) wide. Ladders and inserts shall be galvanized after fabrication in conformance with ASTM A123/A123M.

E. Resilient Connectors

1. Flexible, watertight connectors used for connecting pipe to manholes and inlets shall conform to ASTM C923/ASTM C923M.

F. Hydrostatic Test On Watertight Joints

1. Concrete, Clay, PVC and PE Pipe: A hydrostatic test shall be made on the watertight joint types as proposed. Only one sample joint of each type needs testing; however, if the sample joint fails because of faulty design or workmanship, an additional sample joint may be tested. During the test period, gaskets or other jointing material shall be protected from extreme temperatures which might adversely affect the performance of such materials. Performance requirements for joints in reinforced and nonreinforced concrete pipe shall conform to AASHTO M198 or ASTM C443M ASTM C443. Test requirements for joints in clay pipe shall conform to ASTM C425. Test requirements for joints in PVC and PE plastic pipe shall conform to ASTM D3212.

2. Corrugated Steel and Aluminum Pipe: A hydrostatic test shall be made on the watertight joint system or coupling band type proposed. The moment strength required of the joint is expressed as 15 percent of the calculated moment capacity of the pipe on a transverse section remote from the joint by the AASHTO HB-17 (Division II, Section 26). The pipe shall be supported for the hydrostatic test with the joint located at the point which develops 15 percent of the moment capacity of the pipe based on the allowable span in meters feet for the pipe flowing full or 40,000 foot-pounds (54,233 Newton meters), whichever is less. Performance requirements shall be met

at an internal hydrostatic pressure of 10 psi (69 kPa) for a 10 minute period for both annular corrugated metal pipe and helical corrugated metal pipe with factory reformed ends.

G. Erosion Control Riprap
1. Provide nonerodible rock not exceeding 15 inches (375 mm) in its greatest dimension and choked with sufficient small rocks to provide a dense mass with a minimum thickness of 8 inches (200 mm) or as indicated.

1.3 EXECUTION

A. Excavation for Pipe Culverts and Drainage Structures
1. Excavation of trenches, and for appurtenances and backfilling for culverts and storm drains, shall be in accordance with the applicable portions of Division 02 Section "Earthwork" and the requirements specified below.
2. Trenching: The width of trenches at any point below the top of the pipe shall be not greater than the outside diameter of the pipe plus 12-inches (300 mm) each side of pipe to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Sheeting and bracing, where required, shall be placed within the trench width as specified. Contractor shall not overexcavate. Where trench widths are exceeded, redesign with a resultant increase in cost of stronger pipe or special installation procedures will be necessary. Cost of this redesign and increased cost of pipe or installation shall be borne by the Contractor without additional cost to the Owner.
3. Removal of Rock: Rock in either ledge or boulder formation shall be replaced with suitable materials to provide a compacted earth cushion having a thickness between unremoved rock and the pipe of at least 8 inches (200 mm) or 1/2 inch (13 mm) for each meter foot of fill over the top of the pipe, whichever is greater, but not more than three-fourths the nominal diameter of the pipe. Where bell-and-spigot pipe is used, the cushion shall be maintained under the bell as well as under the straight portion of the pipe. Rock excavation shall be as specified and defined in Division 02 Section "Earthwork".
4. Removal of Unstable Material: Where wet or otherwise unstable soil incapable of properly supporting the pipe, as determined by the the Owner, is unexpectedly encountered in the bottom of a trench, such material shall be removed to the depth required and replaced to the proper grade with select granular material, compacted as provided in paragraph BACKFILLING. When removal of unstable material is due to the fault or neglect of the Contractor while performing shoring and sheeting, water removal, or other specified requirements, such removal and replacement shall be performed at no additional cost to the Owner.

B. Bedding
1. The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe.
2. Concrete Pipe Requirements: When no bedding class is specified or detailed on the drawings, concrete pipe shall be bedded in a soil foundation accurately shaped and rounded to conform to the lowest one-fourth of the outside portion of circular pipe or to the lower curved portion of pipe arch for the entire length of the pipe or pipe arch. When necessary, the bedding shall be tamped. Bell holes and depressions for joints shall be not more than the length, depth, and width required for properly making the particular type of joint.
3. Clay Pipe Requirements: Bedding for clay pipe shall be as specified by ASTM C12.
4. Corrugated Metal Pipe: Bedding for corrugated metal pipe and pipe arch shall be in accordance with ASTM A798/A798M. It is not required to shape the bedding to the pipe geometry. However, for pipe arches, the Contractor shall either shape the bedding to the relatively flat bottom arc or fine grade the foundation to a shallow v-shape. Bedding for corrugated structural plate pipe shall meet requirements of ASTM A807/A807M.
5. Ductile Iron and Cast-Iron Pipe: Bedding for ductile iron and cast-iron pipe shall be as shown on the drawings.

6. Plastic Pipe: Bedding for PVC and PE pipe shall meet the requirements of ASTM D2321. Bedding, haunching, and initial backfill shall be either Class IB or II material.

C. Placing Pipe

1. Each pipe shall be thoroughly examined before being laid; defective or damaged pipe shall not be used. Plastic pipe shall be protected from exposure to direct sunlight prior to laying, if necessary to maintain adequate pipe stiffness and meet installation deflection requirements. Pipelines shall be laid to the grades and alignment indicated. Proper facilities shall be provided for lowering sections of pipe into trenches. Lifting lugs in vertically elongated metal pipe shall be placed in the same vertical plane as the major axis of the pipe. Pipe shall not be laid in water, and pipe shall not be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary. Deflection of installed flexible pipe shall not exceed the following limits:

TYPE OF PIPE	MAXIMUM ALLOWABLE DEFLECTION (%)
Corrugated Steel and Aluminum Alloy	5
Concrete-Lined Corrugated Steel	3
Ductile Iron Culvert	3
Plastic	7.5

Not less than 30 days after the completion of backfilling, the Owner may perform a deflection test on the entire length of installed flexible pipe using a mandrel or other suitable device. Installed flexible pipe showing deflections greater than those indicated above shall be retested by a run from the opposite direction. If the retest also fails, the suspect pipe shall be replaced.

2. Concrete, Clay, PVC, Ribbed PVC, Ductile Iron and Cast-Iron Pipe: Laying shall proceed upgrade with spigot ends of bell-and-spigot pipe and tongue ends of tongue-and-groove pipe pointing in the direction of the flow.
3. Elliptical and Elliptical Reinforced Concrete Pipe: The manufacturer's reference lines, designating the top of the pipe, shall be within 5 degrees of a vertical plane through the longitudinal axis of the pipe, during placement. Damage to or misalignment of the pipe shall be prevented in all backfilling operations.
4. Corrugated PE Pipe: Laying shall be with the separate sections joined firmly on a bed shaped to line and grade and shall follow manufacturer's recommendations.
5. Corrugated Metal Pipe and Pipe Arch: Laying shall be with the separate sections joined firmly together, with the outside laps of circumferential joints pointing upstream, and with longitudinal laps on the sides. Part paved pipe shall be installed so that the centerline of bituminous pavement in the pipe, indicated by suitable markings on the top at each end of the pipe sections, coincides with the specified alignment of pipe. Fully paved steel pipe or pipe arch shall have a painted or otherwise applied label inside the pipe or pipe arch indicating sheet thickness of pipe or pipe arch. Any unprotected metal in the joints shall be coated with bituminous material as specified in AASHTO M190 or AASHTO M243. Interior coating shall be protected against damage from insertion or removal of struts or tie wires. Lifting lugs shall be used to facilitate moving pipe without damage to exterior or interior coatings. During transportation and installation, pipe or pipe arch and coupling bands shall be handled with care to preclude damage to the coating, paving or lining. Damaged coatings, pavings and linings shall be repaired in accordance with the manufacturer's recommendations prior to placing backfill. Pipe on which coating, paving or lining has been damaged to such an extent that satisfactory field repairs cannot be made shall be removed and replaced. Vertical elongation, where indicated, shall be accomplished by factory elongation. Suitable markings or properly placed lifting lugs shall be provided to ensure placement of factory elongated pipe in a vertical plane.
6. Structural-Plate Steel: Structural plate shall be installed in accordance with ASTM A807/A807M. Structural plate shall be assembled in accordance with instructions furnished by the manufacturer. Instructions shall show the position of each plate and the order of assembly. Bolts shall be tightened progressively and uniformly, starting at one end of the structure after all plates are in place. The operation shall be repeated to ensure that all bolts are tightened to meet the torque requirements of 200 foot-pounds (270 Newton meters) plus or minus 50 foot-pounds (68 Newton meters). Any power wrenches used shall be checked by the use of hand torque

wrenches or long-handled socket or structural wrenches for amount of torque produced. Power wrenches shall be checked and adjusted frequently as needed, according to type or condition, to ensure proper adjustment to supply the required torque.

7. Structural-Plate Aluminum: Structural plate shall be assembled in accordance with instructions furnished by the manufacturer. Instructions shall show the position of each plate and the order of assembly. Bolts shall be tightened progressively and uniformly, starting at one end of the structure after all plates are in place. The operation shall be repeated to ensure that all bolts are torqued to a minimum of 100 foot-pounds (136 Newton meters) on aluminum alloy bolts and a minimum of 150 foot-pounds (203 Newton meters) on galvanized steel bolts. Any power wrenches used shall be checked by the use of hand torque wrenches or long-handled socket or structural wrenches for the amount of torque produced. Power wrenches shall be checked and adjusted as frequently as needed, according to type or condition, to ensure that they are in proper adjustment to supply the required torque.
8. Multiple Culverts: Where multiple lines of pipe are installed, adjacent sides of pipe shall be at least half the nominal pipe diameter or 1 meter 3 feet apart, whichever is less.
9. Jacking Pipe Through Fills: Methods of operation and installation for jacking pipe through fills shall conform to requirements specified in Volume 1, Chapter 1, Part 4 of AREMA Manual.

D. Jointing
   1. Concrete and Clay Pipe
      a. Cement-Mortar Bell-and-Spigot Joint: The first pipe shall be bedded to the established gradeline, with the bell end placed upstream. The interior surface of the bell shall be thoroughly cleaned with a wet brush and the lower portion of the bell filled with mortar as required to bring inner surfaces of abutting pipes flush and even. The spigot end of each subsequent pipe shall be cleaned with a wet brush and uniformly matched into a bell so that sections are closely fitted. After each section is laid, the remainder of the joint shall be filled with mortar, and a bead shall be formed around the outside of the joint with sufficient additional mortar. If mortar is not sufficiently stiff to prevent appreciable slump before setting, the outside of the joint shall be wrapped or bandaged with cheesecloth to hold mortar in place.
      b. Cement-Mortar Oakum Joint for Bell-and-Spigot Pipe: A closely twisted gasket shall be made of jute or oakum of the diameter required to support the spigot end of the pipe at the proper grade and to make the joint concentric. Joint packing shall be in one piece of sufficient length to pass around the pipe and lap at top. This gasket shall be thoroughly saturated with neat cement grout. The bell of the pipe shall be thoroughly cleaned with a wet brush, and the gasket shall be laid in the bell for the lower third of the circumference and covered with mortar. The spigot of the pipe shall be thoroughly cleaned with a wet brush, inserted in the bell, and carefully driven home. A small amount of mortar shall be inserted in the annular space for the upper two-thirds of the circumference. The gasket shall be lapped at the top of the pipe and driven home in the annular space with a caulking tool. The remainder of the annular space shall be filled completely with mortar and beveled at an angle of approximately 45 degrees with the outside of the bell. If mortar is not sufficiently stiff to prevent appreciable slump before setting, the outside of the joint thus made shall be wrapped with cheesecloth. Placing of this type of joint shall be kept at least five joints behind laying operations.
      c. Cement-Mortar Diaper Joint for Bell-and-Spigot Pipe: The pipe shall be centered so that the annular space is uniform. The annular space shall be caulked with jute or oakum. Before caulking, the inside of the bell and the outside of the spigot shall be cleaned.
         1) Diaper Bands: Diaper bands shall consist of heavy cloth fabric to hold grout in place at joints and shall be cut in lengths that extend one-eighth of the circumference of pipe above the spring line on one side of the pipe and up to the spring line on the other side of the pipe. Longitudinal edges of fabric bands shall be rolled and stitched around two pieces of wire. Width of fabric bands shall be such that after fabric has been securely stitched around both edges on wires, the wires will be uniformly spaced not less than 200 mm 8 inches apart. Wires shall be cut into

lengths to pass around pipe with sufficient extra length for the ends to be twisted at top of pipe to hold the band securely in place; bands shall be accurately centered around lower portion of joint.

2) Grout: Grout shall be poured between band and pipe from the high side of band only, until grout rises to the top of band at the spring line of pipe, or as nearly so as possible, on the opposite side of pipe, to ensure a thorough sealing of joint around the portion of pipe covered by the band. Silt, slush, water, or polluted mortar grout forced up on the lower side shall be forced out by pouring, and removed.

3) Remainder of Joint: The remaining unfilled upper portion of the joint shall be filled with mortar and a bead formed around the outside of this upper portion of the joint with a sufficient amount of additional mortar. The diaper shall be left in place. Placing of this type of joint shall be kept at least five joints behind actual laying of pipe. No backfilling around joints shall be done until joints have been fully inspected and approved.

d. Cement-Mortar Tongue-and-Groove Joint: The first pipe shall be bedded carefully to the established gradeline with the groove upstream. A shallow excavation shall be made underneath the pipe at the joint and filled with mortar to provide a bed for the pipe. The grooved end of the first pipe shall be thoroughly cleaned with a wet brush, and a layer of soft mortar applied to the lower half of the groove. The tongue of the second pipe shall be cleaned with a wet brush; while in horizontal position, a layer of soft mortar shall be applied to the upper half of the tongue. The tongue end of the second pipe shall be inserted in the grooved end of the first pipe until mortar is squeezed out on interior and exterior surfaces. Sufficient mortar shall be used to fill the joint completely and to form a bead on the outside.

e. Cement-Mortar Diaper Joint for Tongue-and-Groove Pipe: The joint shall be of the type described for cement-mortar tongue-and-groove joint in this paragraph, except that the shallow excavation directly beneath the joint shall not be filled with mortar until after a gauze or cheesecloth band dipped in cement mortar has been wrapped around the outside of the joint. The cement-mortar bead at the joint shall be at least 1/2 inch (15 mm), thick and the width of the diaper band shall be at least 8 inches (200 mm). The diaper shall be left in place. Placing of this type of joint shall be kept at least five joints behind the actual laying of the pipe. Backfilling around the joints shall not be done until the joints have been fully inspected and approved.

f. Plastic Sealing Compound Joints for Tongue-and-Grooved Pipe: Sealing compounds shall follow the recommendation of the particular manufacturer in regard to special installation requirements. Surfaces to receive lubricants, primers, or adhesives shall be dry and clean. Sealing compounds shall be affixed to the pipe not more than 3 hours prior to installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Sealing compounds shall be inspected before installation of the pipe, and any loose or improperly affixed sealing compound shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pulled together. If, while making the joint with mastic-type sealant, a slight protrusion of the material is not visible along the entire inner and outer circumference of the joint when the joint is pulled up, the pipe shall be removed and the joint remade. After the joint is made, all inner protrusions shall be cut off flush with the inner surface of the pipe. If nonmastic-type sealant material is used, the "Squeeze-Out" requirement above will be waived.

g. Flexible Watertight Joints: Gaskets and jointing materials shall be as recommended by the particular manufacturer in regard to use of lubricants, cements, adhesives, and other special installation requirements. Surfaces to receive lubricants, cements, or adhesives shall be clean and dry. Gaskets and jointing materials shall be affixed to the pipe not more than 24 hours prior to the installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Gaskets and jointing materials shall be inspected before installing the pipe; any loose or improperly affixed gaskets and jointing materials shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pushed home. If, while the joint is being made the gasket becomes visibly dislocated the pipe shall be removed and the joint remade.

h. External Sealing Band Joint for Noncircular Pipe: Surfaces to receive sealing bands shall be dry and clean. Bands shall be installed in accordance with manufacturer's recommendations.

2. Corrugated Metal Pipe

a. Field Joints: Transverse field joints shall be designed so that the successive connection of pipe sections will form a continuous line free of appreciable irregularities in the flow line. In addition, the joints shall meet the general performance requirements described in ASTM A798/A798M. Suitable transverse field joints which satisfy the requirements for one or more of the joint performance categories can be obtained with the following types of connecting bands furnished with suitable band-end fastening devices: corrugated bands, bands with projections, flat bands, and bands of special design that engage factory reformed ends of corrugated pipe. The space between the pipe and connecting bands shall be kept free from dirt and grit so that corrugations fit snugly. The connecting band, while being tightened, shall be tapped with a soft-head mallet of wood, rubber or plastic, to take up slack and ensure a tight joint. The annular space between abutting sections of part paved, and fully paved pipe and pipe arch, in sizes 30 inches (750 mm) or larger, shall be filled with a bituminous material after jointing. Field joints for each type of corrugated metal pipe shall maintain pipe alignment during construction and prevent infiltration of fill material during the life of the installations. The type, size, and sheet thickness of the band and the size of angles or lugs and bolts shall be as indicated or where not indicated, shall be as specified in the applicable standards or specifications for the pipe.

b. Flexible Watertight, Gasketed Joints: Installation shall be as recommended by the gasket manufacturer for use of lubricants and cements and other special installation requirements. The gasket shall be placed over one end of a section of pipe for half the width of the gasket. The other half shall be doubled over the end of the same pipe. When the adjoining section of pipe is in place, the doubled-over half of the gasket shall then be rolled over the adjoining section. Any unevenness in overlap shall be corrected so that the gasket covers the end of pipe sections equally. Connecting bands shall be centered over adjoining sections of pipe, and rods or bolts placed in position and nuts tightened. Band Tightening: The band shall be tightened evenly, even tension being kept on the rods or bolts, and the gasket; the gasket shall seat properly in the corrugations. Watertight joints shall remain uncovered for a period of time designated, and before being covered, tightness of the nuts shall be measured with a torque wrench. If the nut has tended to loosen its grip on the bolts or rods, the nut shall be retightened with a torque wrench and remain uncovered until a tight, permanent joint is assured.

E. Concrete Placement

1. Place cast-in-place concrete according to ACI 318/318R.

F. Drainage Structures

1. Manholes and Inlets: Construction shall be of reinforced concrete, plain concrete, brick, precast reinforced concrete, precast concrete segmental blocks, prefabricated corrugated metal, or bituminous coated corrugated metal; complete with frames and covers or gratings; and with fixed galvanized steel ladders where indicated. Pipe studs and junction chambers of prefabricated corrugated metal manholes shall be fully bituminous-coated and paved when the connecting branch lines are so treated. Pipe connections to concrete manholes and inlets shall be made with flexible, watertight connectors.
2. Walls and Headwalls: Construction shall be as indicated.

G. Steel Ladder Installation

1. Ladder shall be adequately anchored to the wall by means of steel inserts spaced not more than 6 feet (1.83 m) vertically, and shall be installed to provide at least 6 inches (152 mm) of space between the wall and the rungs. The wall along the line of the ladder shall be vertical for its entire length.

H. Backfilling

1. Backfilling Pipe in Trenches: After the pipe has been properly bedded, selected material from excavation or borrow, at a moisture content that will facilitate compaction, shall be placed along both sides of pipe in layers not exceeding 6 inches (150 mm) in compacted depth. The backfill shall be brought up evenly on both sides of pipe for the full length of pipe. The fill shall be thoroughly compacted under the haunches of the pipe. Each layer shall be thoroughly compacted with mechanical tampers or rammers. This method of filling and compacting shall continue until the fill has reached an elevation of at least 12 inches (300 mm) above the top of the pipe. The remainder of the trench shall be backfilled and compacted by spreading and rolling or compacted by mechanical rammers or tampers in layers not exceeding 8 inches (200 mm). Tests for density shall be made as necessary to ensure conformance to the compaction requirements specified below. Where it is necessary, in the opinion of the the Owner, that sheeting or portions of bracing used be left in place, the contract will be adjusted accordingly. Untreated sheeting shall not be left in place beneath structures or pavements.
2. Backfilling Pipe in Fill Sections: For pipe placed in fill sections, backfill material and the placement and compaction procedures shall be as specified below. The fill material shall be uniformly spread in layers longitudinally on both sides of the pipe, not exceeding 6 inches (150 mm) in compacted depth, and shall be compacted by rolling parallel with pipe or by mechanical tamping or ramming. Prior to commencing normal filling operations, the crown width of the fill at a height of 12 inches (300 mm) above the top of the pipe shall extend a distance of not less than twice the outside pipe diameter on each side of the pipe or 12 feet (4 m), whichever is less. After the backfill has reached at least 12 inches (300 mm) above the top of the pipe, the remainder of the fill shall be placed and thoroughly compacted in layers not exceeding 8 inches (200 mm).
3. Movement of Construction Machinery: When compacting by rolling or operating heavy equipment parallel with the pipe, displacement of or injury to the pipe shall be avoided. Movement of construction machinery over a culvert or storm drain at any stage of construction shall be at the Contractor's risk. Any damaged pipe shall be repaired or replaced.
4. Compaction
   a. General Requirements: Cohesionless materials include gravels, gravel-sand mixtures, sands, and gravelly sands. Cohesive materials include clayey and silty gravels, gravel-silt mixtures, clayey and silty sands, sand-clay mixtures, clays, silts, and very fine sands. When results of compaction tests for moisture-density relations are recorded on graphs, cohesionless soils will show straight lines or reverse-shaped moisture-density curves, and cohesive soils will show normal moisture-density curves.
   b. Minimum Density: Backfill over and around the pipe and backfill around and adjacent to drainage structures shall be compacted at the approved moisture content to the following applicable minimum density, which will be determined as specified below.
      1) Under airfield and heliport pavements, paved roads, streets, parking areas, and similar-use pavements including adjacent shoulder areas, the density shall be not less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material, up to the elevation where requirements for pavement subgrade materials and compaction shall control.
      2) Under unpaved or turfed traffic areas, density shall not be less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material.
      3) Under nontraffic areas, density shall be not less than that of the surrounding material.
5. Determination of Density: Testing shall be the responsibility of the Contractor and performed at no additional cost to the Owner. Testing shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval. Tests shall be performed in sufficient number to ensure that specified density is being obtained. Laboratory tests for moisture-density relations shall be made in accordance with ASTM D1557 except that mechanical tampers may be used provided the results are correlated with those obtained with the specified hand tamper. Field density tests shall be determined in accordance with ASTM D2167 or ASTM D2922. When ASTM D2922 is used, the calibration curves shall be checked and adjusted, if necessary, using the sand cone method as described in paragraph Calibration of the referenced publications.

ASTM D2922 results in a wet unit weight of soil and when using this method ASTM D3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in ASTM D3017 or ASTM D2922. Test results shall be furnished the the Owner. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed.

I. Pipeline Testing

1. Leakage Tests: Lines shall be tested for leakage by low pressure air or water testing or exfiltration tests, as appropriate. Low pressure air testing for vitrified clay pipes shall conform to ASTM C828. Low pressure air testing for concrete pipes shall conform to ASTM C924/ASTM C924M. Low pressure air testing for plastic pipe shall conform to ASTM F1417. Low pressure air testing procedures for other pipe materials shall use the pressures and testing times prescribed in ASTM C828 or ASTM C924/ASTM C924M, after consultation with the pipe manufacturer. Testing of individual joints for leakage by low pressure air or water shall conform to ASTM C1103/ASTM C1103M. Prior to exfiltration tests, the trench shall be backfilled up to at least the lower half of the pipe. If required, sufficient additional backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection. Visible leaks encountered shall be corrected regardless of leakage test results. When the water table is 600 mm 2 feet or more above the top of the pipe at the upper end of the pipeline section to be tested, infiltration shall be measured using a suitable weir or other device acceptable to the the Owner. An exfiltration test shall be made by filling the line to be tested with water so that a head of at least 2 feet (600 mm) is provided above both the water table and the top of the pipe at the upper end of the pipeline to be tested. The filled line shall be allowed to stand until the pipe has reached its maximum absorption, but not less than 4 hours. After absorption, the head shall be reestablished. The amount of water required to maintain this water level during a 2-hour test period shall be measured. Leakage as measured by the exfiltration test shall not exceed 250 gallons per inch in diameter per mile (60 liters per mm in diameter per kilometer) of pipeline per day **OR** 0.2 gallons per inch in diameter per 100 feet (9 mL per mm in diameter per 100 meters), **as directed**, of pipeline per hour. When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished.
2. Deflection Testing: Perform a deflection test on entire length of installed plastic pipeline on completion of work adjacent to and over the pipeline, including leakage tests, backfilling, placement of fill, grading, paving, concreting, and any other superimposed loads. Deflection of pipe in the installed pipeline under external loads shall not exceed 4.5 percent of the average inside diameter of pipe. Determine whether the allowable deflection has been exceeded by use of a pull-through device or a deflection measuring device.
    a. Pull-through device: This device shall be a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. Circular sections shall be so spaced on the shaft that distance from external faces of front and back sections will equal or exceed diameter of the circular section. Pull-through device may also be of a design promulgated by the Uni-Bell Plastic Pipe Association, provided that the device meets the applicable requirements specified in this paragraph, including those for diameter of the device. Ball, cylinder, or circular sections shall conform to the following:
        1) A diameter, or minor diameter as applicable, of 95 percent of the average inside diameter of the pipe; tolerance of plus 0.5 percent will be permitted.
        2) A homogeneous material throughout, with a density greater than 1.0 as related to water at 39.2 degrees F (4 degrees C), and a surface Brinell hardness of not less than 150.
        3) Center bored and through bolted with a 1/4 inch (6 mm) minimum diameter steel shaft having a yield strength of not less than 70,000 psi (483 MPa), with eyes or loops at each end for attaching pulling cables.
        4) Each eye or loop shall be suitably backed with a flange or heavy washer such that a pull exerted on opposite end of shaft will produce compression throughout remote end.

b. Deflection measuring device: Sensitive to 1.0 percent of the diameter of the pipe being tested and accurate to 1.0 percent of the indicated dimension. Deflection measuring device shall be approved by the the Owner prior to use.

c. Pull-through device: Pass the pull-through device through each run of pipe, either by pulling it through or flushing it through with water. If the device fails to pass freely through a pipe run, replace pipe which has the excessive deflection and completely retest in same manner and under same conditions as specified.

d. Deflection measuring device procedure: Measure deflections through each run of installed pipe. If deflection readings in excess of 4.5 percent of average inside diameter of pipe are obtained, retest pipe by a run from the opposite direction. If retest continues to show a deflection in excess of 4.5 percent of average inside diameter of pipe, remove pipe which has excessive deflection, replace with new pipe, and completely retest in same manner and under same conditions.

e. Warranty period test: Pipe found to have a deflection of greater than 5 percent of average inside diameter when deflection test is performed just prior to end of one-year warranty period shall be replaced with new pipe and tested as specified for leakage and deflection.

J. Field Painting

1. After installation, clean cast-iron frames, covers, gratings, and steps not buried in masonry or concrete to bare metal of mortar, rust, grease, dirt, and other deleterious materials and apply a coat of bituminous paint **OR** After installation, clean steel covers and steel or concrete frames not buried in masonry or concrete to bare metal of mortar, dirt, grease, and other deleterious materials. Apply a coat of primer and apply a top coat as specified in Division 09 Section "Exterior Painting", **as directed.** Do not paint surfaces subject to abrasion.

END OF SECTION 02525

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Task	Specification	Specification Description
02525	01352	No Specification Required
02525	02242	Piped Utilities Basic Materials And Methods
02525	02455b	Sanitary Sewerage
02525	02452	Storm Drainage

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SECTION 02551 - FACILITY NATURAL-GAS PIPING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for facility natural gas piping. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Pipes, tubes, and fittings.
b. Piping specialties.
c. Piping and tubing joining materials.
d. Valves.
e. Pressure regulators.
f. Service meters.
g. Mechanical sleeve seals.
h. Grout.
i. Concrete bases.

C. Definitions
1. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
2. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
3. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Performance Requirements
1. Minimum Operating-Pressure Ratings:
a. Piping and Valves: 100 psig (690 kPa) minimum unless otherwise indicated.
b. Service Regulators: 65 psig (450 kPa) **OR** 100 psig (690 kPa), **as directed**, minimum unless otherwise indicated.
c. Minimum Operating Pressure of Service Meter: 5 psig (34.5 kPa) **OR** 10 psig (69 kPa) **OR** 20 psig (138 kPa) **OR** 65 psig (450 kPa), **as directed**.
2. Natural-Gas System Pressure within Buildings: 0.5 psig (3.45 kPa) or less **OR** More than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa) **OR** More than 2 psig (13.8 kPa) but not more than 5 psig (34.5 kPa), **as directed**.
OR
Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa), and is reduced to secondary pressure of 0.5 psig (3.45 kPa) or less.
OR
Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 2 psig (13.8 kPa) but not more than 5 psig (34.5 kPa), and is reduced to secondary pressure of more than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa).
OR
Natural-Gas System Pressures within Buildings: Three pressure ranges. Primary pressure is more than 2 psig (13.8 kPa) but not more than 5 psig (34.5 kPa), and is reduced to secondary pressures of more than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa), and is reduced again to pressures of 0.5 psig (3.45 kPa) or less.

3. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

E. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
3. Delegated-Design Submittal: For natural-gas piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   a. Detail fabrication and assembly of seismic restraints.
   b. Design Calculations: Calculate requirements for selecting seismic restraints.
4. Welding certificates.
5. Field quality-control reports.
6. Operation and maintenance data.

F. Quality Assurance
1. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Delivery, Storage, And Handling
1. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
2. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
3. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.
4. Protect stored PE pipes and valves from direct sunlight.

H. Project Conditions
1. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
   a. Notify Owner no fewer than two days in advance of proposed interruption of natural-gas service.
   b. Do not proceed with interruption of natural-gas service without Owner's written permission.

1.2 PRODUCTS

A. Pipes, Tubes, And Fittings
1. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
   a. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
   b. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
   c. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.

d. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   1) Material Group: 1.1.
   2) End Connections: Threaded or butt welding to match pipe.
   3) Lapped Face: Not permitted underground.
   4) Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
   5) Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

e. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
   1) Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

f. Mechanical Couplings:
   1) Stainless-steel **OR** Steel, **as directed**, flanges and tube with epoxy finish.
   2) Buna-nitrile seals.
   3) Stainless-steel **OR** Steel, **as directed**, bolts, washers, and nuts.
   4) Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
   5) Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.

2. Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC 1.
   a. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.
   b. Coating: PE with flame retardant.
      1) Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
         a) Flame-Spread Index: 25 or less.
         b) Smoke-Developed Index: 50 **OR** 450, **as directed**, or less.
   c. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
   d. Striker Plates: Steel, designed to protect tubing from penetrations.
   e. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
   f. Operating-Pressure Rating: 5 psig (34.5 kPa).
3. Aluminum Tubing: Comply with ASTM B 210 and ASTM B 241/B 241M.
   a. Aluminum Alloy: Alloy 5456 is prohibited.
   b. Protective Coating: Factory-applied coating capable of resisting corrosion on tubing in contact with masonry, plaster, insulation, water, detergents, and sewerage.
   c. Flare Fittings: Comply with ASME B16.26 and SAE J513.
      1) Copper-alloy fittings.
      2) Metal-to-metal compression seal without gasket.
      3) Dryseal threads shall comply with ASME B1.20.3.
4. Drawn-Temper Copper Tube: Comply with ASTM B 88, Type K (ASTM B 88M, Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B) **OR** ASTM B 837, Type G, **as directed**.
   a. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.
   b. Bronze Flanges and Flanged Fittings: ASME B16.24, Class 150.
      1) Gasket Material: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
      2) Bolts and Nuts: ASME B18.2.1, carbon steel or stainless steel.
   c. Protective Coating for Underground Tubing: Factory-applied, extruded PE a minimum of 0.022 inch (0.56 mm) thick.
5. Annealed-Temper Copper Tube: Comply with ASTM B 88, Type K (ASTM B 88M, Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B) **OR** ASTM B 837, Type G, **as directed**.
   a. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.
   b. Flare Fittings: Comply with ASME B16.26 and SAE J513.

1) Copper fittings with long nuts.
2) Metal-to-metal compression seal without gasket.
3) Dryseal threads complying with ASME B1.20.3.

c. Protective Coating for Underground Tubing: Factory-applied, extruded PE a minimum of 0.022 inch (0.56 mm) thick.

6. Tin-Lined Copper Tube: ASTM B 280, seamless, annealed, with interior tin-plated lining.
   a. Flare Fittings: Comply with ASME B16.26 and SAE J513.
      1) Copper fittings with long nuts.
      2) Metal-to-metal compression seal without gasket.
      3) Dryseal threads complying with ASME B1.20.3.
7. PE Pipe: ASTM D 2513, SDR 11.
   a. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
   b. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
   c. Anodeless Service-Line Risers: Factory fabricated and leak tested.
      1) Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.
      2) Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering. Vent casing aboveground, **as directed**.
      3) Aboveground Portion: PE transition fitting.
      4) Outlet shall be threaded or flanged or suitable for welded connection.
      5) Tracer wire connection.
      6) Ultraviolet shield.
      7) Stake supports with factory finish to match steel pipe casing or carrier pipe.
   d. Transition Service-Line Risers: Factory fabricated and leak tested.
      1) Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
      2) Outlet shall be threaded or flanged or suitable for welded connection.
      3) Bridging sleeve over mechanical coupling.
      4) Factory-connected anode.
      5) Tracer wire connection.
      6) Ultraviolet shield.
      7) Stake supports with factory finish to match steel pipe casing or carrier pipe.
   e. Plastic Mechanical Couplings, NPS 1-1/2 (DN 40) and Smaller: Capable of joining PE pipe to PE pipe.
      1) PE body with molded-in, stainless-steel support ring.
      2) Buna-nitrile seals.
      3) Acetal collets.
      4) Electro-zinc-plated steel stiffener.
   f. Plastic Mechanical Couplings, NPS 2 (DN 50) and Larger: Capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
      1) Fiber-reinforced plastic body.
      2) PE body tube.
      3) Buna-nitrile seals.
      4) Acetal collets.
      5) Stainless-steel bolts, nuts, and washers.
   g. Steel Mechanical Couplings: Capable of joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
      1) Stainless-steel **OR** Steel, **as directed**, flanges and tube with epoxy finish.
      2) Buna-nitrile seals.
      3) Stainless-steel **OR** Steel, **as directed**, bolts, washers, and nuts.
      4) Factory-installed anode for steel-body couplings installed underground.

B. Piping Specialties
   1. Appliance Flexible Connectors:
      a. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
      b. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
      c. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
      d. Corrugated stainless-steel tubing with polymer coating.
      e. Operating-Pressure Rating: 0.5 psig (3.45 kPa).
      f. End Fittings: Zinc-coated steel.
      g. Threaded Ends: Comply with ASME B1.20.1.
      h. Maximum Length: 72 inches (1830 mm).
   2. Quick-Disconnect Devices: Comply with ANSI Z21.41.
      a. Copper-alloy convenience outlet and matching plug connector.
      b. Nitrile seals.
      c. Hand operated with automatic shutoff when disconnected.
      d. For indoor or outdoor applications.
      e. Adjustable, retractable restraining cable.
   3. Y-Pattern Strainers:
      a. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
      b. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
      c. Strainer Screen: 40 **OR** 60, **as directed**,-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
      d. CWP Rating: 125 psig (862 kPa).
   4. Basket Strainers:
      a. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
      b. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
      c. Strainer Screen: 40 **OR** 60, **as directed**,-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
      d. CWP Rating: 125 psig (862 kPa).
   5. T-Pattern Strainers:
      a. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
      b. End Connections: Grooved ends.
      c. Strainer Screen: 40 **OR** 60, **as directed**,-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
      d. CWP Rating: 750 psig (5170 kPa).
   6. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

C. Joining Materials
   1. Joint Compound and Tape: Suitable for natural gas.
   2. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
   3. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F (540 deg C) complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

D. Manual Gas Shutoff Valves
   1. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
   2. General Requirements for Metallic Valves, NPS 2 (DN 50) and Smaller: Comply with ASME B16.33.
      a. CWP Rating: 125 psig (862 kPa).

b. Threaded Ends: Comply with ASME B1.20.1.
c. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
d. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
e. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch (25 mm) and smaller.
f. Service Mark: Valves 1-1/4 inches (32 mm) to NPS 2 (DN 50) shall have initials "WOG" permanently marked on valve body.

3. General Requirements for Metallic Valves, NPS 2-1/2 (DN 65) and Larger: Comply with ASME B16.38.
   a. CWP Rating: 125 psig (862 kPa).
   b. Flanged Ends: Comply with ASME B16.5 for steel flanges.
   c. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   d. Service Mark: Initials "WOG" shall be permanently marked on valve body.
4. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
   a. Body: Bronze, complying with ASTM B 584.
   b. Ball: Chrome-plated brass.
   c. Stem: Bronze; blowout proof.
   d. Seats: Reinforced TFE; blowout proof.
   e. Packing: Separate packnut with adjustable-stem packing threaded ends.
   f. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   g. CWP Rating: 600 psig (4140 kPa).
   h. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
   i. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
5. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
   a. Body: Bronze, complying with ASTM B 584.
   b. Ball: Chrome-plated bronze.
   c. Stem: Bronze; blowout proof.
   d. Seats: Reinforced TFE; blowout proof.
   e. Packing: Threaded-body packnut design with adjustable-stem packing.
   f. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   g. CWP Rating: 600 psig (4140 kPa).
   h. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
   i. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
6. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.
   a. Body: Bronze, complying with ASTM B 584.
   b. Ball: Chrome-plated bronze.
   c. Stem: Bronze; blowout proof.
   d. Seats: Reinforced TFE.
   e. Packing: Threaded-body packnut design with adjustable-stem packing.
   f. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   g. CWP Rating: 600 psig (4140 kPa).
   h. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
   i. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
7. Bronze Plug Valves: MSS SP-78.
   a. Body: Bronze, complying with ASTM B 584.
   b. Plug: Bronze.

c. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
d. Operator: Square head or lug type with tamperproof feature where indicated.
e. Pressure Class: 125 psig (862 kPa).
f. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
g. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

8. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.
a. Body: Cast iron, complying with ASTM A 126, Class B.
b. Plug: Bronze or nickel-plated cast iron.
c. Seat: Coated with thermoplastic.
d. Stem Seal: Compatible with natural gas.
e. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
f. Operator: Square head or lug type with tamperproof feature where indicated.
g. Pressure Class: 125 psig (862 kPa).
h. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
i. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

9. Cast-Iron, Lubricated Plug Valves: MSS SP-78.
a. Body: Cast iron, complying with ASTM A 126, Class B.
b. Plug: Bronze or nickel-plated cast iron.
c. Seat: Coated with thermoplastic.
d. Stem Seal: Compatible with natural gas.
e. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
f. Operator: Square head or lug type with tamperproof feature where indicated.
g. Pressure Class: 125 psig (862 kPa).
h. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
i. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

10. PE Ball Valves: Comply with ASME B16.40.
a. Body: PE.
b. Ball: PE.
c. Stem: Acetal.
d. Seats and Seals: Nitrile.
e. Ends: Plain or fusible to match piping.
f. CWP Rating: 80 psig (552 kPa).
g. Operating Temperature: Minus 20 to plus 140 deg F (Minus 29 to plus 60 deg C).
h. Operator: Nut or flat head for key operation.
i. Include plastic valve extension.
j. Include tamperproof locking feature for valves where indicated on Drawings.

11. Valve Boxes:
a. Cast-iron, two-section box.
b. Top section with cover with "GAS" lettering.
c. Bottom section with base to fit over valve and barrel a minimum of 5 inches (125 mm) in diameter.
d. Adjustable cast-iron extensions of length required for depth of bury.
e. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

E. Motorized Gas Valves
1. Automatic Gas Valves: Comply with ANSI Z21.21.
a. Body: Brass or aluminum.
b. Seats and Disc: Nitrile rubber.
c. Springs and Valve Trim: Stainless steel.

d. Normally closed.
e. Visual position indicator.
f. Electrical **OR** Mechanical, **as directed**, operator for actuation by appliance automatic shutoff device.

2. Electrically Operated Valves: Comply with UL 429.
a. Pilot operated.
b. Body: Brass or aluminum.
c. Seats and Disc: Nitrile rubber.
d. Springs and Valve Trim: Stainless steel.
e. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, and replaceable.
f. NEMA ICS 6, Type 4, coil enclosure.
g. Normally closed.
h. Visual position indicator.

F. Earthquake Valves
1. Earthquake Valves: Comply with ASCE 25.
a. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
b. Maximum Operating Pressure: 5 psig (34.5 kPa).
c. Cast-aluminum body with nickel-plated chrome steel internal parts.
d. Nitrile-rubber valve washer.
e. Sight windows for visual indication of valve position.
f. Threaded end connections complying with ASME B1.20.1.
g. Wall mounting bracket with bubble level indicator.
2. Earthquake Valves: Comply with ASCE 25.
a. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
b. Maximum Operating Pressure: 0.5 psig (3.45 kPa) **OR** 7 psig (48 kPa) **OR** 60 psig (414 kPa), **as directed**.
c. Cast-aluminum body with stainless-steel internal parts.
d. Nitrile-rubber, reset-stem o-ring seal.
e. Valve position, open or closed, indicator.
f. Composition valve seat with clapper held by spring or magnet locking mechanism.
g. Level indicator.
h. End Connections: Threaded for valves NPS 2 (DN 50) and smaller; flanged for valves NPS 2-1/2 (DN 65) and larger.

G. Pressure Regulators
1. General Requirements:
a. Single stage and suitable for natural gas.
b. Steel jacket and corrosion-resistant components.
c. Elevation compensator.
d. End Connections: Threaded for regulators NPS 2 (DN 50) and smaller; flanged for regulators NPS 2-1/2 (DN 65) and larger.
2. Service Pressure Regulators: Comply with ANSI Z21.80.
a. Body and Diaphragm Case: Cast iron or die-cast aluminum.
b. Springs: Zinc-plated steel; interchangeable.
c. Diaphragm Plate: Zinc-plated steel.
d. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
e. Orifice: Aluminum; interchangeable.
f. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
g. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
h. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
i. Overpressure Protection Device: Factory mounted on pressure regulator.

j. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
k. Maximum Inlet Pressure: 100 psig (690 kPa).

3. Line Pressure Regulators: Comply with ANSI Z21.80.
   a. Body and Diaphragm Case: Cast iron or die-cast aluminum.
   b. Springs: Zinc-plated steel; interchangeable.
   c. Diaphragm Plate: Zinc-plated steel.
   d. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
   e. Orifice: Aluminum; interchangeable.
   f. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
   g. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
   h. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
   i. Overpressure Protection Device: Factory mounted on pressure regulator.
   j. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
   k. Maximum Inlet Pressure: 2 psig (13.8 kPa) **OR** 5 psig (34.5 kPa) **OR** 10 psig (69 kPa), **as directed**.
4. Appliance Pressure Regulators: Comply with ANSI Z21.18.
   a. Body and Diaphragm Case: Die-cast aluminum.
   b. Springs: Zinc-plated steel; interchangeable.
   c. Diaphragm Plate: Zinc-plated steel.
   d. Seat Disc: Nitrile rubber.
   e. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
   f. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
   g. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
   h. Maximum Inlet Pressure: 1 psig (6.9 kPa) **OR** 2 psig (13.8 kPa) **OR** 5 psig (34.5 kPa), **as directed**.

H. Service Meters
1. Diaphragm-Type Service Meters: Comply with ANSI B109.1 **OR** ANSI B109.2, **as directed**.
   a. Case: Die-cast aluminum.
   b. Connections: Steel threads.
   c. Diaphragm: Synthetic fabric.
   d. Diaphragm Support Bearings: Self-lubricating.
   e. Compensation: Continuous temperature and pressure, **as directed**.
   f. Meter Index: Cubic feet **OR** Liters **OR** Cubic feet and liters, **as directed**.
   g. Meter Case and Index: Tamper resistant.
   h. Remote meter reader compatible.
   i. Maximum Inlet Pressure: 100 psig (690 kPa).
   j. Pressure Loss: Maximum 0.5-inch wg (124 Pa) **OR** 2.0-inch wg (498 Pa), **as directed**.
   k. Accuracy: Maximum plus or minus 1.0 percent.
2. Rotary-Type Service Meters: Comply with ANSI B109.3.
   a. Case: Extruded aluminum.
   b. Connection: Flange.
   c. Impellers: Polished aluminum.
   d. Rotor Bearings: Self-lubricating.
   e. Compensation: Continuous temperature and pressure, **as directed**.
   f. Meter Index: Cubic feet **OR** Liters **OR** Cubic feet and liters, **as directed**.
   g. Tamper resistant.
   h. Remote meter reader compatible.
   i. Maximum Inlet Pressure: 100 psig (690 kPa).
   j. Accuracy: Maximum plus or minus 2.0 percent.

3. Turbine Meters: Comply with ASME MFC-4M.
   a. Housing: Cast iron or welded steel.
   b. Connection Threads or Flanges: Steel.
   c. Turbine: Aluminum or plastic.
   d. Turbine Bearings: Self-lubricating.
   e. Compensation: Continuous temperature and pressure, **as directed**.
   f. Meter Index: Cubic feet **OR** Liters **OR** Cubic feet and liters, **as directed**.
   g. Tamper resistant.
   h. Remote meter reader compatible.
   i. Maximum Inlet Pressure: 100 psig (690 kPa).
   j. Accuracy: Maximum plus or minus 2.0 percent.
4. Service-Meter Bars:
   a. Malleable- or cast-iron frame for supporting service meter.
   b. Include offset swivel pipes, meter nuts with o-ring seal, and factory- or field-installed dielectric unions.
   c. Omit meter offset swivel pipes if service-meter bar dimensions match service-meter connections.
5. Service-Meter Bypass Fittings:
   a. Ferrous, tee, pipe fitting with capped side inlet for temporary natural-gas supply.
   b. Integral ball-check bypass valve.

I. Dielectric Fittings
1. Dielectric Unions:
   a. Minimum Operating-Pressure Rating: 150 psig (1034 kPa).
   b. Combination fitting of copper alloy and ferrous materials.
   c. Insulating materials suitable for natural gas.
   d. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.
2. Dielectric Flanges:
   a. Minimum Operating-Pressure Rating: 150 psig (1034 kPa).
   b. Combination fitting of copper alloy and ferrous materials.
   c. Insulating materials suitable for natural gas.
   d. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.
3. Dielectric-Flange Kits:
   a. Minimum Operating-Pressure Rating: 150 psig (1034 kPa).
   b. Companion-flange assembly for field assembly.
   c. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or PE bolt sleeves, phenolic washers, and steel backing washers.
   d. Insulating materials suitable for natural gas.
   e. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

J. Sleeves
1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

K. Mechanical Sleeve Seals
1. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   a. Sealing Elements: EPDM **OR** NBR, **as directed**, interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe and sleeve.
   b. Pressure Plates: Plastic **OR** Carbon steel **OR** Stainless steel, **as directed**.

c. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating **OR** Stainless steel, **as directed**, of length required to secure pressure plates to sealing elements. Include one nut and bolt for each sealing element.

L. Escutcheons
1. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to fit around pipe or tube, and OD that completely covers opening.
2. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.
3. One-Piece, Cast-Brass Escutcheons: With set screw.
   a. Finish: Polished chrome-plated **OR** Rough brass, **as directed**.
4. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.
   a. Finish: Polished chrome-plated **OR** Rough brass, **as directed**.
5. One-Piece, Stamped-Steel Escutcheons: With set screw **OR** spring clips, **as directed**, and chrome-plated finish.
6. Split-Plate, Stamped-Steel Escutcheons: With concealed **OR** exposed-rivet, **as directed**, hinge, set screw **OR** spring clips, **as directed**, and chrome-plated finish.
7. One-Piece, Floor-Plate Escutcheons: Cast-iron floor plate.
8. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

M. Grout
1. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   a. Characteristics: Post-hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   b. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
   c. Packaging: Premixed and factory packaged.

N. Labeling And Identifying
1. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored yellow.

1.3 EXECUTION

A. Preparation
1. Close equipment shutoff valves before turning off natural gas to premises or piping section.
2. Inspect natural-gas piping according to NFPA 54 **OR** the International Fuel Gas Code, **as directed**, to determine that natural-gas utilization devices are turned off in piping section affected.
3. Comply with NFPA 54 **OR** the International Fuel Gas Code, **as directed**, requirements for prevention of accidental ignition.

B. Outdoor Piping Installation
1. Comply with NFPA 54 **OR** the International Fuel Gas Code, **as directed**, for installation and purging of natural-gas piping.
2. Install underground, natural-gas piping buried at least 36 inches (900 mm) below finished grade. Comply with requirements in Division 02 Section "Earthwork" for excavating, trenching, and backfilling.
   a. If natural-gas piping is installed less than 36 inches (900 mm) below finished grade, install it in containment conduit.
3. Install underground, PE, natural-gas piping according to ASTM D 2774.
4. Steel Piping with Protective Coating:
   a. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.

b. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
OR
Replace pipe having damaged PE coating with new pipe.

5. Copper Tubing with Protective Coating:
   a. Apply joint cover kits over tubing to cover, seal, and protect joints.
   b. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
6. Install fittings for changes in direction and branch connections.
7. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   a. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
   b. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
8. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
9. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
10. Install pressure gage downstream **OR** upstream and downstream, **as directed**, from each service regulator. Pressure gages are specified in Division 15 Section "Meters And Gages For Hvac Piping".

C. Indoor Piping Installation
1. Comply with NFPA 54 **OR** the International Fuel Gas Code, **as directed**, for installation and purging of natural-gas piping.
2. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
3. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
4. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
5. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
6. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
7. Locate valves for easy access.
8. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
9. Install piping free of sags and bends.
10. Install fittings for changes in direction and branch connections.
11. Install escutcheons at penetrations of interior walls, ceilings, and floors.
    a. New Piping:
       1) Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
       2) Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
          OR
          Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
       3) Piping at Ceiling Penetrations in Finished Spaces: One-piece **OR** Split-casting, **as directed**, cast-brass type with polished chrome-plated finish.
          OR

Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type **OR** Split-plate, stamped-steel type with concealed hinge, **as directed**, and set screw.

4) Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated **OR** rough-brass, **as directed**, finish.
OR
Piping in Unfinished Service Spaces: One-piece, stamped-steel type with set screw **OR** spring clips, **as directed**.

5) Piping in Equipment Rooms: One-piece, cast-brass type.

Piping in Equipment Rooms: One-piece, stamped-steel type with set screw **OR** spring clips, **as directed**.

6) Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

b. Existing Piping:

1) Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
OR
Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and spring clips.

2) Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
OR
Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.

3) Piping in Unfinished Service Spaces: Split-casting, cast-brass type with polished chrome-plated **OR** rough-brass, **as directed**, finish.
OR
Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed **OR** exposed-rivet, **as directed**, hinge and set screw or spring clips.

4) Piping in Equipment Rooms: Split-casting, cast-brass type.
OR
Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.

5) Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

12. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Through-penetration Firestop Systems".
13. Verify final equipment locations for roughing-in.
14. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
15. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
    a. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches (75 mm) long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
16. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
17. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
18. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

a. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
b. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches (38 mm) of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
c. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
d. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
    1) Exception: Tubing passing through partitions or walls does not require striker barriers.
e. Prohibited Locations:
    1) Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
    2) Do not install natural-gas piping in solid walls or partitions.

19. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
20. Connect branch piping from top or side of horizontal piping.
21. Install unions in pipes NPS 2 (DN 50) and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
22. Do not use natural-gas piping as grounding electrode.
23. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
24. Install pressure gage downstream **OR** upstream and downstream, **as directed**, from each line regulator. Pressure gages are specified in Division 15 Section "Meters And Gages For Hvac Piping".

D. Service-Meter Assembly Installation
1. Install service-meter assemblies aboveground, on concrete bases.
2. Install metal shutoff valves upstream from service regulators. Shutoff valves are not required at second regulators if two regulators are installed in series.
3. Install strainer on inlet of service-pressure regulator and meter set.
4. Install service regulators mounted outside with vent outlet horizontal or facing down. Install screen in vent outlet if not integral with service regulator.
5. Install metal shutoff valves upstream from service meters. Install dielectric fittings downstream from service meters.
6. Install service meters downstream from pressure regulators.
7. Install metal bollards to protect meter assemblies. Comply with requirements in Division 05 Section "Metal Fabrications" for pipe bollards.

E. Valve Installation
1. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
2. Install underground valves with valve boxes.
3. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
4. Install earthquake valves aboveground outside buildings according to listing.
5. Install anode for metallic valves in underground PE piping.

F. Piping Joint Construction
1. Ream ends of pipes and tubes and remove burrs.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

3. Threaded Joints:
   a. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
   b. Cut threads full and clean using sharp dies.
   c. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
   d. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
   e. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
4. Welded Joints:
   a. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
   b. Bevel plain ends of steel pipe.
   c. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
5. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
6. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.
7. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.
8. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
   a. Plain-End Pipe and Fittings: Use butt fusion.
   b. Plain-End Pipe and Socket Fittings: Use socket fusion.

G. Hanger And Support Installation
1. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 15 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
2. Comply with requirements for pipe hangers and supports specified in Division 15 Section "Hangers And Supports For Hvac Piping And Equipment".
3. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
   a. NPS 1 (DN 25) and Smaller: Maximum span, 96 inches (2438 mm); minimum rod size, 3/8 inch (10 mm).
   b. NPS 1-1/4 (DN 32): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
   c. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
   d. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): Maximum span, 10 feet (3 m); minimum rod size, 1/2 inch (13 mm).
   e. NPS 4 (DN 100) and Larger: Maximum span, 10 feet (3 m); minimum rod size, 5/8 inch (15.8 mm).
4. Install hangers for horizontal drawn-temper copper tubing with the following maximum spacing and minimum rod sizes:
   a. NPS 3/8 (DN 10): Maximum span, 48 inches (1220 mm); minimum rod size, 3/8 inch (10 mm).
   b. NPS 1/2 and NPS 5/8 (DN 15 and DN 18): Maximum span, 72 inches (1830 mm); minimum rod size, 3/8 inch (10 mm).
   c. NPS 3/4 and NPS 7/8 (DN 20 and DN 22): Maximum span, 84 inches (2134 mm); minimum rod size, 3/8 inch (10 mm).
   d. NPS 1 (DN 25): Maximum span, 96 inches (2440 mm); minimum rod size, 3/8 inch (10 mm).
5. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:

a. NPS 3/8 (DN 10): Maximum span, 48 inches (1220 mm); minimum rod size, 3/8 inch (10 mm).
b. NPS 1/2 (DN 15): Maximum span, 72 inches (1830 mm); minimum rod size, 3/8 inch (10 mm).
c. NPS 3/4 (DN 20) and Larger: Maximum span, 96 inches (2440 mm); minimum rod size, 3/8 inch (10 mm).

H. Connections
1. Connect to utility's gas main according to utility's procedures and requirements.
2. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
3. Install piping adjacent to appliances to allow service and maintenance of appliances.
4. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches (1800 mm) of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
5. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

I. Labeling And Identifying
1. Comply with requirements in Division 15 Section "Identification For Hvac Piping And Equipment" for piping and valve identification.
OR
Install detectable warning tape directly above gas piping, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

J. Painting
1. Comply with requirements in Division 07 for painting interior and exterior natural-gas piping.
2. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
a. Alkyd System: MPI EXT 5.1D.
1) Prime Coat: Alkyd anticorrosive metal primer.
2) Intermediate Coat (for a Premium Grade system): Exterior alkyd enamel matching topcoat.
3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
4) Color: Gray, **unless directed otherwise**.
3. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
a. Latex Over Alkyd Primer System: MPI INT 5.1Q.
1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
2) Intermediate Coat (for a Premium Grade system): Interior latex matching topcoat.
3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
4) Color: Gray, **unless directed otherwise**.
b. Alkyd System: MPI INT 5.1E.
1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
2) Intermediate Coat (for a Premium Grade system): Interior alkyd matching topcoat.
3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
4) Color: Gray, **unless directed otherwise**.
4. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

K. Concrete Bases
1. Concrete Bases: Anchor equipment to concrete base according to seismic codes at Project.

a. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.
c. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
d. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
e. Install anchor bolts to elevations required for proper attachment to supported equipment.
f. Use 3000-psig (20.7-MPa), **unless directed otherwise**, 28-day, compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-place Concrete".

L. Field Quality Control
1. Perform tests and inspections.
2. Tests and Inspections:
a. Test, inspect, and purge natural gas according to NFPA 54 **OR** the International Fuel Gas Code, **as directed**, and authorities having jurisdiction.
3. Natural-gas piping will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.

M. Outdoor Piping Schedule
1. Underground natural-gas piping shall be one of the following:
a. PE pipe and fittings joined by heat fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
b. Steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.
c. Annealed **OR** Drawn, **as directed**,-temper copper tube with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.
2. Aboveground natural-gas piping shall be one of the following:
a. Steel pipe with malleable-iron fittings and threaded joints.
b. Steel pipe with wrought-steel fittings and welded joints.
c. Annealed **OR** Drawn, **as directed**,-temper copper tube with wrought-copper fittings and brazed joints.
3. Branch Piping in Cast-in-Place Concrete to Single Appliance: Annealed-temper copper tube with wrought-copper fittings and brazed **OR** flared, **as directed**, joints. Install piping embedded in concrete with no joints in concrete.
4. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

N. Indoor Piping Schedule For System Pressures Less Than 0.5 psig (3.45 kPa)
1. Aboveground, branch piping NPS 1 (DN 25) and smaller shall be one of the following:
a. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
b. Annealed-temper, tin-lined copper tube with flared joints and fittings.
c. Annealed-temper, copper tube with wrought-copper fittings and brazed **OR** flared, **as directed**, joints.
d. Aluminum tube with flared fittings and joints.
e. Steel pipe with malleable-iron fittings and threaded joints.
2. Aboveground, distribution piping shall be one of the following:
a. Steel pipe with malleable-iron fittings and threaded joints.
b. Steel pipe with wrought-steel fittings and welded joints.
c. Drawn-temper copper tube with wrought-copper fittings and brazed joints.
3. Underground, below building, piping shall be one of the following:
a. Steel pipe with malleable-iron fittings and threaded joints.
b. Steel pipe with wrought-steel fittings and welded joints.

4. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
5. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

O. Indoor Piping Schedule For System Pressures More Than 0.5 psig (3.45 kPa) And Less Than 5 psig (34.5 kPa)
1. Aboveground, branch piping NPS 1 (DN 25) and smaller shall be one of the following:
   a. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
   b. Annealed-temper, tin-lined copper tube with flared joints and fittings.
   c. Annealed-temper, copper tube with wrought-copper fittings and brazed **OR** flared, **as directed**, joints.
   d. Aluminum tube with flared fittings and joints.
   e. Steel pipe with malleable-iron fittings and threaded joints.
2. Aboveground, distribution piping shall be one of the following:
   a. Steel pipe with malleable-iron fittings and threaded joints.
   b. Steel pipe with steel welding fittings and welded joints.
   c. Drawn-temper copper tube with wrought-copper fittings and brazed joints.
3. Underground, below building, piping shall be one of the following:
   a. Steel pipe with malleable-iron fittings and threaded joints.
   b. Steel pipe with wrought-steel fittings and welded joints.
4. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat underground pipe and fittings with protective coating for steel piping.
5. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

P. Indoor Piping Schedule For System Pressures More Than 5 psig (34.5 kPa)
1. Aboveground Piping: Maximum operating pressure more than 5 psig (34.5 kPa).
2. Aboveground, Branch Piping: Steel pipe with steel welding fittings and welded joints.
3. Aboveground, distribution piping shall be one of the following:
   a. Steel pipe with steel welding fittings and welded joints.
   b. Drawn-temper copper tube with wrought-copper fittings and brazed joints.
4. Underground, below building, piping shall be one of the following:
   a. Steel pipe with malleable-iron fittings and threaded joints.
   b. Steel pipe with wrought-steel fittings and welded joints.
5. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
6. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

Q. Underground Manual Gas Shutoff Valve Schedule
1. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.
2. Underground:
   a. PE valves.
   b. NPS 2 (DN 50) and Smaller: Bronze plug valves.
   c. NPS 2-1/2 (DN 65) and Larger: Cast-iron, lubricated **OR** nonlubricated, **as directed**, plug valves.

R. Aboveground Manual Gas Shutoff Valve Schedule
1. Valves for pipe sizes NPS 2 (DN 50) and smaller at service meter shall be one of the following:

a. One-piece, bronze ball valve with bronze trim.
b. Two-piece, full **OR** regular, **as directed**,-port, bronze ball valves with bronze trim.
c. Bronze plug valve.

2. Valves for pipe sizes NPS 2-1/2 (DN 65) and larger at service meter shall be one of the following:
   a. Two-piece, full **OR** regular, **as directed**,-port, bronze ball valves with bronze trim.
   b. Bronze plug valve.
   c. Cast-iron, nonlubricated plug valve.
3. Distribution piping valves for pipe sizes NPS 2 (DN 50) and smaller shall be one of the following:
   a. One-piece, bronze ball valve with bronze trim.
   b. Two-piece, full **OR** regular, **as directed**,-port, bronze ball valves with bronze trim.
   c. Bronze plug valve.
4. Distribution piping valves for pipe sizes NPS 2-1/2 (DN 65) and larger shall be one of the following:
   a. Two-piece, full **OR** regular, **as directed**,-port, bronze ball valves with bronze trim.
   b. Bronze plug valve.
   c. Cast-iron, nonlubricated **OR** lubricated, **as directed**, plug valve.
5. Valves in branch piping for single appliance shall be one of the following:
   a. One-piece, bronze ball valve with bronze trim.
   b. Two-piece, full **OR** regular, **as directed**,-port, bronze ball valves with bronze trim.
   c. Bronze plug valve.

END OF SECTION 02551

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SECTION 02551a - FACILITY LIQUEFIED-PETROLEUM GAS PIPING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for facility liquid-petroleum gas piping. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Pipes, tubes, and fittings.
b. Piping specialties.
c. Piping and tubing joining materials.
d. Valves.
e. Pressure regulators.
f. Service meters.
g. Storage containers.
h. Transport truck unloading facility specialties.
i. Pumps.
j. Vaporizers.
k. Air mixers.
l. Mechanical sleeve seals.
m. Grout.
n. Concrete bases.

C. Definitions
1. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
2. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
3. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
4. LPG: Liquefied-petroleum gas.

D. Performance Requirements
1. Minimum Operating-Pressure Ratings:
a. For Piping Containing Only Vapor:
1) Piping and Valves: 125 psig (862 kPa) unless otherwise indicated.
b. For Piping Containing Liquid:
1) Piping between Shutoff Valves: 350 psig (2413 kPa) unless otherwise indicated.
2) Piping Other Than Above: 250 psig (1723 kPa) unless otherwise indicated.
3) Valves and Fittings: 250 psig (1723 kPa) unless otherwise indicated.
c. Minimum Operating Pressure of Service Meter: 5 psig (34.5 kPa) **OR** 10 psig (69 kPa) **OR** 20 psig (138 kPa) **OR** 65 psig (450 kPa), **as directed**.
2. LPG System Pressure within Buildings: One pressure range. 0.5 psig (3.45 kPa) or less **OR** More than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa) **OR** More than 2 psig (13.8 kPa) but not more than 5 psig (34.5 kPa), **as directed**.
OR
LPG System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa) and is reduced to secondary pressure of 0.5 psig (3.45 kPa) or less.

OR

LPG System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 2 psig (13.8 kPa) but not more than 5 psig (34.5 kPa) and is reduced to secondary pressure of more than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa).

OR

LPG System Pressures within Buildings: Three pressure ranges. Primary pressure is more than 2 psig (13.8 kPa) but not more than 5 psig (34.5 kPa) and is reduced to secondary pressures of more than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa) and is reduced again to pressures of 0.5 psig (3.45 kPa) or less.

3. Delegated Design: Design restraints and anchors for LPG piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
4. Seismic Performance: Vaporizers and storage container supports shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

E. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: For facility LPG piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
3. Delegated-Design Submittal: For LPG piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   a. Detail fabrication and assembly of seismic restraints.
   b. Design Calculations: Calculate requirements for selecting seismic restraints.
4. Seismic Qualification Certificates: Submit certification that vaporizer, air mixer, storage container supports, accessories, and components will withstand seismic forces defined in Division 15 Section "Vibration And Seismic Controls For Hvac Piping And Equipment". Include the following:
   a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
5. Welding certificates.
6. Field quality-control reports.
7. Operation and maintenance data.

F. Quality Assurance
1. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Delivery, Storage, And Handling
1. Handling Flammable Liquids: Remove and dispose of liquids from existing LPG piping according to requirements of authorities having jurisdiction.
2. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

3. Store pipes and tubes with protective PE coating to avoid damaging coating and protect from direct sunlight.
4. Protect stored PE pipes and valves from direct sunlight.

H. Project Conditions
1. Interruption of Existing LPG Service: Do not interrupt LPG service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of LPG supply according to requirements indicated:
   a. Notify Owner no fewer than two days in advance of proposed interruption of LPG service.
   b. Do not proceed with interruption of LPG service without Owner's written permission.

1.2 PRODUCTS

A. Pipes, Tubes, And Fittings
1. Steel Pipe: ASTM A 53/A 53M, black steel, Schedules 40 and 80, Type E or S, Grade B.
   a. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
   b. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
   c. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
   d. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
      1) Material Group: 1.1.
      2) End Connections: Threaded or butt welding to match pipe.
      3) Lapped Face: Not permitted underground.
      4) Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
      5) Bolts and Nuts: ASME B18.2.1, carbon steel aboveground, and stainless steel underground.
   e. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
      1) Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
   f. Mechanical Couplings:
      1) Stainless-steel **OR** Steel, **as directed**, flanges and tube with epoxy finish.
      2) Buna-nitrile seals.
      3) Stainless-steel **OR** Steel, **as directed**, bolts, washers, and nuts.
      4) Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
      5) Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.
2. Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC 1.
   a. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.
   b. Coating: PE with flame retardant.
      1) Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
         a) Flame-Spread Index: 25 or less.
         b) Smoke-Developed Index: 50 **OR** 450, **as directed**, or less.
   c. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
   d. Striker Plates: Steel, designed to protect tubing from penetrations.
   e. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
   f. Operating-Pressure Rating: 5 psig (34.5 kPa).
3. Aluminum Tubing: Comply with ASTM B 210 and ASTM B 241/B 241M.

a. Aluminum Alloy: Alloy 5456 is prohibited.
b. Protective Coating: Factory-applied coating capable of resisting corrosion on tubing in contact with masonry, plaster, insulation, water, detergents, and sewerage.
c. Flare Fittings: Comply with ASME B16.26 and SAE J513.
   1) Copper-alloy fittings.
   2) Metal-to-metal compression seal without gasket.
   3) Dryseal threads shall comply with ASME B1.20.3.

4. Drawn-Temper Copper Tube: Comply with ASTM B 88, Type K (ASTM B 88M, Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B) **OR** ASTM B 837, Type G, **as directed**.
   a. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.
   b. Bronze Flanges and Flanged Fittings: ASME B16.24, Class 150.
      1) Gasket Material: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
      2) Bolts and Nuts: ASME B18.2.1, carbon steel or stainless steel.
   c. Protective Coating for Underground Tubing: Factory-applied, extruded PE a minimum of 0.022 inch (0.56 mm) thick.
5. Annealed-Temper Copper Tube: Comply with ASTM B 88, Type K (ASTM B 88M, Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B) **OR** ASTM B 837, Type G, **as directed**.
   a. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.
   b. Flare Fittings: Comply with ASME B16.26 and SAE J513.
      1) Copper fittings with long nuts.
      2) Metal-to-metal compression seal without gasket.
      3) Dryseal threads complying with ASME B1.20.3.
   c. Protective Coating for Underground Tubing: Factory-applied, extruded PE a minimum of 0.022 inch (0.56 mm) thick.
6. Tin-Lined Copper Tube: ASTM B 280, seamless, annealed, with interior tin-plated lining.
   a. Flare Fittings: Comply with ASME B16.26 and SAE J513.
      1) Copper fittings with long nuts.
      2) Metal-to-metal compression seal without gasket.
      3) Dryseal threads complying with ASME B1.20.3.
7. PE Pipe: ASTM D 2513, SDR 11.
   a. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
   b. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
   c. Anodeless Service-Line Risers: Factory fabricated and leak tested.
      1) Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.
      2) Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B with corrosion-protective coating covering. Vent casing aboveground, **as directed**.
      3) Aboveground Portion: PE transition fitting.
      4) Outlet shall be threaded or flanged or suitable for welded connection.
      5) Tracer wire connection.
      6) Ultraviolet shield.
      7) Stake supports with factory finish to match steel pipe casing or carrier pipe.
   d. Transition Service-Line Risers: Factory fabricated and leak tested.
      1) Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
      2) Outlet shall be threaded or flanged or suitable for welded connection.
      3) Bridging sleeve over mechanical coupling.
      4) Factory-connected anode.
      5) Tracer wire connection.
      6) Ultraviolet shield.

7) Stake supports with factory finish to match steel pipe casing or carrier pipe.

e. Plastic Mechanical Couplings, NPS 1-1/2 (DN 40) and Smaller: Capable of joining PE pipe to PE pipe.
1) PE body with molded-in, stainless-steel support ring.
2) Buna-nitrile seals.
3) Acetal collets.
4) Electro-zinc-plated steel stiffener.

f. Plastic Mechanical Couplings, NPS 2 (DN 50) and Larger: Capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
1) Fiber-reinforced plastic body.
2) PE body tube.
3) Buna-nitrile seals.
4) Acetal collets.
5) Stainless-steel bolts, nuts, and washers.

8. Steel Mechanical Couplings: Capable of joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
1) Stainless-steel **OR** Steel, **as directed**, flanges and tube with epoxy finish.
2) Buna-nitrile seals.
3) Stainless-steel **OR** Steel, **as directed**, bolts, washers, and nuts.
4) Factory-installed anode for steel-body couplings installed underground.

B. Piping Specialties
1. Flexible Piping Joints:
a. Approved for LPG service.
b. Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
c. Minimum working pressure of 250 psig (1723 kPa) and 250 deg F (121 deg C) operating temperature.
d. Flanged- or threaded-end connections to match equipment connected and shall be capable of minimum 3/4-inch (20-mm) misalignment.
e. Maximum 36-inch (914-mm) length for liquid LPG lines.
2. Appliance Flexible Connectors:
a. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
b. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
c. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
d. Corrugated stainless-steel tubing with polymer coating.
e. Operating-Pressure Rating: 0.5 psig (3.45 kPa).
f. End Fittings: Zinc-coated steel.
g. Threaded Ends: Comply with ASME B1.20.1.
h. Maximum Length: 72 inches (1830 mm).
3. Quick-Disconnect Devices: Comply with ANSI Z21.41.
a. Copper-alloy convenience outlet and matching plug connector.
b. Nitrile seals.
c. Hand operated with automatic shutoff when disconnected.
d. For indoor or outdoor applications.
e. Adjustable, retractable restraining cable.
4. Y-Pattern Strainers:
a. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
b. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
c. Strainer Screen: 40 **OR** 60, **as directed**,-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
d. CWP Rating: 125 psig (862 kPa).
5. Basket Strainers:
a. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.

b. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
c. Strainer Screen: 40 **OR** 60, **as directed**,-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
d. CWP Rating: 125 psig (862 kPa).

6. T-Pattern Strainers:
a. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
b. End Connections: Grooved ends.
c. Strainer Screen: 40 **OR** 60, **as directed**,-mesh startup strainer and perforated stainless-steel basket with 57 percent free area.
d. CWP Rating: 750 psig (5170 kPa).

7. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

C. Joining Materials
1. Joint Compound and Tape: Suitable for LPG.
2. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
3. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F (540 deg C) complying with AWS A5.8/A5.8M.

D. Manual Gas Shutoff Valves
1. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
2. Metallic Valves, NPS 2 (DN 50) and Smaller for Liquid Service: Comply with ASME B16.33 and UL 842.
a. CWP Rating: 250 psig (1723 kPa).
b. Threaded Ends: Comply with ASME B1.20.1.
c. Socket ends for brazed joints.
d. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
e. Listing by CSA or agency acceptable to authorities having jurisdiction for valves 1 inch (25 mm) and smaller.
f. Valves 1-1/4 inch (32 mm) and larger shall be suitable for LPG service, with "WOG" indicated on valve body.

3. General Requirements for Metallic Valves, NPS 2 (DN 50) and Smaller for Vapor Service: Comply with ASME B16.33.
a. CWP Rating: 125 psig (862 kPa).
b. Threaded Ends: Comply with ASME B1.20.1.
c. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
d. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
e. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch (25 mm) and smaller.
f. Service Mark: Valves 1-1/4 inch (32 mm) to NPS 2 (DN 50) shall have initials "WOG" permanently marked on valve body.

4. General Requirements for Metallic Valves, NPS 2-1/2 (DN 65) and Larger: Comply with ASME B16.38.
a. CWP Rating: 125 psig (862 kPa).
b. Flanged Ends: Comply with ASME B16.5 for steel flanges.
c. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
d. Service Mark: Initials "WOG" shall be permanently marked on valve body.

5. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
   a. Body: Bronze, complying with ASTM B 584.
   b. Ball: Chrome-plated brass.
   c. Stem: Bronze; blowout proof.
   d. Seats: Reinforced TFE; blowout proof.
   e. Packing: Separate packnut with adjustable-stem packing threaded ends.
   f. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   g. CWP Rating: 600 psig (4143 kPa).
   h. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
   i. Service: Suitable for LPG service with "WOG" indicated on valve body.
6. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
   a. Body: Bronze, complying with ASTM B 584.
   b. Ball: Chrome-plated bronze.
   c. Stem: Bronze; blowout proof.
   d. Seats: Reinforced TFE; blowout proof.
   e. Packing: Threaded-body packnut design with adjustable-stem packing.
   f. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   g. CWP Rating: 600 psig (4143 kPa).
   h. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
   i. Service: Suitable for LPG service with "WOG" indicated on valve body.
7. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.
   a. Body: Bronze, complying with ASTM B 584.
   b. Ball: Chrome-plated bronze
   c. Stem: Bronze; blowout proof.
   d. Seats: Reinforced TFE.
   e. Packing: Threaded-body packnut design with adjustable-stem packing.
   f. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   g. CWP Rating: 600 psig (4140 kPa).
   h. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
   i. Service: Suitable for LPG service with "WOG" indicated on valve body.
8. Bronze Plug Valves: MSS SP-78.
   a. Body: Bronze, complying with ASTM B 584.
   b. Plug: Bronze.
   c. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   d. Operator: Square head or lug type with tamperproof feature where indicated.
   e. Pressure Class: 125 psig (862 kPa).
   f. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
   g. Service: Suitable for LPG service with "WOG" indicated on valve body.
9. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.
   a. Body: Cast iron, complying with ASTM A 126, Class B.
   b. Plug: Bronze or nickel-plated cast iron.
   c. Seat: Coated with thermoplastic.
   d. Stem Seal: Compatible with LPG.
   e. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   f. Operator: Square head or lug type with tamperproof feature where indicated.
   g. Pressure Class: 125 psig (862 kPa).

h. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
i. Service: Suitable for LPG service with "WOG" indicated on valve body.

10. Cast-Iron, Lubricated Plug Valves: MSS SP-78.
    a. Body: Cast iron, complying with ASTM A 126 Class B.
    b. Plug: Bronze or nickel-plated cast iron.
    c. Seat: Coated with thermoplastic.
    d. Stem Seal: Compatible with LPG.
    e. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
    f. Operator: Square head or lug type with tamperproof feature where indicated.
    g. Pressure Class: 125 psig (862 kPa).
    h. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
    i. Service: Suitable for LPG service with "WOG" indicated on valve body.
11. PE Ball Valves: Comply with ASME B16.40.
    a. Body: PE.
    b. Ball: PE.
    c. Stem: Acetal.
    d. Seats and Seals: Nitrile.
    e. Ends: Plain or fusible to match piping.
    f. CWP Rating: 80 psig (552 kPa).
    g. Operating Temperature: Minus 20 to plus 140 deg F (Minus 29 to plus 60 deg C).
    h. Operator: Nut or flat head for key operation.
    i. Include plastic valve extension.
    j. Include tamperproof locking feature for valves where indicated on Drawings.
12. Valve Boxes:
    a. Cast-iron, two-section box.
    b. Top section with cover with "GAS" lettering.
    c. Bottom section with base to fit over valve and barrel a minimum of 5 inches (125 mm) in diameter.
    d. Adjustable cast-iron extensions of length required for depth of bury.
    e. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head and with stem of length required to operate valve.

E. Motorized Gas Valves
1. Hydrostatic Relief Valves: Comply with NFPA 58.
    a. Operating Pressure: 350 psig (2413 kPa).
    b. Body: Brass.
    c. Spring: Stainless steel.
    d. Disc and Seat: Nitrile.
    e. Brass body and stainless-steel, spring-operated valve with resilient rubber disc seat and protective cap.
    f. Factory set and tested.
    g. Listing: Valves listed and labeled by an NRTL acceptable to authorities having jurisdiction.
    h. Valve shall reseat after relieving pressure.
2. Automatic Gas Valves: Comply with ANSI Z21.21.
    a. Body: Brass or aluminum.
    b. Seats and Disc: Nitrile rubber.
    c. Springs and Valve Trim: Stainless steel.
    d. Normally closed.
    e. Visual position indicator.
    f. Electrical **OR** Mechanical, **as directed**, operator for actuation by appliance automatic shutoff device.
3. Electrically Operated Valves: Comply with UL 429.

a. Pilot operated.
b. Body: Brass or aluminum.
c. Seats and Disc: Nitrile rubber.
d. Springs and Valve Trim: Stainless steel.
e. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, replaceable.
f. NEMA ICS 6, Type 4, coil enclosure.
g. Normally closed.
h. Visual position indicator.

F. Earthquake Valves
1. Earthquake Valves: Comply with ASCE 25.
a. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
b. Maximum Operating Pressure: 5 psig (34.5 kPa).
c. Cast-aluminum body with nickel-plated chrome steel internal parts.
d. Nitrile-rubber valve washer.
e. Sight windows for visual indication of valve position.
f. Threaded-end connections complying with ASME B1.20.1.
2. Earthquake Valves: Comply with ASCE 25.
a. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
b. Maximum Operating Pressure: 0.5 psig (3.45 kPa) **OR** 7 psig (48 kPa) **OR** 60 psig (414 kPa), **as directed**.
c. Cast-aluminum body with stainless-steel internal parts.
d. Nitrile-rubber, reset-stem o-ring seal.
e. Valve position, open or closed, indicator.
f. Composition valve seat with clapper held by spring or magnet locking mechanism.
g. Level indicator.
h. End Connections: Threaded for valves NPS 2 (DN 50) and smaller; flanged for valves NPS 2-1/2 (DN 65) and larger.

G. Pressure Regulators
1. General Requirements:
a. Single stage and suitable for LPG.
b. Steel jacket and corrosion-resistant components.
c. Elevation compensator.
d. End Connections: Threaded for regulators NPS 2 (DN 50) and smaller; flanged for regulators NPS 2-1/2 (DN 65) and larger.
2. Service Pressure Regulators: Comply with ANSI Z21.80.
a. Body and Diaphragm Case: Cast iron or die-cast aluminum.
b. Springs: Zinc-plated steel; interchangeable.
c. Diaphragm Plate: Zinc-plated steel.
d. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
e. Orifice: Aluminum; interchangeable.
f. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
g. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet and no pressure sensing piping external to the regulator.
h. Pressure regulator shall maintain discharge pressure setting downstream and not exceed 150 percent of design discharge pressure at shutoff.
i. Overpressure Protection Device: Factory mounted on pressure regulator.
j. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
k. Maximum Inlet Pressure: 100 psig (690 kPa).
3. Line Pressure Regulators: Comply with ANSI Z21.80.
a. Body and Diaphragm Case: Cast iron or die-cast aluminum.
b. Springs: Zinc-plated steel; interchangeable.
c. Diaphragm Plate: Zinc-plated steel.

d. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
e. Orifice: Aluminum; interchangeable.
f. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
g. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet and no pressure sensing piping external to the regulator.
h. Pressure regulator shall maintain discharge pressure setting downstream and not exceed 150 percent of design discharge pressure at shutoff.
i. Overpressure Protection Device: Factory mounted on pressure regulator.
j. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
k. Maximum Inlet Pressure: 2 psig (13.8 kPa) **OR** 5 psig (34.5 kPa) **OR** 10 psig (69 kPa), **as directed**.

4. Appliance Pressure Regulators: Comply with ANSI Z21.18.
a. Body and Diaphragm Case: Die-cast aluminum.
b. Springs: Zinc-plated steel; interchangeable.
c. Diaphragm Plate: Zinc-plated steel.
d. Seat Disc: Nitrile rubber.
e. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
f. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
g. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
h. Maximum Inlet Pressure: 1 psig (6.9 kPa) **OR** 2 psig (13.8 kPa) **OR** 5 psig (34.5 kPa-), **as directed**.

H. Service Meters
1. Diaphragm-Type Service Meters: Comply with ANSI B109.1 **OR** ANSI B109.2, **as directed**.
a. Case: Die-cast aluminum.
b. Connections: Steel threads.
c. Diaphragm: Synthetic fabric.
d. Diaphragm Support Bearings: Self-lubricating.
e. Compensation: Continuous temperature and pressure, **as directed**.
f. Meter Index: Cubic feet **OR** Liters **OR** Cubic feet and liters, **as directed**.
g. Meter Case and Index: Tamper resistant.
h. Remote meter reader compatible.
i. Maximum Inlet Pressure: 100 psig (690 kPa).
j. Pressure Loss: Maximum 0.5-inch wg (124 Pa) **OR** 2.0-inch wg (498 Pa), **as directed**.
k. Accuracy: Maximum plus or minus 1.0 percent.
2. Rotary-Type Service Meters: Comply with ANSI B109.3.
a. Case: Extruded aluminum.
b. Connection: Flange.
c. Impellers: Polished aluminum.
d. Rotor Bearings: Self-lubricating.
e. Compensation: Continuous temperature and pressure, **as directed**.
f. Meter Index: Cubic feet **OR** Liters **OR** Cubic feet and liters, **as directed**.
g. Tamper resistant.
h. Remote meter reader compatible.
i. Maximum Inlet Pressure: 100 psig (690 kPa).
j. Accuracy: Maximum plus or minus 2.0 percent.
3. Turbine Meters: Comply with ASME MFC-4M.
a. Housing: Cast iron or welded steel.
b. Connection Threads or Flanges: Steel.
c. Turbine: Aluminum or plastic.
d. Turbine Bearings: Self-lubricating.
e. Compensation: Continuous temperature and pressure, **as directed**.

f. Meter Index: Cubic feet **OR** Liters **OR** Cubic feet and liters, **as directed**.
g. Tamper resistant.
h. Remote meter reader compatible.
i. Maximum Inlet Pressure: 100 psig (690 kPa).
j. Accuracy: Maximum plus or minus 2.0 percent.

4. Service-Meter Bars:
   a. Malleable- or cast-iron frame for supporting service meter.
   b. Include offset swivel pipes, meter nuts with o-ring seal, and factory- or field-installed dielectric unions.
   c. Omit meter offset swivel pipes if service-meter bar dimensions match service-meter connections.
5. Service-Meter Bypass Fittings:
   a. Ferrous, tee, pipe fitting with capped side inlet for temporary LPG supply.
   b. Integral ball-check bypass valve.

I. Dielectric Fittings
1. Dielectric Unions:
   a. Minimum Operating-Pressure Rating: 150 psig (1034 kPa).
   b. Combination fitting of copper alloy and ferrous materials.
   c. Insulating materials suitable for LPG.
   d. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.
2. Dielectric Flanges:
   a. Minimum Operating-Pressure Rating: 150 psig (1034 kPa).
   b. Combination fitting of copper alloy and ferrous materials.
   c. Insulating materials suitable for LPG.
   d. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.
3. Dielectric-Flange Kits:
   a. Minimum Operating-Pressure Rating: 150 psig (1034 kPa).
   b. Companion-flange assembly for field assembly.
   c. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or PE bolt sleeves, phenolic washers, and steel backing washers.
   d. Insulating materials suitable for LPG.
   e. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

J. Storage Containers
1. Description: Factory fabricated, complying with requirements in NFPA 58 and ASME Boiler and Pressure Vessel Code and bearing the ASME label. Tanks shall be rated for 250-psig (1723-kPa) minimum working pressure.
   a. Liquid outlet and vapor inlet and outlet connections shall have shutoff valves with excess-flow safety shutoff valves and bypass and back-pressure check valves with smaller than 0.039-inch (1-mm) drill-size hole to equalize pressure. Liquid-fill connection shall have backflow check valve.
      1) Connections: Color-code and tag valves to indicate type.
         a) Liquid fill and outlet, red.
         b) Vapor inlet and outlet, yellow.
   b. Level gage shall indicate current level of liquid in the container. Gages shall also indicate storage container contents; e.g., "Butane," "50-50 LPG Mix," or "Propane."
   c. Pressure relief valves, type and number as required by NFPA 58, connected to vapor space and having discharge piping same size as relief-valve outlet and long enough to extend at least 84 inches (2130 mm) directly overhead. Identify relief valves as follows:
      1) Discharge pressure in psig (kPa).
      2) Rate of discharge for standard air in cfm (L/s).
      3) Manufacturer's name.

4) Catalog or model number.

d. Container pressure gage.

e. For outdoor installation, exposed metal surfaces mechanically cleaned, primed, and painted for resistance to corrosion.

f. Ladders for access to valves more than 72 inches (1830 mm) aboveground.

g. Stainless-Steel Nameplate: Attach to aboveground storage container or to adjacent structure for underground storage container.

1) Name and address of supplier or trade name of container.
2) Water capacity in gallons and liters.
3) Design pressure in psig (kPa).
4) Statement, "This container shall not contain a product having a vapor pressure in excess of <**Insert maximum pressure in psig (kPa) at 100 deg F (37.8 deg C)**>."
5) Outside surface area in sq. ft. (sq. m).
6) Year of manufacture.
7) Shell thickness in inches (mm).
8) Overall length in feet (m).
9) OD in feet (m).
10) Manufacturer's serial number.
11) ASME Code label.

h. Felt support pads and two concrete or painted-steel saddles per storage container. Corrosion protection required at container-to-felt contact.

i. Tie straps for each saddle.

j. Straps and anchors for tie-down slab.

k. Asphalt-based coating for corrosion protection.

l. Container connections and valves protected in manway at top of storage container.

m. Manway equipped with ventilation louvers.

K. Transport Truck Unloading Facility

1. Description: Comply with requirements in NFPA 58.
   a. Support structure consisting of a minimum 6-inch (150-mm) steel channel or 6-by-4-inch (150-by-100-mm) rectangular steel tubing, a minimum of 36 inches (914 mm) above and below grade.
   b. Liquid-fill and vapor-return, quick-disconnect fittings.
   c. Liquid and vapor shutoff valves with hydrostatic relief valves mounted between the quick-disconnect fittings and shutoff valves.
   d. Excess-flow safety shutoff valve in vapor-return line.
   e. Backflow check valve in liquid-fill line.
   f. Remote emergency shutoff valve station with underground cable to the vapor emergency shutoff valve.

L. Pumps

1. Description: Factory-assembled and -tested, duplex, positive-displacement, belt drive.
2. Pump Construction:
   a. Casing: Ductile-iron casing with threaded gage tappings at inlet and outlet.
   b. Internal Pressure Relief Valve: For pump protection in addition to the external pressure relief valves.
   c. Impeller: Carbon or composite vane in cast-iron rotor.
   d. Pump Shaft: Carbon steel.
   e. Seal: Mechanical with Buna-N o-ring.
   f. Pump Bearings: Ball bearings with grease fittings.
   g. Baseplate: Bent carbon-steel channel or structural channel.
3. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 15 Section "Common Motor Requirements For Hvac Equipment".

a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 15.
c. Motor Speeds: Single.
d. Bearings: Permanently lubricated **OR** Grease-lubricated, **as directed**, ball bearings.
e. Class I, Division 1, Group D requirements per NFPA 70.

4. Factory-Installed Piping and Specialties:
   a. Pipe: ASTM A 53/A 53M, Type E or S, Grade B; Schedule 40 black steel with welded fittings and joints or Schedule 80 for threaded malleable-iron fittings and joints.
   b. Piping Specialties for Each Pump:
      1) Bypass valve.
      2) Isolation valves.
      3) Unions for each connection.
      4) Check valve.
      5) Basket strainer.
      6) Pressure gages for suction and discharge connections.
      7) Hydrostatic relief valve.
      8) Pilot-operated, pressure-regulating valve.
5. Braided-jacket flexible connectors for suction and discharge connections.
6. Pump and Piping Finish: For outdoor installation, exposed metal surfaces mechanically cleaned, primed, and painted for resistance to corrosion.
7. Controls:
   a. Explosion-proof controls enclosure.
   b. Magnetic starter package with automatic alternator.
   c. Pressure-activated start and stop.
   d. Lag pump starts if lead pump fails.
   e. Audible and visual indication of pump failure.

M. Vaporizers
1. Description: Factory-fabricated, -assembled, and -tested vaporizer with heat exchanger sealed pressure-tight, built on a steel base; including insulated jacket, flue-gas vent, liquid fuel supply and vapor connections, and controls. Assembly shall be FMG labeled and comply with NFPA 58 and NFPA 70.
2. Fabricate base and attachment to vaporizers with reinforcement strong enough to resist vaporizer movement during a seismic event when steel base is anchored to a concrete base.
3. Casing:
   a. Mineral-fiber insulation, a minimum of 2 inches (50 mm) thick, surrounding the heat exchanger.
   b. Integral one-piece skid with forklift access holes.
   c. Lifting lugs on top of vaporizer.
   d. Flue rain cap and bird screen.
   e. Sheet metal jacket with screw-fastened closures and baked-enamel **OR** powder-coat, **as directed**, protective finish.
   f. Mounting base to secure boiler to concrete base.
   g. Control Compartment Enclosure: NEMA 250, Type 4, enclosure housing control panels for LPG-fired vaporizers. Explosion-proof control compartment construction required for electric vaporizers.
4. LPG Liquid and Vapor Circuit Specialties:
   a. Y-type strainer with drain valve at inlet.
   b. Vaporizer coil safety pressure relief valve.
   c. Vaporizer coil blowdown valve.
   d. Vapor outlet isolation valve.
   e. Pressure gages, a minimum of 2-1/2 inches (63 mm) in diameter, at liquid inlet and vapor discharge. Gages shall have operating-temperature ranges so normal operating range is at approximately 50 percent of full range.

f. Inlet safety solenoid valve to close with off-normal operation alarm.
g. Backflow check valve in bypass around inlet safety solenoid valve.
h. Liquid carryover or float-type safety shutoff switch.
i. LPG Vapor Filter: Steel shell designed and manufactured per ASME Boiler and Pressure Vessel Code, Section VIII, Division 1; factory mounted on vaporizer discharge. Shells larger than 5 inches (125 mm) shall be ASME "U" stamped. Fill with stainless-steel, woven-mesh coalescing element to remove 99 percent of particles larger than 10 microns. 250-psig (1723-kPa) minimum working pressure. Finish with corrosion-resistant coating for an exterior application. Include factory-mounted and -piped, differential pressure gage with gage cocks in and out, and minimum NPS 3/4 (DN 20) full-port, ball-type drain valve.

5. Direct-Type, Direct-Fired Heat Exchanger:
   a. Description: ASME-rated and -stamped, LPG, vaporizer coil contained in an enclosure insulated with at least 2-inch- (50-mm-) thick, mineral-fiber board enclosure with a burner.
   b. Burner Tubes and Orifices: Stainless steel.
      1) Gas Train: Control devices and burner control sequence shall be FMG labeled. Include shutoff valve, high- and low-pressure safety switches, pressure regulator, and main- and pilot-control valves.
      2) Pilot: Standing pilot with 100 percent main-valve and pilot safety shutoff.
   c. Burner Operating Controls:
      1) Controls shall maintain safe operating conditions. Mechanical burner safety controls limit operation of the burner.
      2) High-Pressure Cutoff: Manual reset stops burner if operating conditions rise above maximum design pressure.
      3) Operating Vapor-Pressure Control: Factory piped and mounted to control burner.
6. Indirect-Type, Direct-Fired Heat Exchanger:
   a. Description: ASME-rated and -stamped, LPG, vaporizer vessel with a replaceable, immersion-type, electric heating element.
   b. Heating Element Operating Controls:
      1) Operating controls shall maintain safe operating conditions. Safety controls limit operation of the element. Microprocessor-based control system integrates safety and operating controls, **as directed**.
      2) Operating Vapor-Pressure Control: Factory wired and mounted to control heating element.
      3) High-Pressure Cutoff: Manual reset stops burner if operating conditions rise above maximum design pressure.
      4) Alarm Bell and Rotary Beacon: Factory mounted on control panel with silence switch; shall sound alarm for out-of-normal conditions.
      5) Control Transformer: 115-V maximum control voltage.
7. Direct-Type, Water-Bath Heat Exchanger:
   a. Description: Straight, steel fire tubes welded into steel headers with ASME-rated and -stamped, helical, LPG, vaporizer coil submerged in water bath. Include the following:
      1) Water bath filled with water/glycol solution designed to prevent freezing at minus 30 deg F (minus 34 deg C).
      2) Water-bath, high- and low-level sight glasses.
      3) Low-water cutoff to stop burner and annunciate alarm.
      4) Water/glycol fill and vent fitting.
      5) Minimum NPS 3/4 (DN 20) hose-end drain valves.
      6) Operating high- and low-limit aquastat controllers.
      7) Water-bath temperature gage; a minimum of 2-1/2 inches (63 mm) in diameter. Gages shall have operating-temperature ranges so normal operating range is at approximately 50 percent of full range.
   b. Burner Tubes and Orifices: Stainless steel.
      1) Gas Train: Control devices and burner modulation control sequence shall be FMG labeled. Include shutoff valve, high- and low-pressure safety switches, pressure regulator, and main- and pilot-control valves.

2) Pilot: Intermittent-electric-spark **OR** Hot-surface, **as directed**, pilot ignition with 100 percent main-valve and pilot safety shutoff with electronic supervision of burner flame.

c. Burner Operating Controls:

1) Operating controls shall maintain safe operating conditions. Safety controls limit operation of the burner. Microprocessor-based control system integrates safety and operating controls, **as directed**.

2) Operating Water-Bath Temperature Control: Factory wired and mounted to control burner.

3) High-Temperature and High-Pressure Cutoff: Manual reset stops burner if operating conditions rise above maximum design temperature or vapor pressure.

4) Alarm Bell and Rotary Beacon: Factory mounted on control panel with silence switch; shall sound alarm for out-of-normal conditions.

5) Control Transformer: 115-V maximum control voltage.

8. Indirect-Type, Water-Bath Heat Exchanger:

a. Description: Immersion-type, electric heating element with ASME-rated and -stamped, helical, LPG, vaporizer coil submerged in water bath. Include the following:

1) Water bath filled with water/glycol solution designed to prevent freezing at minus 30 deg F (minus 34 deg C).

2) Water-bath, high- and low-level sight glasses.

3) Low-water cutoff to stop electric heater and annunciate alarm.

4) Water/glycol fill and vent fitting.

5) Minimum NPS 3/4 (DN 20) hose-end drain valves.

6) Operating high- and low-limit aquastat controllers.

7) Water-bath temperature gage; a minimum of 2-1/2 inches (63 mm) in diameter. Gages shall have operating-temperature ranges so normal operating range is at approximately 50 percent of full range.

b. Electric Heater Operating Controls:

1) Controls shall maintain safe operating conditions. Safety controls limit operation of the electric element. Microprocessor-based control system integrates safety and operating controls, **as directed**.

2) Operating Water-Bath Temperature Control: Factory wired and mounted to control burner.

3) High-Temperature and High-Pressure Cutoff: Manual reset stops burner if operating conditions rise above maximum design temperature or pressure.

4) Alarm Bell and Rotary Beacon: Factory mounted on control panel with silence switch; shall sound alarm for out-of-normal conditions.

5) Control Transformer: 115-V maximum control voltage.

9. Building Management System Interface: Factory-installed hardware and software to enable building management system to monitor and control set points and display vaporizer status and alarms.

N. Air Mixers

1. Description: Factory-fabricated, -assembled, -calibrated, and -tested, blower-assisted, **as directed**, air mixer with surge tank, built on a steel base; including vapor supply and discharge connections, and controls. Assembly shall be FMG labeled and comply with NFPA 58 and NFPA 70.

2. Fabricate base and attachment to mixers with reinforcement strong enough to resist air mixer movement during a seismic event when steel base is anchored to a concrete base.

3. Mounting Skid, Panels, and Surge Tank:

a. Integral one-piece skid with forklift access holes.

b. Lifting lugs on top of air mixer.

c. Baked-enamel **OR** Powder-coat, **as directed**, protective finish.

d. Mounting base to secure boiler to concrete base.

e. Control Compartment Enclosure: NEMA 250, Type 4, enclosure housing control panels.

f. ASME-stamped surge tank with venturi, isolation valves, excess-flow safeties, and safety relief valves.

4. Blower: Positive-displacement, rotary-lobe type.
   a. Motor: Single speed, with permanently lubricated **OR** grease-lubricated, **as directed**, ball bearings. Comply with requirements in Division 15 Section "Common Motor Requirements For Hvac Equipment".
5. LPG Circuit Specialties:
   a. Venturi solenoid valves.
   b. Venturi nozzles, minimum of 3, for minimum of 10:1 turndown capacity.
   c. Venturi silencers.
   d. Mist filter and strainer with pressure differential gage, and blowdown ball valve.
   e. Inlet and outlet isolation valves.
   f. Pressure gages, a minimum of 2-1/2 inches (63 mm) in diameter, at inlet and discharge. Gages shall have operating-temperature ranges so normal operating range is at approximately 50 percent of full range.
6. Air-Mixer Controls:
   a. Controls shall maintain safe operating conditions. The following safety controls limit the operation of the air mixer. All safety controls are manual reset.
      1) Low-inlet-vapor pressure.
      2) High- or low-discharge pressure.
   b. Alarm Bell and Rotary Beacon: Factory mounted on control panel with silence switch; shall sound alarm for out-of-normal conditions.
   c. Control Transformer: 115-V maximum control voltage.
7. Mount on common skid with vaporizer.

O. Sleeves
1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

P. Mechanical Sleeve Seals
1. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   a. Sealing Elements: EPDM **OR** NBR, **as directed**, interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe and sleeve.
   b. Pressure Plates: Plastic **OR** Carbon steel **OR** Stainless steel, **as directed**.
   c. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating **OR** Stainless steel, **as directed**, of length required to secure pressure plates to sealing elements. Include one nut and bolt for each sealing element.

Q. Escutcheons
1. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to fit around pipe or tube, and OD that completely covers opening.
2. One-Piece, Deep-Pattern Escutcheons: Deep-drawn brass with polished chrome-plated finish.
3. One-Piece, Cast-Brass Escutcheons: With set screw.
   a. Finish: Polished chrome-plated **OR** Rough brass, **as directed**.
4. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.
   a. Finish: Polished chrome-plated **OR** Rough brass, **as directed**.
5. One-Piece, Stamped-Steel Escutcheons: With set screw **OR** spring clips, **as directed**, and chrome-plated finish.
6. Split-Plate, Stamped-Steel Escutcheons: With concealed **OR** exposed-rivet, **as directed**, hinge, set screw **OR** spring clips, **as directed**, and chrome-plated finish.
7. One-Piece, Floor-Plate Escutcheons: Cast-iron floor plate.
8. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

R. Grout
1. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   a. Characteristics: Post-hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   b. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
   c. Packaging: Premixed and factory packaged.

S. Labeling And Identifying
1. Detectable Warning Tape: Acid- and alkali-resistant PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored yellow.

1.3 EXECUTION

A. Earthwork
1. Comply with requirements in Division 02 Section "Earthwork" for excavating, trenching, and backfilling.

B. Preparation
1. Close equipment shutoff valves before turning off LPG to premises or piping section.
2. Inspect LPG piping according to NFPA 58 and NFPA 54 **OR** the International Fuel Gas Code, **as directed**, to determine that LPG utilization devices are turned off in piping section affected.
3. Comply with NFPA 58 and NFPA 54 **OR** the International Fuel Gas Code, **as directed**, requirements for prevention of accidental ignition.

C. Outdoor Piping Installation
1. Comply with NFPA 58 and NFPA 54 **OR** the International Fuel Gas Code, **as directed**, requirements for installation and purging of LPG piping.
2. Install underground, LPG piping buried at least 36 inches (900 mm) below finished grade. Comply with requirements in Division 02 Section "Earthwork" for excavating, trenching, and backfilling.
   a. If LPG piping is installed less than 36 inches (914 mm) below finished grade, install it in containment conduit.
3. Install underground, PE, LPG piping according to ASTM D 2774.
4. Steel Piping with Protective Coating:
   a. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
   b. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
      OR
      Replace pipe having damaged PE coating with new pipe.
5. Copper Tubing with Protective Coating:
   a. Apply joint cover kits over tubing to cover, seal, and protect joints.
   b. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
6. Install fittings for changes in direction and branch connections.
7. Joints for connection to inlets and outlets on vaporizers, air mixers, regulators, and valves may be flanged or threaded to match the equipment.
8. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   a. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
   b. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.

9. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
10. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
11. Install pressure gage downstream **OR** upstream and downstream, **as directed**, from each service regulator. Pressure gages are specified in Division 15 Section "Meters And Gages For Hvac Piping".

D. Indoor Piping Installation
1. Comply with NFPA 54 **OR** the International Fuel Gas Code, **as directed**, for installation and purging of LPG piping.
2. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
3. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
4. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
5. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
6. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
7. Locate valves for easy access.
8. Install LPG piping at uniform grade of 2 percent down toward drip and sediment traps.
9. Install piping free of sags and bends.
10. Install fittings for changes in direction and branch connections.
11. Install escutcheons for penetrations of interior walls, ceilings, and floors.
    a. New Piping:
        1) Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
        2) Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
           OR
           Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
        3) Piping at Ceiling Penetrations in Finished Spaces: One-piece **OR** Split-casting, **as directed**, cast-brass type with polished chrome-plated finish.
           OR
           Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type **OR** Split-plate, stamped-steel type with concealed hinge, **as directed**, and set screw.
        4) Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated **OR** rough-brass, **as directed**, finish.
           OR
           Piping in Unfinished Service Spaces: One-piece, stamped-steel type with set screw **OR** spring clips, **as directed**.
        5) Piping in Equipment Rooms: One-piece, cast-brass type.
           OR
           Piping in Equipment Rooms: One-piece, stamped-steel type with set screw **OR** spring clips, **as directed**.
        6) Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
    b. Existing Piping:

1) Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
OR
Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and spring clips.
2) Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
OR
Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.
3) Piping in Unfinished Service Spaces: Split-casting, cast-brass type with polished chrome-plated **OR** rough-brass, **as directed**, finish.
OR
Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed **OR** exposed-rivet, **as directed**, hinge and set screw or spring clips.
4) Piping in Equipment Rooms: Split-casting, cast-brass type.
OR
Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
5) Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

12. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Through-penetration Firestop Systems" for materials.
13. Verify final equipment locations for roughing-in.
14. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
15. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where readily accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
    a. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches (75 mm) long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
16. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
17. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
18. Concealed Location Installations: Except as specified below, install concealed LPG piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
    a. Above Accessible Ceilings: LPG piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
    b. In Floors: Install LPG piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches (38 mm) of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
    c. In Floor Channels: Install LPG piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
    d. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
        1) Exception: Tubing passing through partitions or walls does not require striker barriers.
    e. Prohibited Locations:

1) Do not install LPG piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
2) Do not install LPG piping in solid walls or partitions.

19. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
20. Connect branch piping from top or side of horizontal piping.
21. Install unions in pipes NPS 2 (DN 50) and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
22. Do not use LPG piping as grounding electrode.
23. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
24. Install pressure gage downstream **OR** upstream and downstream, **as directed**, from each line regulator. Pressure gages are specified in Division 15 Section "Meters And Gages For Hvac Piping".

E. Service-Meter Assembly Installation
1. Install service-meter assemblies aboveground, on concrete bases, **as directed**.
2. Install metal shutoff valves upstream from service regulators. Shutoff valves are not required at second regulators if two regulators are installed in series.
3. Install strainer on inlet of service-pressure regulator and meter set.
4. Install service regulators mounted outside with vent outlet horizontal or facing down. Install screen in vent outlet if not integral with service regulator.
5. Install metal shutoff valves upstream from service meters. Install dielectric fittings downstream from service meters.
6. Install service meters downstream from pressure regulators.
7. Install metal bollards to protect meter assemblies. Comply with requirements in Division 05 Section "Metal Fabrications" for pipe bollards.

F. Valve Installation
1. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
2. Install underground valves with valve boxes.
3. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
4. Install earthquake valves aboveground outside buildings according to listing.
5. Install anode for metallic valves in underground PE piping.

G. Piping Joint Construction
1. Ream ends of pipes and tubes and remove burrs.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3. Threaded Joints:
   a. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
   b. Cut threads full and clean using sharp dies.
   c. Ream threaded pipe ends to remove burrs and restore full ID of pipe.
   d. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
   e. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
4. Welded Joints:
   a. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
   b. Bevel plain ends of steel pipe.
   c. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

5. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Ch. 22, "Pipe and Tube."
6. Flanged Joints: Install gasket material, size, type, and thickness appropriate for LPG service. Install gasket concentrically positioned.
7. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.
8. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
   a. Plain-End Pipe and Fittings: Use butt fusion.
   b. Plain-End Pipe and Socket Fittings: Use socket fusion.

H. Hanger And Support Installation
1. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 15 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
2. Comply with requirements for pipe hangers and supports specified in Division 15 Section "Hangers And Supports For Hvac Piping And Equipment".
3. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
   a. NPS 1 (DN 25) and Smaller: Maximum span, 96 inches (2438 mm); minimum rod size, 3/8 inch (10 mm).
   b. NPS 1-1/4 (DN 32): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
   c. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
   d. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): Maximum span, 10 feet (3 m); minimum rod size, 1/2 inch (13 mm).
   e. NPS 4 (DN 100) and Larger: Maximum span, 10 feet (3 m); minimum rod size, 5/8 inch (16 mm).
4. Install hangers for horizontal, drawn-temper copper tubing with the following maximum spacing and minimum rod sizes:
   a. NPS 3/8 (DN 10): Maximum span, 48 inches (1220 mm); minimum rod size, 3/8 inch (10 mm).
   b. NPS 1/2 and NPS 5/8 (DN 15 and DN 18): Maximum span, 72 inches (1830 mm); minimum rod size, 3/8 inch (10 mm).
   c. NPS 3/4 and NPS 7/8 (DN 20 and DN 22): Maximum span, 84 inches (2134 mm); minimum rod size, 3/8 inch (10 mm).
   d. NPS 1 (DN 25): Maximum span, 96 inches (2440 mm); minimum rod size, 3/8 inch (10 mm).
5. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:
   a. NPS 3/8 (DN 10): Maximum span, 48 inches (1220 mm); minimum rod size, 3/8 inch (10 mm).
   b. NPS 1/2 (DN 15): Maximum span, 72 inches (1830 mm); minimum rod size, 3/8 inch (10 mm).
   c. NPS 3/4 (DN 20) and Larger: Maximum span, 96 inches (2440 mm); minimum rod, 3/8 inch (10 mm).

I. Connections
1. Connect to utility's gas main according to utility's procedures and requirements.
2. Install LPG piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
3. Install piping adjacent to appliances to allow service and maintenance of appliances.
4. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches (1830 mm) of each gas-fired appliances and equipment. Install union between valve and appliances or equipment.

5. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

J. Transport Truck Unloading Facility
1. Install transport truck unloading in a cast-in-place concrete base, 48 inches (1220 mm) square by 36 inches (914 mm) deep. Set top of concrete base at least 6 inches (150 mm) above finished grade.
2. Install remote emergency shutoff station with cable release in an accessible location, a minimum of 25 feet (7.6 m) and a maximum of 100 feet (30 m) away from transport truck unloading.
3. Install at least two 6-inch- (150-mm-) diameter metal bollards set in and filled with concrete on both sides of transport truck unloading. Bollard length shall be at least 48 inches (1220 mm) above and below grade, with concrete encasement a minimum of 12 inches (305 mm) in diameter.

K. Storage Container Installation
1. Fill storage container to at least 80 percent capacity with butane **OR** propane, **as directed**.
2. Install piping connections with swing joints or flexible connectors to allow for storage container settlement and for thermal expansion and contraction.
3. Ground containers according to NFPA 780. Grounding is specified in Division 13 Section "Lightning Protection".
4. Set storage containers in felt pads on concrete or steel saddles. Install corrosion protection at container-to-felt contact.
5. Install tie-downs over storage containers on saddles with proper tension.
6. Set concrete saddles on dowels set in concrete base. Anchor steel saddles to concrete base.
7. Set storage container on concrete ballast base large enough to offset buoyancy of empty storage container immersed in water.
8. Install tie-down straps over container anchored in ballast base and repair damaged coating.
9. Backfill with a minimum coverage for underground or mounded storage containers according to NFPA 58.
10. Backfill with pea gravel as required in Division 02 Section "Earthwork".
11. Install cathodic protection for storage container. Cathodic protection is specified in Division 13 Section "Cathodic Protection".

L. Pump Installation
1. Install pumps with access space for periodic maintenance including removal of motors, impellers, and accessories.
2. Set pumps on and anchored to concrete base.
3. Install suction piping with minimum fittings and change of direction.
4. Connect liquid suction to container, supply to vaporizer, and return line to container.

M. Vaporizer Installation
1. Install vaporizer with access space for periodic maintenance.
2. Set vaporizers on and anchor to concrete base.
3. Connect liquid line from pump set, and vapor supply to distribution piping.
4. Install backup connection from vapor space of container to inlet of pressure-regulating valve at vaporizer discharge to bypass the vaporizer during maintenance. Install shutoff valves to change source from vaporizer to storage container.

N. Air Mixer With Vaporizer Installation
1. Install air mixer with vaporizer with access space for periodic maintenance.
2. Set air mixer with vaporizer on and anchor to concrete base.
3. Connect liquid line from pump set, and mixed gas supply to distribution piping.
4. Install backup connection from vapor space of container to inlet of pressure-regulating valve at vaporizer discharge to bypass vaporizer during maintenance. Install shutoff valves to change source from vaporizer to storage container.

5. Replace filters at Substantial Completion if air mixer was operated during construction.

O. Labeling And Identifying
1. Comply with requirements in Division 15 Section "Identification For Hvac Piping And Equipment" for piping and valve identification.
OR
Install detectable warning tape directly above gas piping, 12 inches (305 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

P. Painting
1. Comply with requirements in Division 07 for painting interior and exterior LPG piping.
2. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components with factory-applied paint or protective coating.
   a. Alkyd System: MPI EXT 5.1D.
      1) Prime Coat: Alkyd anticorrosive metal primer.
      2) Intermediate Coat (for a Premium Grade system): Exterior alkyd enamel matching topcoat.
      3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
      4) Color: Gray, **unless directed otherwise**.
3. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components with factory-applied paint or protective coating.
   a. Latex Over Alkyd Primer System: MPI INT 5.1Q.
      1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
      2) Intermediate Coat (for a Premium Grade system): Interior latex matching topcoat.
      3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
      4) Color: Gray, **unless directed otherwise**.
   b. Alkyd System: MPI INT 5.1E.
      1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
      2) Intermediate Coat (for a Premium Grade system): Interior alkyd matching topcoat.
      3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
      4) Color: Gray, **unless directed otherwise**.
4. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

Q. Concrete Bases
1. Concrete Bases: Anchor equipment to concrete base according to seismic codes at Project.
   a. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
   b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (451-mm) centers around the full perimeter of the base.
   c. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   d. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   e. Install anchor bolts to elevations required for proper attachment to supported equipment.
   f. Use 3000-psig (20.7-MPa), **unless directed otherwise**, 28-day, compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-place Concrete".

R. Field Quality Control
1. Perform tests and inspections.
2. Tests and Inspections:

a. Test, inspect, and purge LPG according to NFPA 58 and NFPA 54 **OR** the International Fuel Gas Code, **as directed**, and requirements of authorities having jurisdiction.

3. LPG piping will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.

S. Outdoor Piping Schedule

1. Underground LPG liquid piping shall be one of the following:
   a. Schedule 40 steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.
   b. Annealed **OR** Drawn, **as directed**,-temper copper tube, Type K (Type A) **OR** Type L (Type B), **as directed**, with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.
2. Aboveground LPG liquid piping shall be one of the following:
   a. NPS 2 (DN 50) and Smaller: Schedule 40 **OR** Schedule 80, **as directed**, steel pipe, malleable-iron threaded fittings and threaded and seal welded, **as directed**, joints. Coat pipe and fittings with protective coating for steel piping.
   b. NPS 2-1/2 (DN 65) and Larger: Schedule 40, steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.
   c. Annealed **OR** Drawn, **as directed**,-temper copper tube, Type L (Type B), with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.
3. Underground LPG vapor piping shall be one of the following:
   a. PE pipe and fittings joined by heat-fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
   b. Schedule 40, steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.
   c. Annealed **OR** Drawn, **as directed**,-temper copper tube, Type L (Type B) with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.
4. Aboveground LPG vapor piping shall be one of the following:
   a. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
   b. Schedule 40, steel pipe with wrought-steel fittings and welded joints, or mechanical couplings.
   c. Annealed **OR** Drawn, **as directed**,-temper copper tube, Type L (Type B), with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.
5. Branch Piping in Cast-in-Place Concrete to Single Appliance: Annealed-temper copper, with wrought-copper fittings and brazed **OR** flared, **as directed**, joints. Install piping embedded in concrete with no joints in concrete.
6. Containment Conduit: Schedule 40, steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

T. Indoor Piping Schedule For System Pressures Less Than 0.5 psig (3.45 kPa)

1. Aboveground, branch piping NPS 1 (DN 25) and smaller shall be one of the following:
   a. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
   b. Annealed-temper, tin-lined copper tube with flared joints and fittings.
   c. Annealed-temper copper tube with wrought-copper fittings and brazed **OR** flared, **as directed**, joints.
   d. Aluminum tube with flared fittings and joints.
   e. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
2. Aboveground, distribution piping shall be one of the following:
   a. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
   b. Schedule 40, steel pipe with wrought-steel fittings and welded joints.

c. Drawn-temper copper tube, Type L (Type B) with wrought-copper fittings and brazed joints.

3. Underground, below building, piping shall be one of the following:
   a. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
   b. Schedule 40, steel pipe with wrought-steel fittings and welded joints.
4. Containment Conduit: Schedule 40, steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
5. Containment Conduit Vent Piping: Schedule 40, steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

U. Indoor Piping Schedule For System Pressures More Than 0.5 psig (3.45 kPa) And Less Than 5 psig (34.5 kPa)
1. Aboveground, branch piping NPS 1 (DN 25) and smaller shall be one of the following:
   a. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
   b. Annealed-temper, tin-lined copper tube with flared joints and fittings.
   c. Annealed-temper copper tube, Type L (Type B) with wrought-copper fittings and brazed **OR** flared, **as directed**, joints.
   d. Aluminum tube with flared fittings and joints.
   e. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
2. Aboveground, distribution piping shall be one of the following:
   a. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
   b. Schedule 40, steel pipe with steel welding fittings and welded joints.
   c. Drawn-temper copper tube, Type L (Type B) **OR** Type G, **as directed**, with wrought-copper fittings and brazed joints.
3. Underground, below building, piping shall be one of the following:
   a. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
   b. Schedule 40, steel pipe with wrought-steel fittings and welded joints.
4. Containment Conduit: Schedule 40, steel pipe with wrought-steel fittings and welded joints. Coat underground pipe and fittings with protective coating for steel piping.
5. Containment Conduit Vent Piping: Schedule 40, steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

V. Indoor Piping Schedule For System Pressures More Than 5 psig (34.5 kPa)
1. Aboveground Piping: Maximum operating pressure more than 5 psig (34.5 kPa).
2. Aboveground, Branch Piping: Schedule 40, steel pipe with steel welding fittings and welded joints.
3. Aboveground, distribution piping shall be one of the following:
   a. Schedule 40, steel pipe with steel welding fittings and welded joints.
   b. Drawn-temper copper tube, Type L (Type B) **OR** Type G, **as directed**, with wrought-copper fittings and brazed joints.
4. Underground, below building, piping shall be one of the following:
   a. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
   b. Schedule 40, steel pipe with wrought-steel fittings and welded joints.
5. Containment Conduit: Schedule 40, steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
6. Containment Conduit Vent Piping: Schedule 40, steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

W. Underground Manual Gas Shutoff Valve Schedule
1. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.
2. Underground Vapor Piping:
   a. PE valves.

b. NPS 2 (DN 50) and Smaller: Bronze, lubricated **OR** nonlubricated, **as directed**, plug valves.
c. NPS 2-1/2 (DN 65) and Larger: Cast-iron, lubricated **OR** nonlubricated, **as directed**, plug valves.

X. Aboveground Manual Gas Shutoff Valve Schedule
1. Aboveground Liquid Piping:
   a. Two-piece, full **OR** regular, **as directed**,-port, bronze ball valves with bronze trim.
2. Valves for pipe NPS 2 (DN 50) and smaller at service meter shall be one of the following:
   a. One-piece, bronze ball valve with bronze trim.
   b. Two-piece, full **OR** regular, **as directed**,-port, bronze ball valves with bronze trim.
   c. Bronze plug valve.
3. Valves for pipe NPS 2-1/2 (DN 65) and larger at service meter shall be one of the following:
   a. Two-piece, full **OR** regular, **as directed**,-port, bronze ball valves with bronze trim.
   b. Bronze plug valve.
   c. Cast-iron, nonlubricated plug valve.
4. Distribution piping valves for pipe NPS 2 (DN 50) and smaller shall be one of the following:
   a. One-piece, bronze ball valve with bronze trim.
   b. Two-piece, full **OR** regular, **as directed**,-port, bronze ball valves with bronze trim.
   c. Bronze plug valve.
5. Distribution piping valves for pipe NPS 2-1/2 (DN 65) and larger shall be one of the following:
   a. Two-piece, full **OR** regular, **as directed**,-port, bronze ball valves with bronze trim.
   b. Bronze plug valve.
   c. Cast-iron, nonlubricated **OR** lubricated, **as directed**, plug valve.
6. Valves in branch piping for single appliance shall be one of the following:
   a. One-piece, bronze ball valve with bronze trim.
   b. Two-piece, full **OR** regular, **as directed**,-port, bronze ball valves with bronze trim.
   c. Bronze plug valve.

END OF SECTION 02551a

Task	Specification	Specification Description
02551	01352	No Specification Required
02551	02242	Piped Utilities Basic Materials And Methods
02553	02242	Piped Utilities Basic Materials And Methods
02555	02242	Piped Utilities Basic Materials And Methods
02555	02455a	Water Distribution
02556	02455a	Water Distribution
02559	02242	Piped Utilities Basic Materials And Methods
02559	02456a	Hydronic Distribution
02559	02456b	Steam Distribution

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SECTION 02561 - UNDERGROUND DUCTS AND UTILITY STRUCTURES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for underground ducts and utility structures. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
   a. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks, and in single duct runs\.
   b. Handholes and boxes.
   c. Manholes.

C. Definition
1. RNC: Rigid nonmetallic conduit.

D. Submittals
1. Product Data: For the following:
   a. Duct-bank materials, including separators and miscellaneous components.
   b. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
   c. Accessories for manholes, handholes, boxes, and other utility structures.
   d. Warning tape.
   e. Warning planks.
2. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:
   a. Duct entry provisions, including locations and duct sizes.
   b. Reinforcement details.
   c. Frame and cover design and manhole frame support rings.
   d. Ladder **OR** Step, **as directed,** details.
   e. Grounding details.
   f. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
   g. Joint details.
3. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:
   a. Duct entry provisions, including locations and duct sizes.
   b. Cover design.
   c. Grounding details.
   d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
4. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
   a. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
   b. Drawings shall be signed and sealed by a qualified professional engineer.
5. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C 858.
6. Field quality-control test reports.

E. Quality Assurance

1. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
2. Comply with ANSI C2.
3. Comply with NFPA 70.

F. Delivery, Storage, And Handling
1. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
2. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
3. Lift and support precast concrete units only at designated lifting or supporting points.

G. Project Conditions
1. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
   a. Notify Owner no fewer than two days in advance of proposed interruption of electrical service.
   b. Do not proceed with interruption of electrical service without Owner's written permission.

1.2 PRODUCTS

A. Conduit
1. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.
2. RNC: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

B. Nonmetallic Ducts And Duct Accessories
1. Underground Plastic Utilities Duct: NEMA TC 6 & 8, Type EB-20-PVC, ASTM F 512, UL 651A, with matching fittings by the same manufacturer as the duct, complying with NEMA TC 9.
2. Underground Plastic Utilities Duct: NEMA TC 6 & 8, Type DB-60-PVC and Type DB-120-PVC, ASTM F 512, with matching fittings by the same manufacturer as the duct, complying with NEMA TC 9.
3. Duct Accessories:
   a. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
   b. Warning Tape: Underground-line warning tape specified in Division 16 Section "Electrical Identification".
   c. Concrete Warning Planks: Nominal 12 by 24 by 3 inches (300 by 600 by 76 mm) in size, manufactured from 6000-psi (41-MPa) concrete.
      1) Color: Red dye added to concrete during batching.
      2) Mark each plank with "ELECTRIC" in 2-inch- (50-mm-) high, 3/8-inch- (10-mm-) deep letters.

C. Precast Concrete Handholes And Boxes
1. Comply with ASTM C 858 for design and manufacturing processes.
2. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
   a. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
   b. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.

c. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.
   1) Cover Hinges: Concealed, with hold-open ratchet assembly.
   2) Cover Handle: Recessed.
d. Frame and Cover: Weatherproof aluminum frame with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.
   1) Cover Hinges: Concealed, with hold-open ratchet assembly.
   2) Cover Handle: Recessed.
e. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
f. Cover Legend: Molded lettering, "ELECTRIC" **OR** "TELEPHONE" **OR** As indicated for each service, **as directed**.
g. Configuration: Units shall be designed for flush burial and have open **OR** closed **OR** integral closed, **as directed,** bottom, unless otherwise indicated.
h. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
   1) Extension shall provide increased depth of 12 inches (300 mm).
   2) Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
i. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.
   1) Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
   2) Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
   3) Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
j. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
   1) Type and size shall match fittings to duct or conduit to be terminated.
   2) Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.
k. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

D. Handholes and Boxes Other Than Precast Concrete
1. Description: Comply with SCTE 77.
   a. Color: Gray **OR** Green, **as directed**.
   b. Configuration: Units shall be designed for flush burial and have open **OR** closed **OR** integral closed, **as directed,** bottom, unless otherwise indicated.
   c. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
   d. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   e. Cover Legend: Molded lettering, "ELECTRIC" **OR** "TELEPHONE" **OR** As indicated for each service, **as directed**.
   f. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
   g. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
   h. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have factory-installed inserts for cable racks and pulling-in irons.
2. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

3. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.
4. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers of polymer concrete **OR** reinforced concrete **OR** cast iron **OR** hot-dip galvanized-steel diamond plate **OR** fiberglass, **as directed**.
5. High-Density Plastic Boxes: Injection molded of high-density polyethylene or copolymer-polypropylene. Cover shall be polymer concrete **OR** hot-dip galvanized-steel diamond plate **OR** plastic, **as directed**.

E. Precast Manholes
1. Comply with ASTM C 858, with structural design loading as specified in Para. 1.3 "Underground Enclosure Application" Article and with interlocking mating sections, complete with accessories, hardware, and features.
   a. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.
      1) Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
      2) Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
      3) Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
   b. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
      1) Type and size shall match fittings to duct or conduit to be terminated.
      2) Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable.
2. Concrete Knockout Panels: 1-1/2 to 2 inches (38 to 50 mm) thick, for future conduit entrance and sleeve for ground rod.
3. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

F. Cast-In-Place Manholes
1. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for conduit entrance and sleeve for ground rod.
2. Materials: Comply with ASTM C 858 and with Division 03 Section "Cast-in-place Concrete".
3. Structural Design Loading: As specified in Para. 1.3 "Underground Enclosure Application" Article.

G. Utility Structure Accessories
1. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
   a. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B **OR** cast aluminum, **as directed,** with milled cover-to-frame bearing surfaces; diameter, 26 inches (660 mm) **OR** 29 inches (737 mm), **as directed**.
      1) Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
      2) Special Covers: Recess in face of cover designed to accept finish material in paved areas.
   b. Cover Legend: Cast in. Selected to suit system.
      1) Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
      2) Legend: "ELECTRIC-HV" for duct systems with medium-voltage cables.
      3) Legend: "SIGNAL" for communications, data, and telephone duct systems.

c. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
   1) Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. (60 L) where packaged mix complying with ASTM C 387, Type M, may be used.

2. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.
3. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch- (50-mm-) diameter eye, and 1-by-4-inch (25-by-100-mm) bolt.
   a. Working Load Embedded in 6-Inch (150-mm), 4000-psi (27.6-MPa) Concrete: 13,000-lbf (58-kN) minimum tension.
4. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch- (32-mm-) diameter eye, rated 2500-lbf (11-kN) minimum tension.
5. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch- (22-mm-) diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
   a. Ultimate Yield Strength: 40,000-lbf (180-kN) shear and 60,000-lbf (270-kN) tension.
6. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch (13-mm) ID by 2-3/4 inches (69 mm) deep, flared to 1-1/4 inches (32 mm) minimum at base.
   a. Tested Ultimate Pullout Strength: 12,000 lbf (53 kN) minimum.
7. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch (13-mm) bolt, 5300-lbf (24-kN) rated pullout strength, and minimum 6800-lbf (30-kN) rated shear strength.
8. Cable Rack Assembly: Steel, hot-rolled **OR** hot-dip, **as directed,** galvanized, except insulators.
   a. Stanchions: T-section or channel; 2-1/4-inch (57-mm) nominal size; punched with 14 holes on 1-1/2-inch (38-mm) centers for cable-arm attachment.
   b. Arms: 1-1/2 inches (38 mm) wide, lengths ranging from 3 inches (75 mm) with 450-lb (204-kg) minimum capacity to 18 inches (460 mm) with 250-lb (114-kg) minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.
   c. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.
9. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.
   a. Stanchions: Nominal 36 inches (900 mm) high by 4 inches (100 mm) wide, with minimum of 9 holes for arm attachment.
   b. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches (75 mm) with 450-lb (204-kg) minimum capacity to 20 inches (508 mm) with 250-lb (114-kg) minimum capacity. Top of arm shall be nominally 4 inches (100 mm) wide, and arm shall have slots along full length for cable ties.
10. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F (2 deg C). Capable of withstanding temperature of 300 deg F (150 deg C) without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.
11. Fixed Manhole Ladders: Arranged for attachment to roof or wall **OR** and floor, **as directed,** of manhole. Ladder and mounting brackets and braces shall be fabricated from nonconductive, structural-grade, fiberglass-reinforced resin **OR** hot-dip galvanized steel, **as directed**.
12. Portable Manhole Ladders: UL-listed, heavy-duty wood **OR** fiberglass, **as directed,** specifically designed for portable use for access to electrical manholes. Minimum length equal to distance from deepest manhole floor to grade plus 36 inches (900 mm). One required.
13. Cover Hooks: Heavy duty, designed for lifts 60 lbf (270 N) and greater **OR** Light duty, designed for lifts less than 60 lbf (270 N), **as directed**. Two required.

H. Source Quality Control
   1. Test and inspect precast concrete utility structures according to ASTM C 1037.

2. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
   a. Tests of materials shall be performed by a independent testing agency.
   b. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
   c. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

1.3 EXECUTION

A. Underground Duct Application
   1. Ducts for Electrical Cables Over 600 V: RNC, NEMA Type EPC-80 **OR** EPC-40 **OR** EB-20, **as directed,**-PVC, in concrete-encased duct bank, unless otherwise indicated.
   2. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-80 **OR** EPC-40 **OR** EB-20, **as directed,**-PVC, in concrete-encased duct bank, unless otherwise indicated.
   3. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-80 **OR** EPC-40 **as directed,**-PVC, in direct-buried duct bank, unless otherwise indicated.
   4. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-80 **OR** EPC-40, **as directed,**-PVC, in direct-buried duct bank, unless otherwise indicated.
   5. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40 **OR** EB-20, **as directed,**-PVC, in concrete-encased duct bank, unless otherwise indicated.
   6. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC **OR** Underground plastic utilities duct, NEMA Type DB-60-PVC **OR** Underground plastic utilities duct, NEMA Type DB-120-PVC, **as directed,** installed in direct-buried **OR** concrete-encased, **as directed,** duct bank, unless otherwise indicated.
   7. Underground Ducts for Telephone, Communications, or Data Circuits: RNC, NEMA Type EPC-40 **OR** DB-60 **OR** DB-120, **as directed,**-PVC, in direct-buried duct bank, unless otherwise indicated.
   8. Underground Ducts for Telephone, Communications, or Data Circuits: RNC, NEMA Type EB-20-PVC, in concrete-encased duct bank, unless otherwise indicated.
   9. Underground Ducts Crossing Paved Paths **OR** Walks and Driveways **OR** Roadways and Railroads, **as directed**: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.

B. Underground Enclosure Application
   1. Handholes and Boxes for 600 V and Less, Including Telephone, Communications, and Data Wiring:
      a. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-10 **OR** H-20, **as directed,** structural load rating.
      b. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 **OR** Polymer concrete, SCTE 77, Tier 15 **OR** Fiberglass enclosures with polymer concrete frame and cover, SCTE 77, Tier 15 **OR** Fiberglass-reinforced polyester resin, SCTE 77, Tier 15 **OR** High-density plastic, SCTE 77, Tier 15, **as directed,** structural load rating.
      c. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 **OR** Polymer concrete units, SCTE 77, Tier 8 **OR** Heavy-duty fiberglass units with polymer concrete frame and cover, SCTE 77, Tier 8 **OR** High-density plastic, SCTE 77, Tier 8, **as directed,** structural load rating.
      d. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin **OR** High-density plastic, **as directed**, structurally tested according to SCTE 77 with 3000-lbf (13 345-N) vertical loading.
   2. Manholes: Precast or cast-in-place concrete.

a. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
b. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

C. Earthwork
1. Excavation and Backfill: Comply with Division 02 Section "Earthwork", but do not use heavy-duty, hydraulic-operated, compaction equipment.
2. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
3. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 02 Section(s) "Lawns And Grasses" AND "Exterior Plants".
4. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting And Patching".

D. Duct Installation
1. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.
2. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches (1220 mm) **OR** 12.5 feet (4 m) **OR** 25 feet (7.5 m), **as directed**, both horizontally and vertically, at other locations, unless otherwise indicated.
3. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
4. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches (250 mm) o.c. for 5-inch (125-mm) ducts, and vary proportionately for other duct sizes.
   a. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line.
   b. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
   c. Grout end bells into structure walls from both sides to provide watertight entrances.
5. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet (3 m) outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 16 Section "Common Work Results For Electrical".
6. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.
7. Pulling Cord: Install 100-lbf- (445-N-) test nylon cord in ducts, including spares.
8. Concrete-Encased Ducts: Support ducts on duct separators.
   a. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 **OR** 5, **as directed,** spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches (150 mm) between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
   b. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
      1) Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion

fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.

2) If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (19-mm) reinforcing rod dowels extending 18 inches (450 mm) into concrete on both sides of joint near corners of envelope.

c. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

d. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.

e. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.

f. Minimum Space between Ducts: 3 inches (75 mm) between ducts and exterior envelope wall, 2 inches (50 mm) between ducts for like services, and 4 inches (100 mm) between power and signal ducts.

g. Depth: Install top of duct bank at least 24 inches (600 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inches (750 mm) below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.

h. Stub-Ups:

1) Use manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Extend concrete encasement throughout the length of the elbow.

OR

Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

a) Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.

b) Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.

i. Warning Tape: Bury warning tape approximately 12 inches (300 mm) above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches (75 mm) of the centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.

9. Direct-Buried Duct Banks:

a. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.

b. Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 **OR** 5, **as directed,** spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches (150 mm) between tiers.

c. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 02 Section "Earthwork" for pipes less than 6 inches (150 mm) in nominal diameter.

d. Install backfill as specified in Division 02 Section "Earthwork".

e. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After

placing last tier, hand-place backfill to 4 inches (100 mm) over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Division 02 Section "Earthwork".

f. Install ducts with a minimum of 3 inches (75 mm) between ducts for like services and 6 inches (150 mm) between power and signal ducts.

g. Depth: Install top of duct bank at least 36 inches (900 mm) below finished grade, unless otherwise indicated.

h. Set elevation of bottom of duct bank below the frost line.

i. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.

OR

Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

1) Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.

2) For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

j. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried ducts and duct banks, placing them 24 inches (600 mm) o.c. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional planks 12 inches (300 mm) apart, horizontally.

E. Installation Of Concrete Manholes, Handholes, And Boxes

1. Cast-in-Place Manhole Installation:
   a. Finish interior surfaces with a smooth-troweled finish.
   b. Windows for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inches (38 to 50 mm) thick, arranged as indicated.
   c. Cast-in-place concrete, formwork, and reinforcement are specified in Division 03 Section "Cast-in-place Concrete".
2. Precast Concrete Handhole and Manhole Installation:
   a. Comply with ASTM C 891, unless otherwise indicated.
   b. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
   c. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch (25-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
3. Elevations:
   a. Manhole Roof: Install with rooftop at least 15 inches (380 mm) below finished grade.
   b. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch (25 mm) above finished grade.
   c. Install handholes with bottom below the frost line, <**Insert depth of frost line below grade at Project site**> below grade.
   d. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
   e. Where indicated, cast handhole cover frame integrally with handhole structure.
4. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.
5. Manhole Access: Circular opening in manhole roof; sized to match cover size.
   a. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.

b. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.

6. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Division 07 Section(s) "Elastomeric Sheet Waterproofing" OR "Thermoplastic Sheet Waterproofing", **as directed.** After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.
7. Dampproofing: Apply dampproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Division 07 Section "Bituminous Dampproofing". After ducts have been connected and grouted, and before backfilling, dampproof joints and connections and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.
8. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.
9. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
10. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches (98 mm) for manholes and 2 inches (50 mm) for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.
11. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

F. Installation Of Handholes And Boxes Other Than Precast Concrete

1. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.
2. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.7-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
3. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
4. Install handholes and boxes with bottom below the frost line, <**Insert depth of frost line below grade at Project site**> below grade.
5. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.
6. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
7. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
   a. Concrete: 3000 psi (20 kPa), 28-day strength, complying with Division 03 Section "Cast-in-place Concrete", with a troweled finish.
   b. Dimensions: 10 inches wide by 12 inches deep (250 mm wide by 300 mm deep).

G. Grounding

1. Ground underground ducts and utility structures according to Division 16 Section "Grounding And Bonding".

H. Field Quality Control

1. Perform the following tests and inspections and prepare test reports:
   a. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
   b. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
   c. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 16 Section "Grounding And Bonding".
2. Correct deficiencies and retest as specified above to demonstrate compliance.

I. Cleaning
1. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
2. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 02561

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Task	Specification	Specification Description
02561	01352	No Specification Required
02561	02242	Piped Utilities Basic Materials And Methods
02561	02455b	Sanitary Sewerage
02561	02452	Storm Drainage
02561	02242b	Sewage Treatment Lagoons

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SECTION 02570 - REPAIR AND MAINTENANCE OF IMHOFF TANKS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for repair and maintenance of sewage treatment plant Imhoff tanks. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Coatings:
1. Epoxy-Filler Compound for concrete surfaces shall comply with Fed. Spec. MMM-A-001993.
2. Coal-Tar Epoxy shall comply with SSPC-PAINT 16.
3. Epoxy Paint shall comply with Mil. Spec. MIL-P-24441.
4. Red-Lead Base Paint shall comply with Fed. Spec. TT-P-86, Type I.
5. Aluminum Finish Paint shall comply with Fed. Spec. TT-P-38.

B. Steel Tank Repair Material for minor leaks shall be a two-component epoxy sealing compound. For badly corroded areas, a steel plate of the same composition and thickness as the original tank shall be used.

C. Pipe and Fittings for replacement shall be equivalent to the existing pipe and fittings.

1.3 EXECUTION

A. Preparation: Drain the contents of the tank and dispose of the sludge and sewage.

B. Leak Repair:
1. Concrete Tanks: Repair concrete tank leaks by cleaning and chipping or sandblasting the area of the leak and applying two-component epoxy concrete sealant.
2. Steel Tanks: Repair steel tank leaks by cleaning, scraping, chipping, or sandblasting the area of the leak and applying epoxy steel sealant. Repair badly corroded areas of steel tanks by cutting out the corroded area and welding a section of new steel plate in place. Welding shall be in compliance with AWS D1.1.

C. Pipe and Fittings: Replace pipe and fittings as required.

D. Cleaning and Coatings:
1. Interior Concrete Surfaces of the tank shall be cleaned with high pressure water or steam to remove dirt and residue, allowed to dry, and brush sandblasted.
2. Holes and Voids in the concrete surfaces left from the blast cleaning shall be filled by means of troweling and squeeze application of epoxy filler. Two coats of coal-tar epoxy shall be applied to the surface after the epoxy has cured.
3. Submerged Ferrous Metal Surfaces such as piping and equipment that are exposed to the sewage shall be sandblasted and coated with two coats of coal-tar epoxy.

4. Exterior Concrete Surfaces of the tank shall be cleaned by means of brush sandblast. The surfaces shall be blown down with air to remove the blasting residue and dust, and two coats of epoxy-polyamide paint shall be applied.
5. Ferrous Metal Surfaces that are not submerged shall be cleaned by means of sandblasting. Coat surfaces with one coat of red-lead base paint. After the base paint has dried sufficiently, apply two coats of aluminum finish paint.

END OF SECTION 02570

SECTION 02570a - REPAIR AND MAINTENANCE OF SIPHON TANK AND SIPHONS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for the repair and maintenance of sewage treatment plant dosing siphon tanks. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Tank Repair Material shall be epoxy type grout complying with Fed. Spec. MMM-A-001993.

B. Concrete Coatings:
1. Outside and Above Grade shall be epoxy type in compliance with Mil. Spec. MIL-P-24441.
2. Inside and Below Grade shall be coal-tar epoxy type in compliance with SSPC-PAINT 16.

C. Steel Repair Material shall be steel plate or epoxy cement and fiberglass cloth.

D. Corroded or Defective Siphons: Replace those parts corroded or defective with new parts compatible with the unit, as recommended by the manufacturer.

E. Steel Coatings:
1. Red-Lead Base Coat shall comply with Fed. Spec. TT-P-86, Type I.
2. Aluminum Paint shall comply with Fed. Spec. TT-P-38.

1.3 EXECUTION

A. Corroded or Broken Pipe and Fittings: Replace as required.

B. Minor Leaks: Repair minor leaks in the tank using material and surface preparation and application methods recommended by the material manufacturer.

C. Spalled Areas: Repair as required.

D. Cleaning and Coating:
1. Interior Concrete Surfaces of the tank shall be cleaned with high pressure water or steam to remove all dirt and residue, allowed to dry, and brush sandblasted in compliance with SSPC-SP 7.
2. The Exterior Concrete Surfaces of the tank shall be cleaned by means of brush sandblasting in compliance with SSPC-SP 7. The surfaces shall be blown down with air to remove the blasting residue and dust, and two coats of epoxy-polyamide paint shall be applied.
3. Holes and Voids in the concrete surfaces left from the blast cleaning shall be filled by means of troweling and squeeze application of an epoxy filler. The surfacing material shall be allowed to cure overnight, and then two coats of coal-tar epoxy complying with SSPC-PAINT 16 shall be applied.

4. Submerged Ferrous Metal Surfaces that are exposed to the sewage shall be sandblasted in compliance with SSPC-SP 10 and coated with two coats of coal-tar epoxy.
5. Ferrous Metal Surfaces that are not submerged shall be cleaned by means of sandblasting in compliance with SSPC-SP 6. Surfaces inaccessible to sandblasting shall be power tool cleaned in compliance with SSPC-SP 3. Surfaces shall be coated with one coat of red-lead base paint. After the base paint has dried sufficiently, two coats of aluminum finish paint shall be applied.

END OF SECTION 02570a

Task	Specification	Specification Description
02570	01352	No Specification Required
02570	02242	Piped Utilities Basic Materials And Methods
02585	02561	Underground Ducts And Utility Structures

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SECTION 02611 - CRUSHED STONE PAVING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of crushed stone paving. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 PRODUCTS

A. Aggregates: Aggregates shall consist of crushed stone or slag, crushed gravel, angular sand, or other approved materials. Aggregates shall be durable, sound, and free from foreign material.
1. Coarse Aggregates, consisting of angular fragments of uniform density and quality, shall have a percentage of wear not to exceed 50 percent after 500 revolutions when tested in accordance with ASTM C131. The amount of flat and elongated particles (length to width greater than 3 to 1) shall not exceed 30 percent.
2. Crushed Gravel shall be manufactured from gravel particles with the following gradation:

100% passing	2" sieve
25 - 60% passing	1/4" sieve
5 - 40% passing	#40 sieve
0 - 10%	#200 sieve

3. Crushed Stone shall contain at least 50 percent by weight of crushed pieces having two or more freshly fractured faces for each range of sizes.
4. Slag shall be an air-cooled blast-furnace product having a dry weight of not less than 65 pcf.

B. Binder Material shall consist of screenings, angular sand, or other finely divided mineral matter processed or naturally combined with the coarse aggregate.

1.3 EXECUTION

A. Installation:
1. Mixing and Placing: Materials shall be mixed in such a manner as to obtain a uniform stabilized-aggregate material and a uniform optimum water content for compaction. Mixing and placing procedures shall produce true grades, minimize segregation and degradation, optimize water content, and ensure a satisfactory base course.
2. Compaction: Each layer of stabilized-aggregate paving shall be compacted. Water content shall be maintained at optimum. Areas inaccessible to the rollers shall be compacted, with mechanical tampers and shall be shaped and finished by hand methods.
3. Layer Thickness: No layer shall be in excess of 8 inches nor less than 3 inches in compacted thickness.
4. Proof Rolling: Materials in paving or underlying materials that produce unsatisfactory results by rolling shall be removed and replaced with satisfactory materials and recompacted.
5. Edges of Paving: Approved materials shall be placed along edges of stabilized-aggregate paving course in such quantities as will compact to thickness of the course being constructed, allowing at least a l-foot width of the shoulder to be rolled and compacted simultaneously with rolling and compacting of each layer of the paving course.
6. Finishing: Finished surface shall be of uniform grade and texture.
7. Thickness Control: Compacted thickness of the stabilized paving course shall be within 1/2 inch of the thickness required.

END OF SECTION 02611

SECTION 02611a - CRUSHED STONE

1.1 GENERAL

A. Description Of Work
1. The work under this section consists of furnishing, placing and compacting crushed stone where called for and as detailed, in conformance with lines, grades and typical as follows or as directed by the Owner.

1.2 PRODUCTS

A. Materials
1. Material shall consist of clean, coating free, durable, sharp angled fragments of crushed stone, crushed ledge rock, or blends thereof that conform to the specific requirements of the following table. Shale will not be acceptable.
2. Crushed Stone used in Absorption Beds shall be washed and free of fines.
3. Gradation: Crushed stone sizes shall meet the gradation requirements of Table 1-1.

TABLE 1-1 (1)GRADATION OF CRUSHED STONE

Size Desig-nation	4"	3"	2-1/2"	2"	1-1/2"	1"	1/2"	1/4"	1/8"	No.80 Sieve
Scree-ning (2)							100	90-100		
1B								100	90-100	0-15
1A							100	90-100	0-15	
1ST							100	0-15		
1						100	90-100	0-15		
2					100	90-100	0-15			
3A				100	90-100	0-15				
3			100	90-100	5-70	0-15				
4A		100	90-100		0-20					
4	100	90-100		0-15						
5	90-100	0-15								

a. Percentage by weight passing the following square openings.
b. Screenings shall include all of the fine material passing a 1/4-inch screen.
4. All crushing plants shall be fitted with tailing chutes so that no aggregate will reach the bins other than that which passes through the proper screens

B. Soundness: Material furnished under this item shall be substantially free of shale or other soft, poor durability particles. A visual inspection of particle composition by the Owner will generally be the basis

for acceptance. Where the State elects to test for this requirement, a Magnesium Sulfate Soundness Loss exceeding 35 percent will be cause for rejection.

C. Contamination: Contamination of the crushed stone with any deleterious material, such as silt, clay, mud, ice, snow or organic materials, through any cause whatsoever, shall be corrected by the Contractor by excavation and replacement of the material in the affected areas.

D. Sampling: Samples and certified gradations shall be furnished by the Contractor to the Owner and approval of these samples must be received prior to delivery or placement of the material.

1.3 EXECUTION

A. Compaction: All material shall be placed in uniform horizontal layers not exceeding 6-inches thickness before compaction. All portions of each layer shall be mechanically compacted to the satisfaction of the Owner. Compaction equipment shall be approved by the Owner.

END OF SECTION 02611a

SECTION 02611b - SELECT GRAVEL

1.1 GENERAL

A. Description Of Work
1. The work under this section consists of furnishing, placing and compacting select gravel where called for and as detailed, in conformance with lines, grades and typical sections as provided or directed by the Owner.

1.2 PRODUCTS

A. Materials
1. Material shall consist of clean, durable gravel or crushed stone free from coating.
2. Select Gravel used for stone paving shall be manufactured from crushed stone and contain no gravel.
3. Gradation of gravel or stone shall be as follows with percent passing calculated by weight:

Select Gravel	
Sieve	Percent Passing
2"	100
1/4"	30 - 65
No. 40	5 - 40
No. 200	0 - 10

1.3 EXECUTION

A. Soundness: Materials furnished under this item shall be substantially free of shale, organic or other soft, poor durability particles. A visual inspection of particle composition by the Owner will generally be the basis for acceptance. Where the Owner elects to test for this requirement, a Magnesium Sulfate Soundness Loss exceeding 35 percent will be cause for rejection.

B. Contamination: Contamination of the Select Gravel with any deleterious material, such as silt, clay, mud, ice, snow or organic material, through any cause whatsoever, shall be corrected by the Contractor by excavation and replacement of the material in the affected area.

C. Sampling: Samples and certified gradations shall be furnished by the Contractor to the Owner and approval of these samples must be received prior to delivery or placement of the material.

D. Compaction:
1. All material shall be placed in uniform horizontal layers not exceeding 6-inches thickness before compaction. All portions of each layer shall be mechanically compacted to the percentage of the Standard Proctor Maximum Density (AASHTO T-99) as follows, unless noted otherwise. Compaction equipment approval shall be made by the Owner.
2. Density determination.
   a. Structures (entire area within 10 feet outside perimeter) 95%
   b. Building Slabs and Steps: 95%
   c. Lawn or Unpaved Areas: 90%
   d. Pavements and Walkways: 95%
   e. Pipes and Tunnels: 95%
   f. Pipe Bedding: 100%

END OF SECTION 02611b

SECTION 02612 - ASPHALT PAVING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for asphalt paving. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Cold milling of existing hot-mix asphalt pavement.
b. Hot-mix asphalt patching.
c. Hot-mix asphalt paving.
d. Hot-mix asphalt paving overlay.
e. Asphalt surface treatments.
f. Pavement-marking paint.
g. Traffic-calming devices.
h. Imprinted asphalt.

C. Definition
1. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

D. Submittals
1. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.
a. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
b. Job-Mix Designs: For each job mix proposed for the Work.
2. Material Certificates: For each paving material, from manufacturer.

E. Quality Assurance
1. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of state in which Project is located.
2. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of State or local DOT for asphalt paving work.
a. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.
3. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.
2. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

G. Project Conditions
1. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:
a. Prime Coat: Minimum surface temperature of 60 deg F (15.6 deg C).
b. Tack Coat: Minimum surface temperature of 60 deg F (15.6 deg C).

c. Slurry Coat: Comply with weather limitations in ASTM D 3910.
d. Asphalt Base Course: Minimum surface temperature of 40 deg F (4.4 deg C) and rising at time of placement.
e. Asphalt Surface Course: Minimum surface temperature of 60 deg F (15.6 deg C) at time of placement.

2. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F (4.4 deg C) for oil-based materials **OR** 55 deg F (12.8 deg C) for water-based materials, **as directed**, and not exceeding 95 deg F (35 deg C).
3. Imprinted Asphalt Paving: Proceed with coating imprinted pavement only when air temperature is at least 50 deg F (10 deg C) and rising and will not drop below 50 deg F (10 deg C) within 8 hours of coating application. Proceed only if no precipitation is expected within two hours after applying the final layer of coating.

1.2 PRODUCTS

A. Aggregates
1. General: Use materials and gradations that have performed satisfactorily in previous installations.
2. Coarse Aggregate: ASTM D 692, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.
3. Fine Aggregate: ASTM D 1073 or AASHTO M 29, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.
a. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.
4. Mineral Filler: ASTM D 242 or AASHTO M 17, rock or slag dust, hydraulic cement, or other inert material.

B. Asphalt Materials
1. Asphalt Binder: AASHTO M 320 or AASHTO MP 1a, PG 64-22 **OR** PG 58-28 **OR** PG 70-22, **as directed**.
2. Asphalt Cement: ASTM D 3381 for viscosity-graded material **OR** ASTM D 946 for penetration-graded material, **as directed**.
3. Prime Coat:
a. ASTM D 2027, medium-curing cutback asphalt, MC-30 or MC-70 **OR** MC-250, **as directed**.
OR
Asphalt emulsion prime coat complying with State or local DOT requirements.
4. Tack Coat: ASTM D 977 or AASHTO M 140 emulsified asphalt, or ASTM D 2397 or AASHTO M 208 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.
5. Fog Seal: ASTM D 977 or AASHTO M 140 emulsified asphalt, or ASTM D 2397 or AASHTO M 208 cationic emulsified asphalt, slow setting, factory diluted in water, of suitable grade and consistency for application.
6. Water: Potable.
7. Undersealing Asphalt: ASTM D 3141, pumping consistency.

C. Auxiliary Materials
1. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.
2. Sand: ASTM D 1073 or AASHTO M 29, Grade Nos. 2 or 3.
3. Paving Geotextile: AASHTO M 288, nonwoven polypropylene; resistant to chemical attack, rot, and mildew; and specifically designed for paving applications.

4. Joint Sealant: ASTM D 6690 or AASHTO M 324, Type I **OR** Type II or III **OR** Type IV, **as directed**, hot-applied, single-component, polymer-modified bituminous sealant.
5. Pavement-Marking Paint: Color shall be White **OR** Yellow **OR** Blue, **as directed**.
   a. Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248, Type N **OR** Type F **OR** Type S, **as directed**; colors complying with FS TT-P-1952.
      OR
      MPI #32 Alkyd Traffic Marking Paint.
      OR
      Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, Type II, with drying time of less than three **OR** 45, **as directed**, minutes.
      OR
      MPI #97 Latex Traffic Marking Paint.
6. Glass Beads: AASHTO M 247, Type 1.
7. Wheel Stops:
   a. Precast, air-entrained concrete, 2500-psi (17.2-MPa) minimum compressive strength, 4-1/2 inches (115 mm) high by 9 inches (225 mm) wide by 72 inches (1800 mm) long. Provide chamfered corners, drainage slots on underside, and holes for anchoring to substrate.
      OR
      Solid, integrally colored, 96 percent recycled HDPE or commingled postconsumer and postindustrial recycled plastic; UV stabilized; 4 inches (100 mm) high by 6 inches (150 mm) wide by 72 inches (1800 mm) long. Provide chamfered corners, drainage slots on underside, and holes for anchoring to substrate.
   b. Dowels: Galvanized steel, 3/4-inch (19-mm) diameter, 10-inch (254-mm) minimum length.
   c. Adhesive: As recommended by wheel-stop manufacturer for application to asphalt pavement.

D. Preformed Traffic-Calming Devices
1. Speed Bumps **OR** Humps **OR** Cushions, **as directed**: Solid, integrally colored, 100 percent postconsumer or commingled postconsumer and postindustrial recycled rubber **OR** plastic, **as directed**; UV stabilized. Provide holes for anchoring to substrate.
   a. Size: Modular bumps 2 inches (51 mm) high by 10 inches (254 mm) wide by 72 inches (1800 mm) long, with overall length as dimensioned on Drawings.
   b. Size: Modular assemblies 3 inches (76 mm) high by 12 feet (3.7 m) in overall width **OR** 4 inches (102 mm) high by 14 feet (4.3 m) in overall width, **as directed**, with overall length as dimensioned on Drawings.
   c. Mounting Hardware: Galvanized-steel spike, 1/2-inch (13-mm) diameter, 10-inch (254-mm) minimum length **OR** lag screw, shield, and washers; 1/2-inch (13-mm) diameter, 8-inch (203-mm) minimum length **OR** hardware as standard with device manufacturer, **as directed**.
   d. Adhesive: As recommended by device manufacturer.

E. Imprinted Asphalt Materials
1. Templates: Imprinted-asphalt manufacturer's standard flexible templates for imprinting pattern into hot asphalt paving.
   a. Pattern: Running bond brick **OR** Cobblestone **OR** Custom pattern indicated on Drawings, **as directed**.
2. Coating System: Imprinted-asphalt manufacturer's standard system formulated for exterior application on asphalt paving surfaces.
   a. Base Coating: Portland cement and epoxy-modified acrylic polymer blended with sand and aggregate, formulated for exterior application on asphalt paving surfaces.
   b. Top Coating: Epoxy-modified acrylic polymer blended with sand and aggregate, formulated for exterior application on asphalt paving surfaces.
   c. Colorant: UV-stable pigment blend, added to each coating layer.
   d. Color: White **OR** Yellow, **as directed**.

3. Precut Marking Material: Imprinted-asphalt manufacturer's standard, reflectorized, thermoplastic, 90-mil (2.3-mm) minimum thickness, formulated for exterior application on asphalt paving surfaces, and matching the imprinted pattern of templates.

F. Mixes
1. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction; designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types"; and complying with the following requirements:
   a. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
   b. Base Course: In accordance with state or local DOT specifications.
   c. Surface Course: In accordance with state or local DOT specifications.
2. Hot-Mix Asphalt Based on ASTM D 3515 Requirements: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types."
   a. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
   b. Provide mixes complying with composition, grading, and tolerance requirements in ASTM D 3515 for the following nominal, maximum aggregate sizes:
      1) Base Course: 1 inch (25 mm).
      2) Surface Course: 1/2 inch (13 mm).
3. Emulsified-Asphalt Slurry: ASTM D 3910, Type 1 **OR** Type 2 **OR** Type 3, **as directed**.

1.3 EXECUTION

A. Examination
1. Verify that subgrade is dry and in suitable condition to begin paving.
2. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
   a. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph (5 km/h).
   b. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes).
   c. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by the Owner, and replace with compacted backfill or fill as directed.
3. Proceed with paving only after unsatisfactory conditions have been corrected.
4. Verify that utilities, traffic loop detectors, and other items requiring a cut and installation beneath the asphalt surface have been completed and that asphalt surface has been repaired flush with adjacent asphalt prior to beginning installation of imprinted asphalt.

B. Cold Milling
1. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.
   a. Mill to a depth of 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**.
   b. Mill to a uniform finished surface free of excessive gouges, grooves, and ridges.
   c. Control rate of milling to prevent tearing of existing asphalt course.
   d. Repair or replace curbs, manholes, and other construction damaged during cold milling.
   e. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
   f. Transport milled hot-mix asphalt to asphalt recycling facility.
   g. Keep milled pavement surface free of loose material and dust.

C. Patching
   1. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches (300 mm) into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.
   2. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.
      a. Pump hot undersealing asphalt under rocking slab until slab is stabilized or, if necessary, crack slab into pieces and roll to reseat pieces firmly.
      b. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.
   3. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m).
      a. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
      b. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
   4. Patching:
      a. Fill excavated pavements with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

         OR

         Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

D. Repairs
   1. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch (25 mm) in existing pavements.
      a. Install leveling wedges in compacted lifts not exceeding 3 inches (75 mm) thick.
   2. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch (6 mm).
      a. Clean cracks and joints in existing hot-mix asphalt pavement.
      b. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch (6 mm) wide. Fill flush with surface of existing pavement and remove excess.
      c. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch (6 mm) wide. Fill flush with surface of existing pavement and remove excess.

E. Surface Preparation
   1. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
   2. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.
      a. Mix herbicide with prime coat if formulated by manufacturer for that purpose.
   3. Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.15 to 0.50 gal./sq. yd. (0.7 to 2.3 L/sq. m). Apply enough material to penetrate and seal but not flood surface. Allow prime coat to cure.
      a. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
      b. Protect primed substrate from damage until ready to receive paving.
   4. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m).
      a. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.

b. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

F. Paving Geotextile Installation
1. Apply tack coat **OR** asphalt binder **OR** asphalt cement, **as directed**, uniformly to existing pavement surfaces at a rate of 0.20 to 0.30 gal./sq. yd. (0.8 to 1.2 L/sq. m).
2. Place paving geotextile promptly according to manufacturer's written instructions. Broom or roll geotextile smooth and free of wrinkles and folds. Overlap longitudinal joints 4 inches (100 mm) and transverse joints 6 inches (150 mm).
   a. Protect paving geotextile from traffic and other damage and place hot-mix asphalt paving overlay the same day.

G. Hot-Mix Asphalt Placing
1. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
   a. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
   b. Place hot-mix asphalt surface course in single lift.
   c. Spread mix at minimum temperature of 250 deg F (121 deg C).
   d. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
   e. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
2. Place paving in consecutive strips not less than 10 feet (3 m) wide unless infill edge strips of a lesser width are required.
   a. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.
3. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

H. Joints
1. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
   a. Clean contact surfaces and apply tack coat to joints.
   b. Offset longitudinal joints, in successive courses, a minimum of 6 inches (150 mm).
   c. Offset transverse joints, in successive courses, a minimum of 24 inches (600 mm).
   d. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations" **OR** as shown on Drawings, **as directed**.
   e. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
   f. Compact asphalt at joints to a density within 2 percent of specified course density.

I. Compaction
1. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
   a. Complete compaction before mix temperature cools to 185 deg F (85 deg C).
2. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

3. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
   a. Average Density:
      1) 96 percent of reference laboratory density according to ASTM D 6927 or AASHTO T 245, but not less than 94 percent nor greater than 100 percent.
      OR
      92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.
4. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
5. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.
6. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
7. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
8. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

J. Asphalt Curbs
1. Construct hot-mix asphalt curbs over compacted pavement surfaces. Apply a light tack coat unless pavement surface is still tacky and free from dust. Spread mix at minimum temperature of 250 deg F (121 deg C).
   a. Asphalt Mix: Same as pavement surface-course mix.
2. Place hot-mix asphalt to curb cross section indicated or, if not indicated, to local standard shapes, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

K. Asphalt Traffic-Calming Devices
1. Construct hot-mix asphalt speed bumps, humps, cushions, and tables over compacted pavement surfaces. Apply a tack coat unless pavement surface is still tacky and free from dust. Spread mix at minimum temperature of 250 deg F (121 deg C).
   a. Tack Coat Application: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m).
   b. Asphalt Mix: Same as pavement surface-course mix.
   c. Before installation, mill pavement that will be in contact with bottom of traffic-calming device. Mill to a depth of 1 inch (25 mm) from top of pavement to a clean, rough profile.
2. Place hot-mix asphalt to cross section indicated, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

L. Installation Tolerances
1. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
   a. Base Course: Plus or minus 1/2 inch (13 mm).
   b. Surface Course: Plus 1/4 inch (6 mm), no minus.
2. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot (3-m) straightedge applied transversely or longitudinally to paved areas:
   a. Base Course: 1/4 inch (6 mm).
   b. Surface Course: 1/8 inch (3 mm).
   c. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch (6 mm).

3. Traffic-Calming Devices: Compact and form asphalt to produce the contour indicated and within a tolerance of plus or minus 1/8 inch (3 mm) of height indicated above pavement surface.

M. Surface Treatments
1. Fog Seals: Apply fog seal at a rate of 0.10 to 0.15 gal./sq. yd. (0.45 to 0.7 L/sq. m) to existing asphalt pavement and allow to cure. With fine sand, lightly dust areas receiving excess fog seal.
2. Slurry Seals: Apply slurry coat in a uniform thickness according to ASTM D 3910 and allow to cure.
   a. Roll slurry seal to remove ridges and provide a uniform, smooth surface.

N. Pavement Marking
1. Do not apply pavement-marking paint until layout, colors, and placement have been verified with the Owner.
2. Allow paving to age for 30 **OR** 90, **as directed**, days before starting pavement marking.
3. Sweep and clean surface to eliminate loose material and dust.
4. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils (0.4 mm).
   a. Broadcast glass beads uniformly into wet pavement markings at a rate of 6 lb/gal. (0.72 kg/L).

O. Wheel Stops
1. Install wheel stops in bed of adhesive as recommended by manufacturer.
2. Securely attach wheel stops to pavement with not less than two galvanized-steel dowels embedded at one-quarter to one-third points. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel beneath top of wheel stop.

P. Preformed Traffic-Calming Devices
1. Install preformed speed bumps **OR** humps **OR** cushions, **as directed**, in bed of adhesive as recommended by manufacturer for heavy traffic.
2. Securely attach preformed speed bumps **OR** humps **OR** cushions, **as directed**, to pavement with hardware spaced as recommended by manufacturer for heavy traffic. Recess head of hardware beneath top surface.

Q. Imprinting Asphalt
1. General: Imprint asphalt according to manufacturer's written instructions, using manufacturer's recommended equipment.
2. Freshly Laid Asphalt: Immediately after asphalt has been laid and compacted but still plastic, begin the surface imprinting process.
   a. Monitor asphalt surface temperature in compliance with manufacturer's written recommendations to ensure required temperature to perform surface imprinting.
   b. Reheat asphalt if surface temperature drops below that required.
3. Reheating Asphalt: Soften asphalt pavement surface by heating to a depth of at least 1/2 inch (13 mm) without burning asphalt.
   a. Heat to a temperature of 300 to 325 deg F (149 to 163 deg C) immediately before applying templates.
   b. Regularly monitor the pavement temperature to prevent overheating.
   c. Direct flame heaters are not permitted.
   d. If pavement is overheated and begins to emit black smoke, remove damaged pavement by milling down 1 inch (25 mm) and replace removed pavement with new, compacted surface course prior to resuming imprinting work.
4. Surface Imprinting: Apply and imprint templates to a minimum depth of 1/4 inch (6 mm) **OR** as required to embed precut marking material flush or barely beneath pavement surface, **as directed**.

5. Coating Application: After imprinted surface has cooled, apply two layers of base coating followed by two layers of top coating **OR** four layers of top coating, **as directed**. Do not allow traffic until coating has completely dried and cured.
6. Precut Marking Material Application: Position precut marking material aligned with imprinted pattern and slowly heat to a temperature no higher than 325 deg F (163 deg C) until marking material begins to liquefy and flow. Do not allow traffic until installed marking material has cooled to ambient temperature.

R. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.
3. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.
4. Traffic-Calming Devices: Finished height of asphalt speed bumps, humps, cushions, and tables above pavement will be measured for compliance with tolerances.
5. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979 or AASHTO T 168.
    a. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
    b. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.
        1) One core sample will be taken for every 1000 sq. yd. (836 sq. m) or less of installed pavement, with no fewer than 3 cores taken.
        2) Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.
6. Replace and compact hot-mix asphalt where core tests were taken.
7. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

S. Disposal
1. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.
    a. Do not allow milled materials to accumulate on-site.

END OF SECTION 02612

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SECTION 02612a - BITUMINOUS PAVING-REPAIR AND RESURFACING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials repair and resurfacing of bituminous pavements. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Reports: Copies of test results, within 24 hours after completion of tests.
2. Waybills and Delivery Tickets: Copies of waybills or delivery tickets, during the progress of the work.

1.2 PRODUCTS:

A. Asphaltic Concrete:
1. Hot-Mixed, Hot-Mixed Asphaltic Concrete and Emulsified asphalt shall comply with requirements of ASTM D 3515.
2. Plant-Mixed, Stockpiled Asphalt Cold Mixes shall comply with the requirements of Asphalt Institute Specification PM-2.

B. Bituminous Prime: Bituminous primer shall comply with ASTM D 2027.

C. Base Course: Base course material shall comply with State highway department specification for dense-graded, high-quality material.

D. Bituminous Tack Coat: Bituminous tack coat shall comply with ASTM D 2027.

1.3 EXECUTION:

A. Preparation of Areas for Patching:
1. Pot Holes: Trim the perimeter of each hole to a vertical face with a carborundum blade in a square or rectangular pattern at least 18 inches from ragged edge. Remove material to a depth that provides a uniform well-compacted bottom surface. Remove all loose material resulting from trimming or otherwise existing in the hole. If subbase is disturbed, reestablish in a like manner to adjacent substrate. Areas to be repaired shall be dry before repair is started.
2. Alligator-Cracked and Rutted Areas: The pavement shall be sawed or cut with pavement breakers to a smooth vertical face 18 inches outside of the alligator-cracked area. Unsatisfactory material shall be removed in a manner not to disturb the sides of the excavated area.
3. Slippage Areas: Saw a rectangular area around the slippage area that overlaps into the well-bonded material by at least 18 inches. The depth of the saw cut shall be equal to the thickness of the layer of material that is slipping. The surface where slipping is occurring shall be broomed clean and all loose material removed.

B. Installation:
1. Application Temperatures: Application temperatures for all asphalt material shall comply with provisions of the Asphalt Institute Publications and the applicable ASTM Standards.

2. Base Course: Place base course material in layers not exceeding a compacted thickness of 6 inches. After placing, compact each layer by mechanical compactors to a density of not less than the density of the corresponding layer of the adjacent pavement structure.
3. Prime Coat: Prime base course with MC-70 liquid asphalt at a rate of 0.20 to 0.30 gallon per sq. yd. Bolt excess prime with sand before the surfacing material is applied.
4. Tack Coat: Give the edges of existing asphaltic concrete or surfaces of Portland cement concrete and asphaltic concrete a tack coat of MC-70 liquid asphalt at a rate of 0.05 to 0.15 gallon per sq. yd. Allow the material to cure before placing the surfacing material.
5. Hot-Mixed Asphaltic Concrete: Place the material in layers not exceeding 2-1/2 inches in thickness and compact to a density equal to the density of the adjacent asphaltic concrete.
6. Stockpiled Cold Mixes: The compacted thickness of each layer of material shall not exceed 2 inches. Before compaction, the material shall be allowed to aerate, if necessary, until the proper amount of cohesion has developed to obtain adequate compaction. When more than one layer is used, each layer shall be thoroughly cured before the succeeding layer is placed.

END OF SECTION 02612a

SECTION 02612b - ASPHALTIC CONCRETE OVERLAYS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of asphaltic concrete overlays. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Asphalt Cement: The asphalt cement shall comply with ASTM D 946 penetration grade 85-100 requirements and shall show a negative spot test when tested in compliance with AASHTO T 102.

B. Mineral Aggregates: Shall comply with ASTM D 3515 for 3/4-inch maximum aggregate mix.

C. Test Properties: The bituminous mixture shall meet the following requirements when tested in compliance with MIL-STD 620.

Stability minimum, lb	500
Flow maximum, 1/100-in. units	20
Voids total mix, %	3-5
Voids filled with bitumen, %	75-85

1.3 EXECUTION

A. Preparation of Existing Surface: The Contractor shall raise and reset all structures such as manhole frames, valve boxes, drainage structures, etc., to meet the required grade. An asphalt tack coat shall be applied to all contact surfaces in advance of the asphalt concrete overlay placement. The asphalt tack shall be placed at an asphalt residue coverage rate of 0.05 gal/sq yd.

B. Installation:
1. Joints: Longitudinal joints of the overlay shall be offset at least 1 foot from existing joints. Transverse joints shall be offset at least 2 feet from existing transverse joints.
2. All Asphalt Concrete Mixture and Pavement that are contaminated, damaged, or defective shall be removed and replaced by the Contractor. Skin patching of rolled pavement will not be permitted.
3. Compaction of Mixture: The asphalt concrete mixture shall be rolled until a density of not less than 95 percent and not more than 100 percent of laboratory compacted specimen is obtained.
4. Surface Smoothness: After final rolling, the pavement surface shall not vary in excess of 1/8 inch from a 10-foot straightedge laid on the surface.

END OF SECTION 02612b

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SECTION 02613 - COLD MIX RECYCLING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of cold mix recycling of existing paving and the addition of new materials. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Aggregates:
1. General: Aggregates shall consist of material obtained from milling, or removing and crushing the existing in situ material, and/or new aggregate material as needed.
2. Aggregate Quality and Gradation: Aggregate for bituminous mixture shall be of such size that the material can be spread with a paver to the desired thickness and compacted to meet the specified smoothness, grade, and density requirements. New aggregates shall be approved and be equal to or better than the reclaimed aggregate in quality. Maximum size of new aggregate shall not exceed one-half of the layer thickness and in no case shall the maximum aggregate size exceed 1 inch.

B. Bituminous Materials: Bituminous materials, if required, shall be an emulsified asphalt conforming to ASTM D 977 or ASTM D 2397, grade as required.

C. Job-Mix Formula: The Job-Mix Formula (JMF) for the recycled mixture will be furnished by the Contractor to the Owner. The formula will indicate a definite percentage of water and asphalt to be added to the mixture. The JMF will be allowed an asphalt content tolerance of 0.3 percent. The asphalt content may be adjusted by the Owner to improve paving mixture, without adjustment in contract unit price. When asphalt is added, the optimum asphalt content will be selected to provide the following properties when samples are compacted at 250 F with 75 blows of standard Marshall hammer on each side of the specimen.

Property	Requirement
Stability minimum, pounds	1,800
Flow maximum, 1/100-inch units	16
Voids in total mix, percent	3-5
Voids filled with bitumen, percent	70-80

The water content will be selected to provide maximum density when samples are prepared at the optimum asphalt content and compacted with 75 blows of Marshall hammer at ambient temperature. When no asphalt binder is added to the mixture, the water content will be selected by the Owner to provide maximum density.

1.3 EXECUTION

A. Preparation of Bituminous Mixtures: The required amount of bituminous material for each batch, or calibrated amount of continuous mixing, shall be introduced into the mixer. Aggregates, asphalt emulsion, and water shall be mixed for 35 seconds or longer, as necessary, to thoroughly coat all

particles with bituminous material. When longer mixing time is necessary, additional mixing time shall be determined by the Owner.

B. Conditioning of Existing Surface: Ruts or soft yielding spots that appear in the existing pavement areas and deviations of surface from requirements specified shall be corrected. An asphalt tack coat shall be applied to all contact surfaces in advance of the recycled overlayment. The asphalt tack shall be placed at an asphalt residue coverage rate of 0.05 gal/sq. yd.

C. Placing:
   1. Layer Thickness and Curing: Each layer of compacted mixture shall be no more than 2-1/2 inches in thickness; each layer of bituminous mixture shall be allowed to cure for at least 5 days before placing a succeeding layer.
   2. Compaction of Mixture: Bituminous mixtures shall be rolled until all roller marks are eliminated and a density of at least 86 percent of the theoretical maximum density has been obtained when tested in accordance with MIL-STD-620, Method 101 or ASTM D 2041. When bituminous material is not added to the cold recycled mixture, the material shall be compacted to 100 percent of density determined by MIL-STD-621, Method 100, compaction effort designation CE-55.
   3. Joints: Longitudinal joints shall be offset at least 1 foot from existing joints. Transverse joints shall be offset at least 2 feet from existing transverse joints.
   4. Surface Smoothness: After final rolling, the pavement surface shall not vary in excess of 1/8 inch from a straightedge laid on the surface.

END OF SECTION 02613

SECTION 02614 - CEMENT CONCRETE PAVEMENT

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for cement concrete pavement. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Driveways.
   b. Roadways.
   c. Parking lots.
   d. Curbs and gutters.
   e. Walks.

C. Definitions
1. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

D. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
   a. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.
   b. Design Mixtures for Credit ID 1.1: For each concrete mixture containing fly ash as a replacement for portland cement or other portland cement replacements. For each design mixture submitted, include an equivalent concrete mixture that does not contain portland cement replacements, to determine amount of portland cement replaced.
3. Shop Drawings: Indicate pavement markings, lane separations, and defined parking spaces. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.
4. Samples: For each type of product or exposed finish, prepared as Samples of size indicated below:
   a. Exposed Aggregate: 10-lb (4.5-kg) Sample of each mix.
   b. Wheel Stops: 6 inches (150 mm) long showing cross section; with fasteners.
   c. Preformed Traffic-Calming Devices: 6 inches (150 mm) long showing cross section; with fasteners.
5. Other Action Submittals:
   a. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
6. Qualification Data: For qualified Installer of detectable warnings, ready-mix concrete manufacturer and testing agency.
7. Material Certificates: For the following, from manufacturer:
   a. Cementitious materials.
   b. Steel reinforcement and reinforcement accessories.
   c. Fiber reinforcement.
   d. Admixtures.
   e. Curing compounds.
   f. Applied finish materials.

g. Bonding agent or epoxy adhesive.
h. Joint fillers.

8. Material Test Reports: For each of the following:
   a. Aggregates. Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.
9. Field quality-control reports.

E. Quality Assurance
1. Detectable Warning Installer Qualifications: An employer of workers trained and approved by manufacturer of stamped concrete paving systems.
2. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
   a. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").
3. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
   a. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
4. Concrete Testing Service: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures.
5. ACI Publications: Comply with ACI 301 (ACI 301M) unless otherwise indicated.
6. Preinstallation Conference: Conduct conference at Project site.

F. Project Conditions
1. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
2. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F (4.4 deg C) for oil-based materials **OR** 55 deg F (12.8 deg C) for water-based materials, **as directed**, and not exceeding 95 deg F (35 deg C).

1.2 PRODUCTS

A. Forms
1. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
   a. Use flexible or uniformly curved forms for curves with a radius of 100 feet (30.5 m) or less. Do not use notched and bent forms.
2. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

B. Steel Reinforcement
1. Recycled Content: Provide steel reinforcement with an average recycled content of steel so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
2. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from as-drawn steel **OR** galvanized-steel, **as directed**, wire into flat sheets.
3. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.
4. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A, plain steel.
5. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420); deformed.
6. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A 615/A 615M, Grade 60 (Grade 420) deformed bars.

7. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 60 (Grade 420) deformed bars.
8. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60 (Grade 420), deformed bars; assembled with clips.
9. Plain-Steel Wire: ASTM A 82/A 82M, as drawn **OR** galvanized, **as directed**.
10. Deformed-Steel Wire: ASTM A 496/A 496M.
11. Epoxy-Coated-Steel Wire: ASTM A 884/A 884M, Class A coated, plain **OR** deformed, **as directed**.
12. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) plain-steel bars; zinc coated (galvanized) after fabrication according to ASTM A 767/A 767M, Class I coating, **as directed**. Cut bars true to length with ends square and free of burrs.
13. Epoxy-Coated, Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60 (Grade 420), plain-steel bars.
14. Tie Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
    OR
    Hook Bolts: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.
15. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:
    a. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
    b. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
16. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.
17. Zinc Repair Material: ASTM A 780.

C. Concrete Materials
1. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:
    a. Portland Cement: ASTM C 150, gray **OR** white, **as directed**, portland cement Type I **OR** Type II **OR** Type I/II **OR** Type III **OR** Type V, **as directed**. Supplement with the following, **as directed**:
        1) Fly Ash: ASTM C 618, Class C or Class F.
        2) Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
    b. Blended Hydraulic Cement: ASTM C 595, Type IS, portland blast-furnace slag **OR** Type IP, portland-pozzolan, **as directed**, cement.
2. Normal-Weight Aggregates: ASTM C 33, Class 4S **OR** Class 4M **OR** Class 1N, **as directed**, uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials, **as directed**.
    a. Maximum Coarse-Aggregate Size: 1-1/2 inches (38 mm) **OR** 1 inch (25 mm) **OR** 3/4 inch (19 mm), **as directed**, nominal.
    b. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
3. Exposed Aggregate: Selected, hard, and durable; washed; free of materials with deleterious reactivity to cement or that cause staining; from a single source, with gap-graded coarse aggregate as follows:
    a. Aggregate Sizes: 3/4 to 1 inch (19 to 25 mm) **OR** 1/2 to 3/4 inch (13 to 19 mm) **OR** 3/8 to 5/8 inch (10 to 16 mm), **as directed**, nominal.
    b. Aggregate Source, Shape, and Color: A**s required to meet Project requirements**.
4. Water: Potable and complying with ASTM C 94/C 94M.
5. Air-Entraining Admixture: ASTM C 260.

6. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
   a. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
   b. Retarding Admixture: ASTM C 494/C 494M, Type B.
   c. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
   d. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
   e. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
   f. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
7. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, **as directed**, nonfading, and resistant to lime and other alkalis.

D. Fiber Reinforcement
1. Synthetic Fiber: Monofilament or fibrillated polypropylene fibers engineered and designed for use in concrete paving, complying with ASTM C 1116/C 1116M, Type III, 1/2 to 1-1/2 inches (13 to 38 mm) long.

E. Curing Materials
1. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry or cotton mats.
2. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
3. Water: Potable.
4. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.
5. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
6. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.

F. Related Materials
1. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork in preformed strips.
2. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.
3. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
4. Epoxy Bonding Adhesive: ASTM C 881/C 881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:
   a. Types I and II, non-load bearing **OR** Types IV and V, load bearing, **as directed**, for bonding hardened or freshly mixed concrete to hardened concrete.
5. Chemical Surface Retarder: Water-soluble, liquid, set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch (3 to 6 mm).
6. Pigmented Mineral Dry-Shake Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.
7. Rock Salt: Sodium chloride crystals, kiln dried, coarse gradation with 100 percent passing 3/8-inch (9.5-mm) sieve and 85 percent retained on a No. 8 (2.36-mm) sieve.

G. Detectable Warning Materials

1. Detectable Warning Stamp: Semirigid polyurethane mats with formed underside capable of imprinting detectable warning pattern on plastic concrete; perforated with a vent hole at each dome.
   a. Size of Stamp: One piece matching detectable warning area shown on Drawings **OR** 24 by 24 inches (610 by 610 mm) **OR** 24 by 36 inches (610 by 914 mm) **OR** 24 by 48 inches (610 by 1220 mm) **OR** 26 by 26 inches (660 by 660 mm) **OR** 26 by 36 inches (660 by 914 mm), **as directed**.
2. Liquid Release Agent: Manufacturer's standard, clear, evaporating formulation designed to facilitate release of stamp mats.

H. Pavement Markings
1. Pavement-Marking Paint: Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248, Type N **OR** Type F **OR** Type S, **as directed**; colors complying with FS TT-P-1952.
   a. Color: White **OR** Yellow **OR** Blue **OR** As indicated, **as directed**.
2. Pavement-Marking Paint: MPI #32 Alkyd Traffic Marking Paint.
   a. Color: White **OR** Yellow **OR** Blue **OR** As indicated, **as directed**.
3. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, Type II, with drying time of less than three **OR** 45, **as directed**, minutes.
   a. Color: White **OR** Yellow **OR** Blue **OR** As indicated, **as directed**.
4. Pavement-Marking Paint: MPI #97 Latex Traffic Marking Paint.
   a. Color: White **OR** Yellow **OR** Blue **OR** As indicated, **as directed**.
5. Glass Beads: AASHTO M 247, Type 1 **OR** FS TT-B-1325, Type 1A, **as directed**.

I. Wheel Stops
1. Wheel Stops: Precast, air-entrained concrete, 2500-psi (17.2-MPa) minimum compressive strength, 4-1/2 inches (115 mm) high by 9 inches (225 mm) wide by 72 inches (1820 mm) long. Provide chamfered corners and drainage slots on underside and holes for anchoring to substrate.
   a. Dowels: Galvanized steel, 3/4 inch (19 mm) in diameter, 10-inch (254-mm) minimum length.
2. Wheel Stops: Solid, integrally colored, 96 percent recycled HDPE, or commingled postconsumer and postindustrial recycled rubber or plastic; UV stabilized; 4 inches (100 mm) high by 6 inches (150 mm) wide by 72 inches (1820 mm) long. Provide chamfered corners and drainage slots on underside and holes for anchoring to substrate.
   a. Color: Black **OR** Yellow **OR** Gray **OR** Green **OR** Blue, **as directed**.
   b. Dowels: Galvanized steel, 3/4 inch (19 mm) in diameter, 10-inch (254-mm) minimum length.
   c. Adhesive: As recommended by wheel stop manufacturer for application to concrete pavement.

J. Preformed Traffic-Calming Devices
1. Speed Bumps **OR** Humps **OR** Cushions, **as directed**: Solid, integrally colored, 100 percent postconsumer or commingled postconsumer and postindustrial recycled rubber or plastic; UV stabilized. Provide holes for anchoring to substrate.
   a. Bump Size: Modular 2 inches (50 mm) high by 10 inches (254 mm) wide by 72 inches (1800 mm) long, with overall length as dimensioned on Drawings.
   b. Hump **OR** Cushion, **as directed**, Size: Modular assemblies 3 inches (75 mm) high by 12 feet (3.7 m) in overall width **OR** 4 inches (100 mm) high by 14 feet (4.3 m) in overall width, **as directed**, with overall length as dimensioned on Drawings.
   c. Color: Black **OR** Yellow, **as directed**.
   d. Mounting Hardware: Galvanized-steel lag screw, shield, and washers; 1/2-inch (13-mm) diameter, 8-inch (200-mm) minimum length **OR** hardware as standard with device manufacturer for use with concrete paving, **as directed**.
   e. Adhesive: As recommended by device manufacturer.

K. Concrete Mixtures
1. Prepare design mixtures, proportioned according to ACI 301 (ACI 301M), for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.
   a. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
   b. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that meet or exceed requirements.
2. Proportion mixtures to provide normal-weight concrete with the following properties:
   a. Compressive Strength (28 Days): 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**.
   b. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45 **OR** 0.50, **as directed**.
   c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm) **OR** 8 inches (200 mm), **as directed**, plus or minus 1 inch (25 mm).
3. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
   a. Air Content: 5-1/2 **OR** 4-1/2 **OR** 2-1/2, **as directed**, percent plus or minus 1.5 percent for 1-1/2-inch (38-mm) nominal maximum aggregate size.
   b. Air Content: 6 **OR** 4-1/2 **OR** 3, **as diredcted**, percent plus or minus 1.5 percent for 1-inch (25-mm) nominal maximum aggregate size.
   c. Air Content: 6 **OR** 5 **OR** 3-1/2, **as directed**, percent plus or minus 1.5 percent for 3/4-inch (19-mm) nominal maximum aggregate size.
4. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 **OR** 0.30, **as directed**, percent by weight of cement.
5. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
   a. Use water-reducing admixture **OR** high-range, water-reducing admixture **OR** high-range, water-reducing and retarding admixture **OR** plasticizing and retarding admixture, **as directed**, in concrete as required for placement and workability.
   b. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
6. Cementitious Materials: Limit percentage by weight of cementitious materials other than portland cement according to ACI 301 (ACI 301M) requirements for concrete exposed to deicing chemicals **OR** as follows, **as directed**:
   a. Fly Ash or Pozzolan: 25 percent.
   b. Ground Granulated Blast-Furnace Slag: 50 percent.
   c. Combined Fly Ash or Pozzolan, and Ground Granulated Blast-Furnace Slag: 50 percent, with fly ash or pozzolan not exceeding 25 percent.
7. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd. (0.60 kg/cu. m) **OR** 1.5 lb/cu. yd. (0.90 kg/cu. m), **as directed**.
8. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

L. Concrete Mixing
1. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M, **as directed**. Furnish batch certificates for each batch discharged and used in the Work.
   a. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.
2. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.
   a. For concrete batches of 1 cu. yd. (0.76 cu. m) or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.

b. For concrete batches larger than 1 cu. yd. (0.76 cu. m), increase mixing time by 15 seconds for each additional 1 cu. yd. (0.76 cu. m).
c. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

1.3 EXECUTION

A. Examination
1. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
2. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
a. Completely proof-roll subbase in one direction and repeat in perpendicular direction, **as directed**. Limit vehicle speed to 3 mph (5 km/h).
b. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes).
c. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch (13 mm) according to requirements in Division 02 Section "Earthwork".
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Remove loose material from compacted subbase surface immediately before placing concrete.

C. Edge Forms And Screed Construction
1. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
2. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

D. Steel Reinforcement
1. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
2. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
3. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
4. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
5. Zinc-Coated Reinforcement: Use galvanized-steel wire ties to fasten zinc-coated reinforcement. Repair cut and damaged zinc coatings with zinc repair material.
6. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M.
7. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch (50-mm) overlap of adjacent mats.

E. Joints
1. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
a. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

2. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
   a. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
   b. Provide tie bars at sides of paving strips where indicated.
   c. Butt Joints: Use bonding agent **OR** epoxy bonding adhesive, **as directed**, at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
   d. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
   e. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
3. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
   a. Locate expansion joints at intervals of 50 feet (15.25 m) unless otherwise indicated.
   b. Extend joint fillers full width and depth of joint.
   c. Terminate joint filler not less than 1/2 inch (13 mm) or more than 1 inch (25 mm) below finished surface if joint sealant is indicated.
   d. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
   e. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
   f. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
4. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows, to match jointing of existing adjacent concrete paving:
   a. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch (6-mm) **OR** 3/8-inch (10-mm), **as directed**, radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces, **as directed**.
      1) Tolerance: Ensure that grooved joints are within 3 inches (75 mm) either way from centers of dowels.
   b. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
      1) Tolerance: Ensure that sawed joints are within 3 inches (75 mm) either way from centers of dowels.
   c. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
   d. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch (6-mm) **OR** 3/8-inch (10-mm), **as directed**, radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces, **as directed**.

F. Concrete Placement
   1. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.
   2. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.

3. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
4. Comply with ACI 301 (ACI 301M) requirements for measuring, mixing, transporting, and placing concrete.
5. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.
6. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
7. Consolidate concrete according to ACI 301 (ACI 301M) by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
   a. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.
8. Screed paving surface with a straightedge and strike off.
9. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
10. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.
11. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.
    a. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.
12. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
    a. When air temperature has fallen to or is expected to fall below 40 deg F (4.4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.
    b. Do not use frozen materials or materials containing ice or snow.
    c. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.
13. Hot-Weather Placement: Comply with ACI 301 (ACI 301M) and as follows when hot-weather conditions exist:
    a. Cool ingredients before mixing to maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
    b. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
    c. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

G. Float Finishing
1. General: Do not add water to concrete surfaces during finishing operations.
2. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
   a. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.

b. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.
c. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch (1.6 to 3 mm) deep with a stiff-bristled broom, perpendicular to line of traffic.

H. Special Finishes
1. Monolithic Exposed-Aggregate Finish: Expose coarse aggregate in paving surface as follows:
a. Immediately after float finishing, spray-apply chemical surface retarder to paving according to manufacturer's written instructions.
b. Cover paving surface with plastic sheeting, sealing laps with tape, and remove when ready to continue finishing operations.
c. Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more than one-third of the average diameter of the aggregate and not more than one-half of the diameter of the smallest aggregate.
d. Fine-spray surface with water and brush. Repeat cycle of water flushing and brushing until cement film is removed from aggregate surfaces to depth required.
2. Seeded Exposed-Aggregate Finish: Immediately after initial floating, spread a single layer of aggregate uniformly on paving surface. Tamp aggregate into plastic concrete and float finish to entirely embed aggregate with mortar cover of 1/16 inch (1.6 mm).
a. Spray-apply chemical surface retarder to paving according to manufacturer's written instructions.
b. Cover paving surface with plastic sheeting, sealing laps with tape, and remove sheeting when ready to continue finishing operations.
c. Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more than one-third of the average diameter of the aggregate and not more than one-half of the diameter of the smallest aggregate.
d. Fine-spray surface with water and brush. Repeat cycle of water flushing and brushing until cement film is removed from aggregate surfaces to depth required.
3. Slip-Resistive Aggregate Finish: Before final floating, spread slip-resistive aggregate finish on paving surface according to manufacturer's written instructions and as follows:
a. Uniformly spread 25 lb/100 sq. ft. (12 kg/10 sq. m) **OR** 40 lb/100 sq. ft. (19.5 kg/10 sq. m) **OR** 60 lb/100 sq. ft. (29 kg/10 sq. m), **as directed**, of dampened, slip-resistive aggregate over paving surface in two applications. Tamp aggregate flush with surface using a steel trowel, but do not force below surface.
b. Uniformly distribute approximately two-thirds of slip-resistive aggregate over paving surface with mechanical spreader, allow to absorb moisture, and embed by power floating. Follow power floating with a second slip-resistive aggregate application, uniformly distributing remainder of material at right angles to first application to ensure uniform coverage, and embed by power floating.
c. Cure concrete with curing compound recommended by slip-resistive aggregate manufacturer. Apply curing compound immediately after final finishing.
d. After curing, lightly work surface with a steel wire brush or abrasive stone and water to expose nonslip aggregate.
4. Rock-Salt Finish: After initial floating **OR** troweling **OR** brooming, **as directed**, uniformly spread rock salt over paving surface at the rate of 5 lb/100 sq. ft. (0.2 kg/10 sq. m).
a. Embed rock salt into plastic concrete with roller or magnesium float.
b. Cover paving surface with 1-mil- (0.025-mm-) thick polyethylene sheet and remove sheet when concrete has hardened and seven-day curing period has elapsed.
c. After seven-day curing period, saturate concrete with water and broom-sweep surface to dissolve remaining rock salt, thereby leaving pits and holes.
5. Pigmented Mineral Dry-Shake Hardener Finish: After initial floating, apply dry-shake materials to paving surface according to manufacturer's written instructions and as follows:

a. Uniformly spread dry-shake hardener at a rate of 100 lb/100 sq. ft. (49 kg/10 sq. m), unless greater amount is recommended by manufacturer to match paving color required.
b. Uniformly distribute approximately two-thirds of dry-shake hardener over the concrete surface with mechanical spreader; allow hardener to absorb moisture and embed it by power floating. Follow power floating with a second application of pigmented mineral dry-shake hardener, uniformly distributing remainder of material at right angles to first application to ensure uniform color, and embed hardener by final power floating.
c. After final power floating, apply a hand-trowel finish followed by a broom finish.
d. Cure concrete with curing compound recommended by dry-shake hardener manufacturer. Apply curing compound immediately after final finishing.

I. Detectable Warnings
1. Blockouts: Form blockouts in concrete for installation of detectable paving units specified in Division 02 Section "Unit Pavers".
   a. Tolerance for Opening Size: Plus 1/4 inch (6 mm), no minus.
2. Stamped Detectable Warnings: Install stamped detectable warnings as part of a continuous concrete paving placement and according to stamp-mat manufacturer's written instructions.
   a. Before using stamp mats, verify that the vent holes are unobstructed.
   b. Apply liquid release agent to the concrete surface and the stamp mat.
   c. Stamping: While initially finished concrete is plastic **OR** After application and final floating of pigmented mineral dry-shake hardener, **as directed**, accurately align and place stamp mats in sequence. Uniformly load, gently vibrate, and press mats into concrete to produce imprint pattern on concrete surface. Load and tamp mats directly perpendicular to the stamp-mat surface to prevent distortion in shape of domes. Press and tamp until mortar begins to come through all of the vent holes. Gently remove stamp mats.
   d. Trimming: After 24 hours, cut off the tips of mortar formed by the vent holes.
   e. Remove residual release agent according to manufacturer's written instructions, but no fewer than three days after stamping concrete. High-pressure-wash surface and joint patterns, taking care not to damage stamped concrete. Control, collect, and legally dispose of runoff.

J. Concrete Protection And Curing
1. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
2. Comply with ACI 306.1 for cold-weather protection.
3. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.
4. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
5. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:
   a. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
      1) Water.
      2) Continuous water-fog spray.
      3) Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.
   b. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm) and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period using cover material and waterproof tape.
   c. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas that have been subjected to

heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

K. Paving Tolerances
1. Comply with tolerances in ACI 117 and as follows:
a. Elevation: 3/4 inch (19 mm).
b. Thickness: Plus 3/8 inch (10 mm), minus 1/4 inch (6 mm).
c. Surface: Gap below 10-foot- (3-m-) long, unleveled straightedge not to exceed 1/2 inch (13 mm).
d. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches (13 mm per 300 mm) of tie bar.
e. Lateral Alignment and Spacing of Dowels: 1 inch (25 mm).
f. Vertical Alignment of Dowels: 1/4 inch (6 mm).
g. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches (6 mm per 300 mm) of dowel.
h. Joint Spacing: 3 inches (75 mm).
i. Contraction Joint Depth: Plus 1/4 inch (6 mm), no minus.
j. Joint Width: Plus 1/8 inch (3 mm), no minus.

L. Pavement Marking
1. Do not apply pavement-marking paint until layout, colors, and placement have been verified with the Owner.
2. Allow concrete paving to cure for a minimum of 28 days and be dry before starting pavement marking.
3. Sweep and clean surface to eliminate loose material and dust.
4. Apply paint with mechanical equipment to produce markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils (0.4 mm).
a. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to concrete surface. Mask an extended area beyond edges of each stencil to prevent paint application beyond stencil. Apply paint so that it cannot run beneath stencil.
b. Broadcast glass beads uniformly into wet markings at a rate of 6 lb/gal. (0.72 kg/L).

M. Wheel Stops
1. Install wheel stops in bed of adhesive applied as recommended by manufacturer.
2. Securely attach wheel stops to paving with not less than two steel **OR** galvanized-steel, **as directed**, dowels located at one-quarter to one-third points. Install dowels in drilled holes in the paving and bond dowels to wheel stop. Recess head of dowel beneath top of wheel stop.

N. Preformed Traffic-Calming Devices
1. Install preformed speed bumps **OR** humps **OR** cushions, **as directed**, in bed of adhesive applied as recommended by manufacturer for heavy traffic.
2. Securely attach preformed speed bumps **OR** humps **OR** cushions, **as directed**, to paving with hardware spaced as recommended by manufacturer for heavy traffic. Recess head of hardware beneath top surface.

O. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
a. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. (76 cu. m) **OR** 5000 sq. ft. (465 sq. m), **as directed**, or fraction thereof of each concrete mixture placed each day.

1) When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

b. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.

c. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

d. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when it is 80 deg F (27 deg C) and above, and one test for each composite sample.

e. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.

f. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.

1) A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

3. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).

4. Test results shall be reported in writing to the Owner, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

5. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by the Owner but will not be used as sole basis for approval or rejection of concrete.

6. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by the Owner.

7. Concrete paving will be considered defective if it does not pass tests and inspections.

8. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

9. Prepare test and inspection reports.

P. Repairs And Protection

1. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by the Owner.

2. Drill test cores, where directed by the Owner, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

3. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

4. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 02614

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SECTION 02614a - ROLLER COMPACTED CONCRETE PAVEMENT

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of roller compacted concrete pavement. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Cementitious Materials:
1. Portland cement shall conform to ASTM C 150, Type I. Low alkali is to be used with aggregates when directed. In lieu of low-alkali cement, the Contractor may use a combination of Portland cement that does not meet the low-alkali requirement with a suitable pozzolan or ground granulated blast-furnace slag (GGBFS) provided the following requirement is met. The expansion of the proposed combination shall be equal to or less than the expansion of a low-alkali cement meeting the requirements of ASTM C 150 when tested in conformance with ASTM C 441. These two tests shall be performed concurrently at an independent certified laboratory at the Contractor's expense. the Owner reserves the right to confirm the test results and to adjust the percentage of pozzolan or GGBFS in the combination to suit other requirements at no additional cost to the Owner. Portland cement shall be furnished in bulk.
2. Pozzolan shall conform to ASTM C 618, and, in addition, limits in Table 2A, Uniformity Requirements (for air content) shall apply to all fly ash. Table 1A, Supplementary Optional Chemical Requirement for Maximum Alkalies, shall apply when it is to be used with aggregates listed to require low-alkali cement. Pozzolan shall be furnished in bulk.
3. The temperature of the cementitious materials as delivered to the site shall not exceed 150 degrees F.

B. Admixtures: All chemical admixtures furnished as liquids shall be in a solution of suitable viscosity and dilution for field use as determined by the Owner.
1. Water-Reducing Admixture (WRA) shall meet the requirements of ASTM C 494, Type D.
2. Air-entraining admixture shall conform to ASTM C 260.

C. Water for washing aggregates and for mixing and curing concrete shall be free from injurious amounts of oil, acid, salt, alkali, organic matter, or other deleterious substances and shall comply with COE CRD-C 400.

D. Aggregates
1. Composition: Fine aggregate shall consist of natural sand, manufactured sand, or a combination of natural and manufactured sands. Coarse aggregate shall consist of gravel, crushed gravel, crushed stone, air-cooled blast-furnace slag, or a combination thereof.
OR
All concrete mixtures will be proportioned by the Owner except that proportions for the slipformed facing concrete mixture will be selected by the Contractor. RCC shall be composed of cementitious materials, water, fine and coarse aggregates, and possibly admixtures. The cementitious material shall be portland cement, or portland cement in combination with pozzolan. An admixture when approved or directed will be a water-reducing/retarding admixture. Air-entraining admixture will be used in the bedding concrete and other conventional concrete.

1.3 EXECUTION

A. Concrete Mixing Plant: A continuous mixing plant(s) shall be capable of producing RCC of the same quality and uniformity as would be produced in a conventional redi-mix batch plant and shall be capable of producing a uniform continuous product (at both maximum and minimum production rates) that is mixed so that complete intermingling of all ingredients occurs without balling, segregation, and wet or dry portions.

B. Trucks: Truck mixers or agitators used for transporting central-mixed conventional concrete shall conform to the applicable requirements of ASTM C 94. Truck mixers shall not be used to transport concrete with larger than 37.5 mm (1-1/2-inch) nominal maximum size aggregate (NMSA) or 2 inch slump, or less. Nonagitating trucks may be used for transporting conventional central-mixed concrete over a smooth road when the hauling time is less than 15 minutes and the slump is less than 3 inches. Bodies of nonagitating trucks shall be smooth, water-tight, metal containers specifically designed to transport concrete, shaped with rounded corners to minimize segregation.

C. Belt Conveyors: Belt conveyors shall be designed and operated to assure a uniform flow of concrete from mixer or delivery truck to final place of deposit without segregation of ingredients or loss of mortar and shall be provided with positive means for preventing segregation of the concrete or loss of mortar at transfer points and the point of placing. The NMSA required in mixture proportions furnished by the Owner will not be changed to accommodate the belt width.

D. Spreading and Remixing Equipment: The primary spreading procedure shall be accomplished by dozer. Graders or other equipment not specified may be used to facilitate the RCC spreading process only when approved. For open, unrestricted areas, the dozer shall be a minimum size and weight equivalent to a Caterpillar D-6. For restricted placement areas, such as placement of RCC near the dam crest or next to abutments, the dozer shall have as a minimum a size and weight equivalent to a Caterpillar D-4. There shall be a minimum of one operating dozer for each 200 cubic yards of RCC placed each hour. The dozers shall be equipped with well-maintained grousers. A front-end loader with operator shall be available to assist with deposition and spreading of RCC as needed in confined areas. The equipment shall be maintained in good operating condition. The equipment shall not leak or drip oil, grease, or other visible contaminants onto the RCC surface. All equipment used for spreading and remixing that leaves the surface of the structure for maintenance or repairs or, for any other reason, must be cleaned of all contaminants by an approved method before returning to the structure surface. Under no conditions shall a dozer or other tracked vehicle be operated on other than fresh uncompacted RCC except to facilitate startup operations for each lift and by approved procedures.

E. Compaction Equipment:
1. Self-propelled vibratory rollers shall be used for primary rolling and shall be double-drum. They shall transmit a dynamic impact to the surface through a smooth steel drum by means of revolving weights, eccentric shafts, or other equivalent methods. The compactor shall have a minimum gross mass of 20,000 pounds and shall produce a minimum dynamic force of 350 pounds per linear inch of drum width. The operating frequency shall be variable in the approximate range of 1,700 to 3,000 cycles per minute. The amplitude shall be adjustable between 0.015 and 0.04 inches. The roller shall be capable of full compaction in both forward and reverse directions. The roller shall be operated at speeds not exceeding 2.2 ft/s. Within the range of the operating capability of the equipment, the Owner may direct or approve variations to the frequency, amplitude, and speed of operation which result in the specified density at the fastest production rate.
2. Small vibratory rollers shall be used to compact the RCC where the larger vibratory rollers specified above cannot maneuver. The rollers shall compact the RCC to the required density and shall be so demonstrated during construction of the test section. Small vibratory rollers cannot compact the RCC to the same density and thickness as the primary rollers. When small rollers are used, total lift thickness of the RCC layer or lift shall be reduced to not over 6 inches

uncompacted thickness to permit adequate compaction. Rollers shall have independent speed and vibration controls and shall be capable of a wide range of speed adjustments.

3. The tampers shall compact the RCC to the required density and shall be so demonstrated during construction of the test section. Tampers cannot compact the RCC to the same density and thickness as the primary rollers. When tampers are used, thickness of each RCC layer that is to be compacted shall be reduced to not more than 6 inches uncompacted thickness to assure adequate compaction.

F. Placing During Rain: RCC shall not be placed during rainfall of 0.1 inch/hr or more. During periods of lesser rainfall, placement of RCC may continue if, in the opinion of the Owner, no damage to the RCC is occurring. Work shall commence only after excess free surface water and contaminated paste or RCC have been removed. The surface shall have gained sufficient strength (no less than 4 hours after the RCC placement was suspended) to prevent rutting, pumping, intermixing of rainwater with the RCC, or other damage to the RCC. When the RCC surface has been contaminated or damaged in any manner, the RCC surface shall be washed to break up and remove laitance and/or mud-like coatings from the surface. Any undercut coarse aggregate shall be removed. All waste shall be removed and disposed of in an approved manner.

G. Hot-Weather Placement: In hot-weather placement the temperature of the RCC shall be controlled so that it does not exceed 75.0 degrees F when placed. Placement shall be suspended as soon as the RCC temperature exceeds 75 degrees F. Measures that can be taken to prevent temperatures exceeding75 degrees F include, but are not limited to; 1.) chilling mixing water, 2.) sprinkling aggregate stockpiles, 3.) use of a canopy to shade the RCC placement areas, 4.) placing during nighttime and early morning hours, or 5.) restricting placements to cloudy days. Use of any of these systems shall not be reason for extension of completion dates specified in these specifications. In addition, to prevent potential damage to the RCC due to hot-weather related placement conditions, all RCC operation shall be suspended between June 15 and October 31, unless directed otherwise.

END OF SECTION 02614a

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SECTION 02614b - DECORATIVE CEMENT CONCRETE PAVEMENT

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for decorative cement concrete pavement. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes colored, stamped, stenciled, and stained concrete paving.

C. Definitions
1. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

D. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
   a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.
   b. Design Mixtures for Credit ID 1.1: For each concrete mixture containing fly ash as a replacement for portland cement or other portland cement replacements. For each design mixture submitted, include an equivalent concrete mixture that does not contain portland cement replacements, to determine amount of portland cement replaced.
3. Samples: For each type of exposed color, pattern, or texture indicated.
4. Other Action Submittals:
   a. Design Mixtures: For each decorative concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
5. Qualification Data: For qualified Installer, ready-mix concrete manufacturer, and testing agency.
6. Material Certificates: For the following, from manufacturer:
   a. Cementitious materials.
   b. Steel reinforcement and reinforcement accessories.
   c. Fiber reinforcement.
   d. Admixtures.
   e. Curing compounds.
   f. Applied finish materials.
   g. Bonding agent or epoxy adhesive.
   h. Joint fillers.
7. Material Test Reports: For each of the following:
   a. Aggregates. Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.
8. Field quality-control reports.

E. Quality Assurance
1. Installer Qualifications: An employer of workers trained and approved by manufacturer of decorative concrete paving systems.
2. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

a. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

3. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
   a. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
4. Source Limitations: Obtain decorative concrete paving products and each type or class of cementitious material of the same brand from same manufacturer's plant, and obtain each aggregate from single source.
5. Concrete Testing Service: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures.
6. ACI Publications: Comply with ACI 301 (ACI 301M) unless otherwise indicated.
7. Preinstallation Conference: Conduct conference at Project site.

F. Project Conditions
1. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

1.2 PRODUCTS

A. Forms
1. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
   a. Use flexible or uniformly curved forms for curves of a radius of 100 feet (30.5 m) or less. Do not use notched and bent forms.
2. Forms for Textured Finish Concrete: Units of face design, size, arrangement, and configuration indicated. Provide solid backing and form supports to ensure stability of textured form liners.
3. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

B. Steel Reinforcement
1. Recycled Content: Provide steel reinforcement with an average recycled content of steel so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
2. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from as-drawn steel wire into flat sheets.
3. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420); deformed.
4. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60 (Grade 420), deformed bars; assembled with clips.
5. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.
6. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) plain-steel bars. Cut bars true to length with ends square and free of burrs.
7. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:
   a. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

C. Concrete Materials
1. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

a. Portland Cement: ASTM C 150, gray **OR** white, **as directed**, portland cement Type I **OR** Type II **OR** Type I/II **OR** Type III **OR** Type V, **as directed**. Supplement with the following, **as directed**:
   1) Fly Ash: ASTM C 618, Class C or F.
   2) Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

b. Blended Hydraulic Cement: ASTM C 595, Type IS, portland blast-furnace slag **OR** Type IP, portland-pozzolan, **as directed**, cement.

2. Normal-Weight Aggregates: ASTM C 33, Class 4S **OR** Class 4M **OR** Class 1N, **as directed**, uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials, **as directed**.
   a. Maximum Aggregate Size: 1-1/2 inches (38 mm) **OR** 1 inch (25 mm) **OR** 3/4 inch (19 mm), **as directed**, nominal.
   b. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
3. Water: Potable and complying with ASTM C 94/C 94M.
4. Air-Entraining Admixture: ASTM C 260.
5. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
   a. Water-Reducing Admixture: ASTM C 494/C 494M, Type A, colored, **as directed**.
   b. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D, colored, **as directed**.
   c. Water-Reducing and Accelerating Admixture: ASTM C 494/C 494M, Type E.
6. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, **as directed**, nonfading, and resistant to lime and other alkalis.

D. Fiber Reinforcement
1. Synthetic Fiber: Monofilament or fibrillated polypropylene fibers engineered and designed for use in decorative concrete paving, complying with ASTM C 1116/C 1116M, Type III, 1/2 to 1-1/2 inches (13 to 38 mm) long.

E. Surface Coloring Materials
1. Pigmented Mineral Dry-Shake Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.
2. Pigmented Powder Release Agent: Factory-packaged, dry combination of surface-conditioning and dispersing agents interground with color pigments that facilitates release of stamp mats. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.
3. Liquid Release Agent: Manufacturer's standard, clear, evaporating formulation that facilitates release of stamp mats and texture rollers.

F. Stamping Devices
1. Stamp Mats: Semirigid polyurethane mats with projecting textured and ridged underside capable of imprinting texture and joint patterns on plastic concrete.
2. Stamp Tools: Open-grid, aluminum or rigid-plastic stamp tool capable of imprinting joint patterns on plastic concrete.
3. Rollers: Manually controlled, water-filled aluminum rollers with projecting ridges on drum capable of imprinting texture and joint patterns on plastic concrete.
4. Texture Rollers: Manually controlled, abrasion-resistant polyurethane rollers capable of imprinting texture on plastic concrete.

G. Stencil Materials
1. Stencils: Manufacturer's standard, moisture-resistant paper or reusable plastic stencils, designed for use on plastic concrete.

H. Stain Materials
1. Reactive Stain: Acidic-based stain with wetting agents and high-grade, UV-stable metallic salts that react with calcium hydroxide in cured concrete to produce permanent, variegated, or translucent color effects.
2. Penetrating Stain: Water-based, acrylic latex, penetrating stain with colorfast pigments.

I. Curing And Sealing Materials
1. Curing Paper: Nonstaining, waterproof paper, consisting of two layers of kraft paper cemented together and reinforced with fiber, and complying with ASTM C 171.
2. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.
3. Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type I, Class B, manufactured for colored concrete.
   a. For integrally colored concrete, curing compound shall be pigmented type approved by coloring admixture manufacturer.
   b. For concrete indicated to be sealed, curing compound shall be compatible with sealer.
4. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type I, Class A, manufactured for use with colored concrete.
5. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type I, Class A, manufactured for use with colored concrete.
6. Clear Acrylic Sealer: Manufacturer's standard, waterborne, nonyellowing and UV-resistant, membrane-forming, medium-gloss, acrylic copolymer emulsion solution, manufactured for colored concrete, containing not less than 15 percent solids by volume.
7. Slip-Resistance-Enhancing Additive: Manufacturer's standard finely graded aggregate or polymer additive, designed to be added to clear acrylic sealer to enhance slip resistance of sealed paving surface.

J. Related Materials
1. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork in preformed strips.
2. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
3. Epoxy Bonding Adhesive: ASTM C 881/C 881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:
   a. Types I and II, non-load bearing **OR** Types IV and V, load bearing, **as directed**, for bonding hardened or freshly mixed concrete to hardened concrete.
4. Polyethylene Film: ASTM D 4397, 1 mil (0.025 mm) thick, clear.

K. Concrete Mixtures
1. Prepare design mixtures, proportioned according to ACI 301 (ACI 301M), for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.
   a. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
2. Proportion mixtures to provide normal-weight concrete with the following properties:
   a. Compressive Strength (28 Days): 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**.
   b. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45 **OR** 0.50, **as directed**.
   c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm), **as directed**, plus or minus 1 inch (25 mm).
3. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
   a. Air Content: 5-1/2 **OR** 4-1/2 **OR** 2-1/2, **as directed**, percent plus or minus 1.5 percent for 1-1/2-inch (38-mm) nominal maximum aggregate size.

b. Air Content: 6 **OR** 4-1/2 **OR** 3, **as directed**, percent plus or minus 1.5 percent for 1-inch (25-mm) nominal maximum aggregate size.
c. Air Content: 6 **OR** 5 **OR** 3-1/2, **as directed**, percent plus or minus 1.5 percent for 3/4-inch (19-mm) nominal maximum aggregate size.

4. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 **OR** 0.30, **as directed**, percent by weight of cement.
5. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
   a. Use water-reducing admixture **OR** water-reducing and retarding admixture **OR** water-reducing and accelerating admixture, **as directed**, in concrete as required for placement and workability.
   b. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
6. Cementitious Materials: Limit percentage by weight of cementitious materials other than portland cement according to ACI 301 (ACI 301M) requirements for concrete exposed to deicing chemicals **OR** as follows, **as directed**:
   a. Fly Ash or Pozzolan: 25 percent.
   b. Ground Granulated Blast-Furnace Slag: 50 percent.
   c. Combined Fly Ash or Pozzolan, and Ground Granulated Blast-Furnace Slag: 50 percent, with fly ash or pozzolan not exceeding 25 percent.
7. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd. (0.60 kg/cu. m).
8. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

L. Concrete Mixing
1. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M, **as directed**. Furnish batch certificates for each batch discharged and used in the Work.
   a. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.
2. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.
   a. For concrete batches of 1 cu. yd. (0.76 cu. m) or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
   b. For concrete batches larger than 1 cu. yd. (0.76 cu. m), increase mixing time by 15 seconds for each additional 1 cu. yd. (0.76 cu. m).
   c. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

1.3 EXECUTION

A. Examination
1. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
2. Proof-roll prepared subbase surface below decorative concrete paving to identify soft pockets and areas of excess yielding.
   a. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph (5 km/h).
   b. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes).
   c. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch (13 mm) according to requirements in Division 02 Section "Earthwork".

3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Remove loose material from compacted subbase surface immediately before placing concrete.
2. Protect adjacent construction from discoloration and spillage during application of color hardeners, release agents, stains, curing compounds, and sealers.

C. Edge Forms And Screed Construction
1. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
2. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

D. Steel Reinforcement
1. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
2. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
3. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
4. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
5. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch (50-mm) overlap to adjacent mats.

E. Joints
1. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
   a. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.
2. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
   a. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
   b. Butt Joints: Use bonding agent **OR** epoxy bonding adhesive, **as directed**, at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
   c. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
   d. Dowelled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
3. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
   a. Locate expansion joints at intervals of 50 feet (15.25 m) unless otherwise indicated.
   b. Extend joint fillers full width and depth of joint.
   c. Terminate joint filler not less than 1/2 inch (13 mm) or more than 1 inch (25 mm) below finished surface if joint sealant is indicated.
   d. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
   e. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.

f. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

4. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows, to match jointing of existing adjacent decorative concrete paving, **as directed**:
   a. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch (6-mm) **OR** 3/8-inch (10-mm), **as directed**, radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.
      1) Tolerance: Ensure that grooved joints are within 3 inches (75 mm) either way from centers of dowels.
   b. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
      1) Tolerance: Ensure that sawed joints are within 3 inches (75 mm) in both directions from center of dowels.
   c. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
5. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch (6-mm) **OR** 3/8-inch (10-mm), **as directed**, radius. Repeat tooling of edges after applying surface finishes. Eliminate edging tool marks on concrete surfaces.

F. Concrete Placement
1. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.
2. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.
3. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
4. Comply with ACI 301 (ACI 301M) requirements for measuring, mixing, transporting, and placing concrete.
5. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.
6. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
7. Consolidate concrete according to ACI 301 (ACI 301M) by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
   a. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.
8. Screed paving surface with a straightedge and strike off.
9. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
10. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
    a. When air temperature has fallen to or is expected to fall below 40 deg F (4.4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture

temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.

b. Do not use frozen materials or materials containing ice or snow.

c. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

11. Hot-Weather Placement: Comply with ACI 301 (ACI 301M) and as follows when hot-weather conditions exist:

a. Cool ingredients before mixing to maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

b. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.

c. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

G. Float Finishing

1. General: Do not add water to concrete surfaces during finishing operations.

2. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

H. Integrally Colored Concrete Finish

1. Integrally Colored Concrete Finish: After final floating, apply the following finish:

a. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.

b. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.

c. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch (1.6 to 3 mm) deep with a stiff-bristled broom, perpendicular to line of traffic.

I. Stenciling

1. Cut stencils to slab width and lay on wet concrete. Overlap "mortar joint" on trailing edge of each section of stencil onto leading "mortar joint" of previous section.

2. Trim stencils to fit slab and adjacent patterns.

3. Slightly embed stencil into concrete by rolling with stencil roller.

4. Apply pigmented mineral dry-shake hardener materials to concrete surfaces according to manufacturer's written instructions.

5. Stencil Rolling:

a. Apply pigmented powder release agent **OR** liquid release agent, **as directed**, according to manufacturer's written instructions prior to applying texture roller to surface of concrete.

b. Perform rolling operation to produce required texture on concrete surface.

6. Remove stencils when concrete has sufficiently cured to bear weight. Do not leave stencils in concrete overnight.

7. Remove debris with mechanical blower prior to application of curing compound. If release agent is applied, delay removal of debris for 24 hours, then flood area with low-pressure water hose, wetting release agent, and follow by cleaning surface with pressure washer.

J. Pigmented Mineral Dry-Shake Hardener

1. Pigmented Mineral Dry-Shake Hardener Finish: After initial floating, apply dry-shake materials to paving surfaces according to manufacturer's written instructions and as follows:

a. Uniformly apply dry-shake hardener at a rate of 100 lb/100 sq. ft. (49 kg/10 sq. m) unless greater amount is recommended by manufacturer to match paving color required.
b. Uniformly distribute approximately two-thirds of dry-shake hardener over the concrete surface with mechanical spreader; allow hardener to absorb moisture and embed it by power floating. Follow power floating with a second application of pigmented mineral dry-shake hardener, uniformly distributing remainder of material at right angles to first application to ensure uniform color, and embed hardener by final power floating.
c. After final power floating, apply the following finish:
1) Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
2) Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.
3) Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch (1.6 to 3 mm) deep with a stiff-bristled broom, perpendicular to line of traffic.

2. Pigmented Powder Release Agent: Uniformly distribute onto dry-shake-hardened and still-plastic concrete at a rate of 3 to 4 lb/100 sq. ft. (1.5 to 2 kg/10 sq. m).
3. Liquid Release Agent: Uniformly mist surface of dry-shake-hardened and still-plastic concrete at a rate of 5 gal/1000 sq. ft. (0.2 L/sq. m).

K. Stamping
1. Mat Stamping: After floating and while concrete is plastic, apply mat-stamped finish.
a. Pigmented Powder Release Agent: Uniformly distribute onto concrete at a rate of 3 to 4 lb/100 sq. ft. (1.5 to 2 kg/10 sq. m).
b. Liquid Release Agent: Apply liquid release agent to the concrete surface and the stamp mat. Uniformly mist surface of concrete at a rate of 5 gal/1000 sq. ft. (0.2 L/sq. m).
c. After application of release agent, accurately align and place stamp mats in sequence.
d. Uniformly load mats and press into concrete to produce required imprint pattern and depth of imprint on concrete surface. Gently remove stamp mats. Hand stamp edges and surfaces unable to be imprinted by stamp mats.
e. Remove residual release agent according to manufacturer's written instructions, but no fewer than three days after stamping concrete. High-pressure-wash surface and joint patterns, taking care not to damage stamped concrete. Control, collect, and legally dispose of runoff.
2. Tool Stamping: After floating and while concrete is plastic, apply tool-stamped finish.
a. Cover surface with polyethylene film, stretch taut to remove wrinkles, lap sides and ends 3 inches (75 mm), and secure to edge forms. Lightly broom surface to remove air bubbles.
b. Accurately align and place stamp tools in sequence and tamp into concrete to produce required imprint pattern and depth of imprint on concrete surface. Gently remove stamp tools. Hand stamp edges and surfaces unable to be imprinted by stamp tools.
c. Carefully remove polyethylene film immediately after tool stamping.
3. Roller Stamping: After floating and while concrete is plastic, apply roller-stamped finish.
a. Cover surface with polyethylene film, stretch taut to remove wrinkles, lap sides and ends 3 inches (75 mm), and secure to edge forms. Lightly broom surface to remove air bubbles.
b. Accurately align roller and perform rolling operation to produce required imprint pattern and depth of imprint on concrete surface. Hand stamp surfaces inaccessible to roller.
c. Carefully remove polyethylene film immediately after roller stamping.

L. Concrete Protection And Curing
1. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
2. Comply with ACI 306.1 for cold-weather protection.
3. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during

finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

4. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
5. Curing Compound: Apply curing compound immediately after final finishing. Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas that have been subjected to heavy rainfall within three hours after application. Maintain continuity of coating, and repair damage during curing period.
   a. Cure integrally colored concrete with a pigmented, **as directed**, curing compound.
   b. Cure concrete finished with pigmented mineral dry-shake hardener with a pigmented, **as directed**, curing compound.
6. Curing and Sealing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.
7. Curing Paper: Cure with unwrinkled curing paper in pieces large enough to cover the entire width and edges of slab. Do not lap sheets. Fold curing paper down over paving edges and secure with continuous banks of earth to prevent displacement or billowing due to wind. Immediately repair holes or tears in paper.

M. Staining
1. Newly placed concrete paving shall be at least 14 **OR** 30, **as directed**, days old before staining.
2. Prepare surfaces according to manufacturer's written instructions and as follows:
   a. Clean concrete thoroughly by scraping, applying solvents or stripping agents, sweeping and pressure washing, or scrubbing with a rotary floor machine and detergents recommended by stain manufacturer. Rinse until water is clear and allow surface to dry.
      1) Do not use acidic solutions to clean surfaces.
   b. Test surfaces with droplets of water. If water beads and does not penetrate surface, or penetrates only in some areas, profile surfaces by acid etching, grinding, sanding, or abrasive blasting. Retest and continue profiling surface until water droplets immediately darken and uniformly penetrate concrete surfaces.
   c. Apply acidic solution to dampened concrete surfaces, scrubbing with uncolored, acid-resistant nylon-bristle brushes until bubbling stops and concrete surface has texture of 120-grit sandpaper. Do not allow solution to dry on concrete surfaces. Rinse until water is clear. Control, collect, and legally dispose of runoff.
   d. Neutralize concrete surfaces and rinse until water is clear. Test surface for residue with clean white cloth. Test surface according to ASTM F 710 to ensure pH is between 7 and 8.
3. Scoring: Score decorative jointing in paving surfaces 1/16 inch (1.6 mm) deep with diamond blades to match pattern indicated. Rinse until water is clear. Score after **OR** before, **as directed**, staining.
   a. Joint Width: 3/8 inch (10 mm).
4. Allow paving surface to dry before applying stain. Verify readiness of paving to receive stain according to ASTM D 4263 by tightly taping 18-by-18-inch (450-by-450-mm), 4-mil- (0.1-mm-) thick polyethylene sheet to a representative area of paving surface. Apply stain only if no evidence of moisture has accumulated under sheet after 16 hours.
5. Reactive Stain: Apply reactive stain to paving surfaces according to manufacturer's written instructions and as follows:
   a. Apply stain by uncolored bristle brush, roller, or high-volume, low-pressure sprayer and immediately scrub into concrete surface with uncolored, acid-resistant nylon-bristle brushes in continuous, circular motion. Do not spread stain after fizzing stops. Allow to dry four hours and repeat application of stain in sufficient quantity to obtain color consistent with approved mockup.
   b. Remove stain residue after four hours by wet scrubbing with commercial-grade detergent recommended by stain manufacturer. Rinse until water is clear. Control, collect, and legally dispose of runoff.

6. Penetrating Stain: Apply penetrating stain to paving surfaces according to manufacturer's written instructions and as follows:
   a. Apply first coat of stain to dry, clean surfaces by airless sprayer or by high-volume, low-pressure sprayer.
   b. Allow to dry four hours and repeat application of stain in sufficient quantity to obtain color consistent with approved mockup.
   c. Rinse until water is clear. Control, collect, and legally dispose of runoff.

N. Sealer
1. Clear Acrylic Sealer: Apply uniformly in two coats in continuous operations according to manufacturer's written instructions. Allow first coat to dry before applying second coat, at 90 degrees to the direction of the first coat using same application methods and rates.
   a. Begin sealing dry surface no sooner than 14 days after concrete placement.
   b. Allow stained concrete surfaces to dry before applying sealer.
   c. Thoroughly mix slip-resistance-enhancing additive into sealer before applying sealer according to manufacturer's written instructions. Stir sealer occasionally during application to maintain even distribution of additive.

O. Paving Tolerances
1. Comply with tolerances in ACI 117 and as follows:
   a. Elevation: 3/4 inch (19 mm).
   b. Thickness: Plus 3/8 inch (10 mm), minus 1/4 inch (6 mm).
   c. Surface: Gap below 10-foot- (3-m-) long, unleveled straightedge not to exceed 1/2 inch (13 mm).
   d. Lateral Alignment and Spacing of Dowels: 1 inch (25 mm).
   e. Vertical Alignment of Dowels: 1/4 inch (6 mm).
   f. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches (6 mm per 300 mm) of dowel.
   g. Joint Spacing: 3 inches (75 mm).
   h. Contraction Joint Depth: Plus 1/4 inch (6 mm), no minus.
   i. Joint Width: Plus 1/8 inch (3 mm), no minus.

P. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
   a. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. (76 cu. m) **OR** 5000 sq. ft. (465 sq. m), **as directed**, or fraction thereof of each concrete mixture placed each day.
      1) When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
   b. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
   c. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
   d. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when it is 80 deg F (27 deg C) and above, and one test for each composite sample.
   e. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
   f. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.
      1) A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

3. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).
4. Test results shall be reported in writing to the Owner, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
5. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by the Owner but will not be used as sole basis for approval or rejection of concrete.
6. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by the Owner.
7. Decorative concrete paving will be considered defective if it does not pass tests and inspections.
8. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
9. Prepare test and inspection reports.

Q. Repairs And Protection
1. Remove and replace decorative concrete paving that is broken or damaged or does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by the Owner.
2. Detailing: Grind concrete "squeeze" left from tool placement. Color ground areas with slurry of color hardener mixed with water and bonding agent. Remove excess release agent with high-velocity blower.
3. Protect decorative concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
4. Maintain decorative concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 02614b

SECTION 02614c - PORTLAND CEMENT CONCRETE OVERLAYS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of Portland cement concrete overlays. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Coarse Aggregate:
1. Composition: Coarse aggregate shall consist of gravel, crushed gravel, crushed stone, a combination thereof, or crushed blast-furnace slag.
2. Particle Shape: Particles of the coarse aggregate shall be generally spherical or cubical in shape. The quantity of flat and elongated particles in any size group shall not exceed 20 percent by weight as determined by ASTM D 3398.
3. Gradation: The maximum size of coarse aggregate shall be the lesser of 1/4 of the pavement thickness or 2 inches nominal size. Gradation limits are specified in ASTM C 136.
4. Deleterious Substances: The amount of deleterious substances in the coarse aggregate shall not exceed the limits, defined in ASTM C 117 and C 123.

B. Fine Aggregate shall consist of natural sand, manufactured sand, or a combination of natural and manufactured sand and shall be composed of clean, hard, durable particles. Particles of the fine aggregate shall be generally spherical or cubical in shape. Gradation limits are specified in ASTM C 136.

C. Portland Cement shall be Type I in compliance with ASTM C 150.

D. Air-Entraining Admixture shall be in compliance with ASTM C 260. Concrete mixtures shall have air content by volume of concrete of 4 to 7 percent based on measurements made immediately after discharge from the mixer.

E. Concrete Mixture shall have a nominal slump of 2 inches with a maximum of 3 inches and a 28-day flexural strength of not less than 650 psi.

F. Joint and Crack Sealing Materials: Joint filler, joint sealant, and crack sealant shall comply with the following:
1. Expansion Joint Fillers shall comply with ASTM D 1751 or D 1752 or shall be resin impregnated fiberboard in compliance with the physical requirements of ASTM D 1752.
2. Type I Sealant shall comply with Fed. Spec. SS-S-200, except that sealant may be furnished as a ready-mixed liquid.
3. Type II Sealant shall comply with Fed. Spec. SS-S-1401.
4. Type V Sealant shall comply with COE CRD-C-527 and may be either a single- or multiple-component material.

G. Epoxy-Resin Materials: Materials used in epoxy-resin grout, mortar, and concrete shall comply with the following:
1. Epoxy-Resin Grout shall be a two-compound material formulated to comply with ASTM C 881.

2. Epoxy-Resin Concrete shall be composed of epoxy-resin binder and uniformly graded aggregate in compliance with ASTM C 144. The maximum size of aggregate shall be 3/8 or 1/2 inch.

H. Dowels shall be plain steel bars complying with ASTM A 499.

1.3 EXECUTION

A. Preparation of Existing Surface: The Contractor shall raise and reset all structures such as manhole frames, valve boxes, drainage structures, etc. to meet the required grade. Bonding course shall be applied to the area prepared to receive overlay and shall be of epoxy-resin grout and Portland cement mortar.

B. Concrete Placement: Concrete shall be placed within 45 minutes from the time all ingredients are charged into the mixing drum.

C. Vibration: In the final phases of placing, surface vibrating equipment shall be used, and the duration of vibration shall not exceed 20 seconds.

D. Joints shall be saw cut and in alignment with underlying existing joints.

E. Finishing:
1. Transverse Finishing: Immediately after placement, concrete shall be accurately struck off and screeded to such elevation that when consolidated and finished, the surface of the pavement will be free from porous places and will be at the required grade. The finishing machine shall make at least two trips over each area of pavement to compact the concrete and produce a surface of uniform texture, true to grade.
2. Longitudinal Floating: After completion of the transverse finishing, the longitudinal mechanical float shall be operated to smooth and finish the pavement to grade.
3. Hand Finishing shall be with an approved strike and tamping template and a longitudinal float.
4. Straightedge Finishing: After the longitudinal floating is completed but while the concrete is still plastic, minor irregularities and score marks in the pavement surface shall be eliminated by means of long-handled wood floats and straightedges. The final finish shall be made with the straightedges, which shall be used to float the entire pavement surface.
5. Burlap Drag Finishing: When most of the water glaze or sheen has disappeared and before the concrete becomes nonplastic, drag the surface of the pavement in the direction of the concrete placement with a multiple-ply burlap drag.
6. Edging: After other finishing has been completed, the edges of slabs along the forms and at the joints shall be carefully finished with an edging tool to form a smooth rounded surface of the required radius.

F. Concrete Curing and Protection:
1. Concrete Curing Methods shall consist of mat method, impervious sheeting method, or liquid membrane curing method.
2. Concrete Protection: Protect repaired areas against damage prior to final acceptance. Traffic shall be excluded from repaired areas.

END OF SECTION 02614c

Task	Specification	Specification Description
02616	02612	Asphalt Paving

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SECTION 02617 - CRACK SEALING OF BITUMINOUS PAVEMENTS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for crack sealing of bituminous pavements. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Manufacturer's Recommendations: Where installation procedures, or any part thereof, are required to be in accordance with the manufacturer's recommendations, printed copies of these recommendations shall be submitted to the Owner. Installation of the material will not be allowed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.
2. Schedules/Construction Equipment List: List of proposed equipment to be used in performance of construction work including descriptive data shall be submitted to the Owner.
3. Samples: Samples of the materials (sealant, primer if required, and backup material), in sufficient quantity for testing and approval shall be submitted to the Owner. No material will be allowed to be used until it has been approved.

C. Safety: Joint sealant shall not be placed within 25 feet of any liquid oxygen (LOX) equipment, LOX storage, or LOX piping. Joints in this area shall be thoroughly cleaned and left unsealed.

D. Test Requirements: The joint sealant and backup or separating material shall be tested for conformance with the referenced applicable material specification. Testing of the materials shall be performed in an approved independent laboratory and certified copies of the test reports shall be submitted and approved prior to the use of the materials at the job site. Samples will be retained by the Owner for possible future testing should the materials appear defective during or after application. Conformance with the requirements of the laboratory tests specified will not constitute final acceptance of the materials. Final acceptance will be based on the performance of the in-place materials.

E. Equipment: Machines, tools, and equipment used in the performance of the work required by this section shall be approved before the work is started and shall be maintained in satisfactory condition at all times.

1.2 PRODUCTS

A. Materials
1. Liquid Asphalt: ASTM D 2027, Grade MC-250.
2. Emulsified Asphalt: ASTM D 977, Grade AS-2.
3. Sealing Compound: ASTM D 3405.
4. Backer Rod: ASTM D 5249.
5. Fine Aggregate: Natural sand or crusher dust having a maximum size of not more than 1/8 inch and be free of clay or organic-matter.

1.3 EXECUTION

A. Preparation:
1. All cracks to be sealed shall be cleaned of dirt and debris, and moisture shall be removed.

2. Crack Cleaning Equipment shall consist of a portable air compressor with hose and nozzles for directing air directly into cracks and stiff bristle brooms.
3. Heating Equipment for Liquid Asphalt shall be mobile and shall be equipped with an agitating device for stirring material during heating, a thermometer, regulating equipment for heat control, and a gravity-type draw-off valve.
4. Heating Equipment for Sealing Compound: Unless otherwise required by the manufacturer's recommendations, the equipment shall be mobile and shall consist of double-boiler, agitator-type kettles with oil medium in the outer space for heat transfer. The applicator unit shall be so designed that the sealant will circulate through the delivery hose and return to the inner kettle when not sealing cracks.
5. Application Equipment shall have a spout or nozzle of such size that the sealing material will be placed in the cracks without entrapping air in cracks or spreading material on adjacent pavement surface.

B. Installation:
1. Backer Rod: Install backer in accordance with manufacturer's instructions where required under sealing compound.
2. Sealing Compound: All cracks 1/8 inch wide and wider shall be sealed. The application temperature for sealing compound shall comply with ASTM C 1193. Cracks 1/2 inch wide and wider shall be filled with a slurry of fine sand and an emulsified asphalt or liquid asphalt. After the slurry has cured, cracks shall be sealed with liquid asphalt or emulsified asphalt and lightly sanded.
3. Liquid and Emulsified Asphalt Sealer: The temperature shall be varied so that it flows freely into cracks and completely fills cracks without entrapping air. Cracks shall be free of moisture before filling and shall be filled slightly above the pavement surface. When excess sealer has been removed, the sealer shall be covered with fine sand.
4. Traffic Control: Traffic will not be permitted over sealed cracks until the sealer has cooled so that it is not picked up by vehicle tires. The Contractor will be responsible for all barricades and flagmen necessary to control traffic.

END OF SECTION 02617

SECTION 02617a - SPRAY APPLICATIONS, SEAL COATS, AND SURFACE TREATMENTS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for the spray applications, seal coats, and surface treatments of asphalt concrete pavements. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Bituminous Material: Bituminous material shall be liquid asphalt complying with ASTM D 2028, Grade RC-25O, or tar complying with ASTM D 490, Grade RT-6.

B. Aggregate: Aggregates shall consist of crushed stone, crushed gravel, or crushed slag. The moisture content of the aggregate shall be such that the aggregate will be readily coated with the bituminous material. Aggregate gradations shall be in compliance with ASTM C 136.

C. Construction Equipment
1. Bituminous Distributor shall be designed and equipped to distribute the bituminous material uniformly at even heat on variable widths of surface at readily determined and controlled rates and pressures recommended by the manufacturer and with an allowable variation from any specified rate not exceeding 5 percent.
2. Single-Pass Surface Treatment Machine shall be capable of distributing the bituminous material and aggregates uniformly in controlled amounts in a single-pass operation over the surface to be sealed.
3. Heating Equipment for Storage Tanks shall consist of steam coils, hot oil coils, or electrical coils. If steam or hot oil coils are used, the coils must be so designed and maintained that the bituminous material cannot become contaminated.
4. Power Rollers shall be the self-propelled tandem and three-wheel type rollers, weighing not less than 5 tons and shall be suitable for rolling bituminous pavements.
5. Self-Propelled Pneumatic-Tired rollers shall have a total compacting width of not less than 60 inches. The gross weight shall be adjustable within the ranges of 200 to 350 lb/in. of compacting width.
6. Spreading Equipment: Aggregate spreading equipment shall be adjustable and capable of spreading aggregate at controlled amounts per square yard.
7. Drags: Broom drags shall consist of brooms mounted on a frame, designed to spread fine aggregate uniformly over the surface of a bituminous pavement. Towing equipment shall have pneumatic tires.
8. Brooms and Blowers shall be of the power type and shall be suitable for cleaning surfaces of bituminous pavements.

1.3 EXECUTION

A. Installation
1. Spreading Aggregate: Application of seal aggregate shall immediately follow the application of bituminous material, and in no case shall the time to application exceed 15 minutes.

2. Brooming and Rolling: Begin the rolling operations immediately following the application of cover aggregate. Rolling shall be accomplished with pneumatic-tired rollers; steel-wheeled rollers shall be used in a supplementary capacity only. All surplus aggregate shall be swept off the surface and removed not less than 26 hours or more than four days after rolling is completed.

END OF SECTION 02617a

Task	Specification	Specification Description
02617	02612	Asphalt Paving

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SECTION 02618 - TRAFFIC COATINGS

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for traffic coating. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes traffic coatings for the following applications:
   a. Interior and exterior pedestrian traffic.
   b. Vehicular traffic.
   c. Pavement markings.

C. Submittals
1. Product Data: For each product indicated.
2. Shop Drawings: Show extent of each traffic coating. Include details for treating substrate joints and cracks, flashings, deck penetrations, and other termination conditions.
3. Samples: For each type of finish indicated.
4. Material test reports.
5. Material certificates.
6. Qualification data.
7. Maintenance data.
8. Warranty.
9. LEED Submittal:
   a. Product Data for Credit EQ 4.2: For interior field-applied traffic coatings and pavement marking paints, including printed statement of VOC content.

D. Quality Assurance
1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of traffic coatings required for this Project.
2. Fire-Test-Response Characteristics: Provide traffic coating materials with the fire-test-response characteristics as determined by testing identical products per test method below for deck type and slopes indicated by an independent testing and inspecting agency that is acceptable to authorities having jurisdiction.
   a. Class A **OR** B **OR** C, **as directed**, roof covering per ASTM E 108 or UL 790.
3. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
1. Deliver materials in original packages and containers with seals unbroken and bearing manufacturer's labels showing the following information:
   a. Manufacturer's brand name.
   b. Type of material.
   c. Directions for storage.
   d. Date of manufacture and shelf life.
   e. Lot or batch number.
   f. Mixing and application instructions.
   g. Color.
2. Store materials in a clean, dry location protected from exposure to direct sunlight. In storage areas, maintain environmental conditions within range recommended in writing by manufacturer.

F. Project Conditions

1. Environmental Limitations: Apply traffic coatings within the range of ambient and substrate temperatures recommended in writing by manufacturer. Do not apply traffic coatings to damp or wet substrates, when temperatures are below 40 deg F (5 deg C), when relative humidity exceeds 85 percent, or when temperatures are less than 5 deg F (3 deg C) above dew point.
   a. Do not apply traffic coatings in snow, rain, fog, or mist, or when such weather conditions are imminent during the application and curing period. Apply only when frost-free conditions occur throughout the depth of substrate.
2. Do not install traffic coating until items that will penetrate membrane have been installed.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which traffic coating manufacturer agrees to repair or replace traffic coatings that deteriorate during the specified warranty period. Warranty does not include deterioration or failure of traffic coating due to unusual weather phenomena, failure of prepared and treated substrate, formation of new substrate cracks exceeding 1/16 inch (1.6 mm) in width, fire, vandalism, or abuse by snowplow, maintenance equipment, and truck traffic.
   a. Deterioration of traffic coatings includes the following:
      1) Adhesive or cohesive failures.
      2) Abrasion or tearing failures.
      3) Surface crazing or spalling.
      4) Intrusion of water, oils, gasoline, grease, salt, deicer chemicals, or acids into deck substrate.
   b. Warranty Period: Five years from date of Substantial Completion.

1.2 PRODUCTS

A. Materials
1. Traffic Coatings: Complying with ASTM C 957.
2. Material Compatibility: Provide primers; base, intermediate, and topcoats; and miscellaneous materials that are compatible with one another and with substrate under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
3. VOC Content: Provide traffic coatings and pavement marking paints, for use inside the weatherproofing system, with VOC content of 150 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Traffic Coating
1. Primer: Manufacturer's standard factory-formulated primer recommended for substrate and conditions indicated.
   a. Material: Epoxy **OR** Urethane, **as directed**.
2. Preparatory and Base Coats: Single- or multicomponent, aromatic liquid urethane elastomer.
3. Intermediate Coat: Single- or multicomponent, aromatic liquid urethane elastomer **OR** Single- or multicomponent, aliphatic liquid urethane elastomer **OR** Liquid epoxy, **as directed**.
4. Topcoat: Single- or multicomponent, aromatic liquid urethane elastomer **OR** Single- or multicomponent, aliphatic liquid urethane elastomer **OR** Single- or multicomponent, aromatic liquid urethane elastomer with UV inhibitors **OR** Liquid epoxy, **as directed**.
   a. Color: As selected by the Owner from manufacturer's full range.
5. Aggregate: Uniformly graded, washed silicon carbide sand **OR** Uniformly graded, washed silica sand **OR** Uniformly graded, washed flint shot silica **OR** Walnut shell granules **OR** Aluminum-oxide grit, **as directed**, of particle sizes, shape, and minimum hardness recommended in writing by traffic coating manufacturer.
   a. Spreading Rate: As recommended by manufacturer for substrate and service conditions indicated, but not less than the following:
      1) Intermediate Coat: 8 to 10 lb/100 sq. ft. (3.6 to 4.5 kg/10 sq. m) **OR** To refusal, **as directed**.

2) Topcoat: 8 to 10 lb/100 sq. ft. (3.6 to 4.5 kg/10 sq. m) **OR** As required to achieve slip-resistant finish, **as directed**.

C. Miscellaneous Materials
1. Joint Sealants: As specified in Division 07 Section "Joint Sealants".
2. Sheet Flashing: Nonstaining.
a. Minimum Thickness: 60 mils (1.5 mm) **OR** 50 mils (1.3 mm), **as directed**.
b. Material: Sheet material recommended in writing by traffic coating manufacturer **OR** Uncured neoprene sheet **OR** Cured neoprene sheet, **as directed**.
3. Adhesive: Contact adhesive recommended in writing by traffic coating manufacturer.
4. Reinforcing Strip: Fiberglass mesh recommended in writing by traffic coating manufacturer.

D. Pavement Markings
1. Pavement-Marking Paint: Alkyd-resin ready mixed, complying with AASHTO M 248, Type S **OR** N **OR** F, **as directed**.
a. Color: White **OR** Yellow **OR** As indicated, **as directed**.
1) Use blue for spaces accessible to people with disabilities.
2. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, with drying time of less than three **OR** 45, **as directed**, minutes.
a. Color: White **OR** Yellow **OR** As indicated, **as directed**.
1) Use blue for spaces accessible to people with disabilities.
3. Glass Beads: AASHTO M 247, Type 1.

1.3 EXECUTION

A. Examination
1. Examine substrates, with Installer present, for compliance with requirements and for other conditions affecting performance of traffic coatings.
a. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance.
b. Verify compatibility with and suitability of substrates.
c. Begin coating application only after minimum concrete curing and drying period recommended by traffic coating manufacturer has passed, after unsatisfactory conditions have been corrected, and after surfaces are dry.
d. Verify that substrates are visibly dry and free of moisture.
1) Test for moisture vapor transmission by plastic sheet method according to ASTM D 4263.
2) Test for moisture content by measuring with an electronic moisture meter **OR** method recommended in writing by manufacturer, **as directed**.
e. Application of coating indicates acceptance of surfaces and conditions.

B. Preparation
1. Clean and prepare substrates according to ASTM C 1127 and manufacturer's written recommendations to produce clean, dust-free, dry substrate for traffic coating application.
2. Mask adjoining surfaces not receiving traffic coatings, deck drains, and other deck substrate penetrations to prevent spillage, leaking, and migration of coatings.
3. Concrete Substrates: Mechanically abrade concrete surfaces to a uniform profile according to ASTM D 4259. Do not acid etch.
a. Remove grease, oil, paints, and other penetrating contaminants from concrete.
b. Remove concrete fins, ridges, and other projections.
c. Remove laitance, glaze, efflorescence, curing compounds, concrete hardeners, form-release agents, and other incompatible materials that might affect coating adhesion.
d. Remove remaining loose material to provide a sound surface, and clean surfaces according to ASTM D 4258.

C. Terminations And Penetrations
   1. Prepare vertical and horizontal surfaces at terminations and penetrations through traffic coatings and at expansion joints, drains, and sleeves according to ASTM C 1127 and manufacturer's written recommendations.
   2. Provide sealant cants at penetrations and at reinforced and nonreinforced, deck-to-wall butt joints.
   3. Terminate edges of deck-to-deck expansion joints with preparatory base-coat strip.
   4. Install sheet flashings at deck-to-wall expansion and dynamic joints, and bond to deck and wall substrates according to manufacturer's written recommendations.

D. Joint And Crack Treatment
   1. Prepare, treat, rout, and fill joints and cracks in substrates according to ASTM C 1127 and manufacturer's written recommendations. Before coating surfaces, remove dust and dirt from joints and cracks according to ASTM D 4258.
      a. Comply with recommendations in ASTM C 1193 for joint-sealant installation.

E. Traffic Coating Application
   1. Apply traffic coating material according to ASTM C 1127 and manufacturer's written recommendations.
      a. Start traffic coating application in presence of manufacturer's technical representative.
      b. Verify that wet film thickness of each component coat complies with requirements every 100 sq. ft. (9 sq. m).
   2. Apply traffic coatings to prepared wall terminations and vertical surfaces to height indicated, and omit aggregate on vertical surfaces.
   3. Cure traffic coatings according to manufacturer's written recommendations. Prevent contamination and damage during application and curing stages.

F. Pavement Markings
   1. Do not apply traffic paint for striping and other markings until traffic coating has cured according to manufacturer's written recommendations.
   2. Apply traffic paint for striping and other markings with mechanical equipment to produce uniform straight edges. Apply at manufacturer's recommended rates for a 15-mil- (0.38-mm-) minimum wet film thickness.
   3. Spread glass beads uniformly into wet traffic paint at a rate of 6 lb/gal. (0.72 kg/L).

G. Field Quality Control
   1. Testing: Engage a qualified testing agency to perform the following field tests and inspections and prepare test reports:
      a. Samples of material delivered to Project site shall be taken, identified, sealed, and certified in presence of Owner and Contractor.
      b. Testing agency shall perform tests for characteristics specified, using applicable referenced testing procedures.
      c. Testing agency shall verify thickness of coatings during traffic coating application.
      d. If test results show traffic coating materials do not comply with requirements, remove noncomplying materials, prepare surfaces, and reapply traffic coatings.
   2. Flood Testing: Flood test each deck area for leaks, according to recommendations in ASTM D 5957, after traffic coating has completely cured. Install temporary containment assemblies, plug or dam drains, and flood with potable water.
      a. Flood to an average depth of 2-1/2 inches (65 mm) with a minimum depth of 1 inch (25 mm) and not exceeding a depth of 4 inches (100 mm).
      b. Flood each area for 24 **OR** 48 **OR** 72, **as directed**, hours.
      c. After flood testing, repair leaks, repeat flood tests, and make further repairs until traffic coating installation is watertight.
      d. Engage an independent testing agency to observe flood testing and examine underside of decks and terminations for evidence of leaks during flood testing.

3. Final Traffic Coating Inspection: Arrange for traffic coating manufacturer's technical personnel to inspect membrane installation on completion.
   a. Notify the Owner or Owner 48 hours in advance of date and time of inspection.
4. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

H. Protecting And Cleaning
1. Protect traffic coatings from damage and wear during remainder of construction period.
2. Clean spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 02618

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Task	Specification	Specification Description
02618	02612	Asphalt Paving
02618	02614	Cement Concrete Pavement

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SECTION 02620 - STEEL CURBS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of steel curbs. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Standard Steel Curb Sections: Noncorrosive steel sections as required to match existing.

B. Coating: Steel curb sections shall be zinc coated.

C. Joint Materials
1. Expansion Joint Fillers: ASTM D 1751 or ASTM D 1752.
2. Joint Sealers: ASTM D 1850.

D. Concrete: Concrete shall have a minimum compressive strength of 3,000 psi. The maximum size of aggregate shall be 1-1/2 inches. Concrete shall have a slump of not more than 3 inches and an air content by volume of concrete of 3 to 6 percent.

1.3 EXECUTION

A. Preparation: The subgrade shall be constructed to grade and cross section. The subgrade shall be of materials equal in bearing quality to the subgrade under the adjacent pavement and shall be compacted. The subgrade shall be maintained in a smooth, compacted condition, in conformity with the required section and established grade until the concrete is placed. The subgrade shall be in a moist condition when concrete is placed.

B. Installation
1. Steel Curb Setting: Steel curbs shall be carefully set to alignment and grade and to conform to the dimensions of the curb.
2. Concrete Placement And Finishing: Concrete shall be placed in layers not to exceed 6 inches. Concrete shall be thoroughly consolidated. Floated surfaces shall then be brushed with longitudinal strokes. The top surface of the entrance shall be finished to grade with a wood float. Expansion joints and contraction joints shall be constructed at right angles to the line of curb. Contraction joints shall be constructed by means of 1/8-inch thick separators, of a section conforming to the cross section of the curb and gutter. Contraction joints shall match joints in abutting Portland cement concrete pavement. At other pavements, construction joints shall be placed at not less than 5 feet nor greater than 15 feet apart. Expansion joints shall be formed by means of preformed expansion joint filler material cut and shaped to the cross section of curb. Expansion joints shall be provided in curb at the end of all returns. Expansion joints shall match expansion joints of abutting Portland cement concrete pavement. At other pavements, expansion joints at least 1/2 inch in width shall be provided at intervals not exceeding 45 feet. Exposed concrete surfaces shall be cured for not less than 7 days.

3. Backfilling: After curing, debris shall be removed and the area adjoining the concrete shall be backfilled, graded, and compacted.
4. Sealing Joints: Expansion joints and the top 1-inch depth of contraction joints shall be sealed with joint sealer. The joint opening shall be thoroughly cleaned before the sealing material is placed. Excess material on exposed surfaces of the concrete shall be removed immediately and exposed concrete surfaces cleaned.

END OF SECTION 02620

SECTION 02620a - POROUS UNIT PAVING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for porous unit paving. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
   a. Porous paving consisting of concrete pavers set in aggregate setting beds.
   b. Edge restraints.
   c. Cast-in-place concrete edge restraints.
   d. Precast concrete curbs.
   e. Granite curbs.

C. Submittals
1. Product Data: For materials other than aggregates.
2. Sieve Analyses: For aggregate materials, according to ASTM C 136.
3. Samples:
   a. Full-size units of each type of unit paver indicated.
   b. Exposed edge restraints.
   c. Precast concrete curbs.
   d. Granite curbs.
   e. Aggregate fill.
4. Material Certificates: For unit pavers. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.

D. Quality Assurance
1. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
1. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.
2. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

1.2 PRODUCTS

A. Concrete Unit Pavers
1. Concrete Grid Pavers: Grid paving units complying with ASTM C 1319, made from normal-weight aggregates.
2. Solid Concrete Pavers for Porous Paving: Solid interlocking paving units of shapes that provide openings between units, complying with ASTM C 936, resistant to freezing and thawing when tested according to ASTM C 67, **as directed**, and made from normal-weight aggregates.
   a. Thickness: 2-3/8 inches (60 mm) **OR** 3-1/8 inches (80 mm) **OR** 3-1/2 inches (90 mm) **OR** 4 inches (100 mm), **as directed**.
   b. Face Size and Shape: As indicated.
   c. Color: As indicated by manufacturer's designations **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.

B. Accessories
1. Plastic Edge Restraints: Triangular PVC extrusions, 1-3/4 inches (45 mm) high by 3-1/2 inches (90mm) wide **OR** 3-1/8 inches (80 mm) high by 9-1/2 inches (240 mm) wide, **as directed**, designed to serve as edge restraints for unit pavers; rigid type for straight edges and flexible type for curved edges, with pipe connectors and 3/8-inch- (9.5-mm-) diameter by 12-inch- (300-mm-) long steel spikes.
2. Steel Edge Restraints: Painted steel edging, 3/16 inch (4.8 mm) thick by 4 inches (100 mm) high **OR** 1/4 inch (6.4 mm) thick by 5 inches (125 mm) high, **as directed**, with loops pressed from or welded to face to receive stakes at 36 inches (900 mm) o.c., and with steel stakes 15 inches (380 mm) long for each loop.
   a. Color: As indicated by manufacturer's designations **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.
3. Aluminum Edge Restraints: Straight, 1/8-inch- (3.2-mm-) thick by 4-inch- (100-mm-) high **OR** Straight, 3/16-inch- (4.8-mm-) thick by 4-inch- (100-mm-) high **OR** L-shaped, 1/8-inch- (3.2-mm-) thick by 1-3/8-inch- (35-mm-) high **OR** L-shaped, 3/16-inch- (4.8-mm-) thick by 2-1/4-inch- (57-mm-) high, **as directed**, extruded-aluminum edging, with loops pressed from face to receive stakes at 12 inches (300 mm) o.c., and with aluminum stakes 12 inches (300 mm) long for each loop.
4. Precast Concrete Curbs: Made from normal-weight concrete with a compressive strength not less than 5000 psi (35 MPa) **OR** 6000 psi (41 MPa), **as directed**, and water absorption not more than 5 percent, in shapes and sizes indicated.
   a. Color and Texture: As indicated by manufacturer's designations **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.
5. Granite Curbs: Granite curbing, with face battered 1 inch per foot (1:12), produced in random lengths not less than 36 inches (900 mm) from granite complying with ASTM C 615.
   a. Granite Color and Grain: Light gray **OR** Dark gray **OR** Buff **OR** White **OR** Black **OR** Pink, **as directed**, with fine **OR** medium **OR** coarse, **as directed**, grain.
   b. Top Width: 4 inches (100 mm) **OR** 5 inches (125 mm) **OR** 6 inches (150 mm), **as directed**.
   c. Face Height: 4 inches (100 mm) **OR** 6 inches (150 mm) **OR** 8 inches (200 mm), **as directed**.
   d. Total Height: 12 inches (300 mm) **OR** 16 inches (400 mm) **OR** 18 inches (450 mm), **as directed**.
   e. Top Finish: Sawed **OR** Thermal **OR** Bushhammered, **as directed**.
   f. Face Finish: Split **OR** Sawed **OR** Thermal **OR** Bushhammered, **as directed**.

C. Aggregate Setting-Bed Materials
1. Graded Aggregate for Subbase: Sound crushed stone or gravel complying with ASTM D 448 for Size No. 57 **OR** ASTM D 448 for Size No. 5 **OR** ASTM D 2940, subbase material **OR** requirements in Division 02 Section "Earthwork" for subbase material, **as directed**.
2. Graded Aggregate for Base Course: Sound crushed stone or gravel complying with ASTM D 448 for Size No. 8 **OR** ASTM D 448 for Size No. 57 **OR** ASTM D 2940, base-course material **OR** requirements in Division 02 Section "Earthwork" for base-course material, **as directed**.
3. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33 for fine aggregate.
4. Soil Mix for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33 for fine aggregate blended with planting soil mix complying with requirements in Division 02 Section(s) "Lawns And Grasses" OR "Exterior Plants", **as directed**. Use blend consisting of 1/2 sand and 1/2 soil mix **OR** 2/3 sand and 1/3 soil mix, **as directed**.
5. Graded Aggregate for Leveling Course: Sound crushed stone or gravel complying with ASTM D 448 for Size No. 8 **OR** 9, **as directed**.
6. Soil for Porous Paver Fill: Planting soil mix complying with requirements in Division 02 Section(s) "Lawns And Grasses" OR "Exterior Plants", **as directed**.

7. Graded Aggregate for Porous Paver Fill: Sound crushed stone or gravel complying with ASTM D 448 for Size No. 8 **OR** 9, **as directed**.
   a. Provide stone of color indicated **OR** to match the Owner's sample, **as directed**.
8. Grass Seed: Comply with requirements in Division 02 Section "Lawns And Grasses".
9. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications; made from polyolefins or polyesters, with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
   a. Survivability: Class 2; AASHTO M 288.
   b. Apparent Opening Size: No. 60 (0.250-mm) sieve, maximum; ASTM D 4751.
   c. Permittivity: 0.02 per second, minimum; ASTM D 4491.
   d. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.
10. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
    a. Survivability: Class 2; AASHTO M 288.
    b. Apparent Opening Size: No. 40 (0.425-mm) sieve, maximum; ASTM D 4751.
    c. Permittivity: 0.5 per second, minimum; ASTM D 4491.
    d. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

1.3 EXECUTION

A. Preparation
   1. Proof-roll prepared subgrade according to requirements in Division 02 Section "Earthwork" to identify soft pockets and areas of excess yielding. Proceed with porous paver installation only after deficient subgrades have been corrected and are ready to receive subbase and base **OR** base, **as directed**, course for porous paving.

B. Installation, General
   1. Do not use unit pavers with chips, cracks, voids, discolorations, and other defects that might be structurally unsound or visible in finished work.
   2. Cut unit pavers with motor-driven masonry saw equipment or a block splitter, **as directed**, to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
   3. Tolerances:
      a. Variation in Plane between Adjacent Units (Lipping): Do not exceed 1/16-inch (1.5-mm) unit-to-unit offset from flush.
      b. Variation from Level or Indicated Slope: Do not exceed 1/8 inch in 24 inches (3 mm in 600 mm) and 1/4 inch in 10 feet (6 mm in 3 m) or a maximum of 1/2 inch (13 mm).
   4. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.
      a. Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after porous paver installation.
      b. For metal edge restraints with top edge exposed, drive stakes at least 1 inch (25 mm) below top edge.
      c. Install job-built concrete edge restraints to comply with requirements in Division 02 Section "Cement Concrete Pavement".
   5. Provide curbs as indicated. Install curbs before placing unit pavers.
      a. Install precast concrete **OR** granite, **as directed**, curbs on a bedding of compacted base-course material over compacted subgrade. Install curbs before placing base course for pavers. Set curbs at elevations indicated, accurately aligned, and place and compact base-course material behind curbs as indicated.
      b. Install precast concrete curbs on aggregate base course after placing and compacting base course for pavers. Set curbs with top edge 1 inch (25 mm) below top of pavers. Anchor curbs with metal stakes driven through holes in curbs into base-course material.

c. Install precast concrete curbs on aggregate-base course after placing and compacting base course for pavers. Set curbs with top surface 1/2 inch (13 mm) **OR** 2 inches (50 mm) **OR** 4 inches (100 mm), **as directed**, above top of pavers. Anchor curbs with metal stakes driven behind curbs into base-course material.

C. Setting-Bed Installation
1. Compact soil subgrade uniformly to at least 95 percent of ASTM D 698 **OR** ASTM D 1557, **as directed**, laboratory density.
2. Proof-roll prepared subgrade to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by the Owner, and replace with compacted backfill or fill as directed.
3. Place separation **OR** drainage, **as directed**, geotextile over prepared subgrade, overlapping ends and edges at least 12 inches (300 mm).
4. For light-traffic uses, place aggregate subbase **OR** subbase and base, **as directed**, compact by tamping with plate vibrator, and screed to depth indicated.
5. For heavy-duty applications, place aggregate subbase **OR** subbase and base, **as directed**, compact to 100 percent of ASTM D 1557 maximum laboratory density, and screed to depth indicated.
6. Place drainage geotextile over compacted subbase, overlapping ends and edges at least 12 inches (300 mm).
7. Place drainage geotextile over compacted base course, overlapping ends and edges at least 12 inches (300 mm).
8. Place leveling course and screed to a thickness of 1 to 1-1/2 inches (25 to 38 mm) **OR** 2 to 2-1/2 inches (50 to 64 mm) **OR** 3 inches (76 mm), **as directed**, taking care that moisture content remains constant and density is loose and constant until pavers are set and compacted.

D. Paver Installation
1. Set unit pavers on leveling course, being careful not to disturb leveling base. If pavers have lugs or spacer bars to control spacing, place pavers hand tight against lugs or spacer bars. If pavers do not have lugs or spacer bars, place pavers with a 1/16-inch- (1.6-mm-) minimum and 1/8-inch- (3.2-mm-) maximum joint width. Use string lines to keep straight lines. Fill gaps between units that exceed 3/8 inch (10 mm) with pieces cut to fit from full-size pavers.
   a. When installation is performed with mechanical equipment, use only unit pavers with lugs or spacer bars on sides of each unit.
2. Compact pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbf (16- to 22-kN) compaction force at 80 to 90 Hz. Use vibrator with neoprene mat on face of plate or other means as needed to prevent cracking and chipping of pavers. Perform at least three passes across paving with vibrator.
   a. Compact pavers when there is sufficient surface to accommodate operation of vibrator, leaving at least 36 inches (900 mm) of uncompacted pavers adjacent to temporary edges.
   b. Before ending each day's work, compact installed concrete pavers except for 36-inch (900 mm) width of uncompacted pavers adjacent to temporary edges (laying faces).
   c. As work progresses to perimeter of installation, compact installed pavers that are adjacent to permanent edges unless they are within 36 inches (90 mm) of laying face.
   d. Before ending each day's work and when rain interrupts work, cover pavers that have not been compacted and leveling course on which pavers have not been placed with nonstaining plastic sheets to protect them from rain.
3. Place soil fill as follows, immediately after vibrating pavers into leveling course. Spread and screed soil fill level with tops of pavers. Vibrate pavers and add soil fill until porous paving is filled to about 3/4 inch (19 mm) from top surface; remove excess soil fill if any.
   a. Before ending each day's work, place soil fill in installed porous paving except for 42-inch (1067-mm) width of unfilled paving adjacent to temporary edges (laying faces).
   b. As work progresses to perimeter of installation, place soil fill in installed paving that is adjacent to permanent edges unless it is within 42 inches (1067 mm) of laying face.

c. Before ending each day's work and when rain interrupts work, cover paving that has not been filled with nonstaining plastic sheets to protect it from rain.

4. After filling pavers with soil, sow seed to comply with requirements in Division 02 Section "Lawns And Grasses". except sow seed at half the rate specified for seeding lawns. Sweep seed from surfaces of pavers into voids and water with fine spray.
   a. Within 24 hours after sowing seed, spread an additional 3/16 inch (4.8 mm) of soil fill over seed and soak with water.
5. Place graded aggregate fill immediately after vibrating pavers into leveling course. Spread and screed aggregate fill level with tops of pavers.
   a. Before ending each day's work, place aggregate fill in installed porous paving except for 42-inch (1067-mm) width of unfilled paving adjacent to temporary edges (laying faces).
   b. As work progresses to perimeter of installation, place aggregate fill in installed paving that is adjacent to permanent edges unless it is within 42 inches (1067 mm) of laying face.
   c. Before ending each day's work and when rain interrupts work, cover paving that has not been filled with nonstaining plastic sheets to protect it from rain.
6. Remove and replace pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

E. Maintenance And Protection
   1. Water newly planted grass and keep moist until grass is established. Maintain grass that is planted in paving to comply with requirements in Division 02 Section "Lawns And Grasses".
   2. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades for 60 days after planting.

END OF SECTION 02620a

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Task	Specification	Specification Description
02620	02614	Cement Concrete Pavement

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SECTION 02630 - ASPHALT CONCRETE SIDEWALKS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of asphalt concrete sidewalks. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Asphaltic Concrete:
1. Hot-Mixed, Hot-Laid Bituminous Paving Mixtures: ASTM D 3515.
2. Plant-Mixed, Stockpiled Asphalt Cold Mixes: Asphalt Institute Manual MS-l4.

B. Bituminous Prime: ASTM D 2027, Grades MC-30 or MC-70; ASTM D 2028, Grade RC-70; or ASTM D 2026, Grade SC-70.

C. Base Course: ASTM D 2940.

D. Bituminous Tack Coat: ASTM D 977, Grades RS-1, MS-1 or SS-1h; ASTM D 2027, Grade MC-30; ASTM D 2028, Grade RC-70; ASTM D 2026, Grade SC-70; or ASTM D 2397, Grades CRS-1 or CSS-1.

E. Seal Coat: ASTM D 2027, Grade HC-250 or MC-800; or D 2028, Grade RC-250 or RC-800.

F. Slurry Coat Mixture shall be comprised of 70 percent sand or fine aggregate, 10 percent water, and 20 percent liquid or emulsified asphalt.
1. Fine Aggregate: ASTM D 1073, Grade 2.
2. Emulsified Asphalt: ASTM D 977, Grades SS-1 or SS-1h.

1.3 EXECUTION

A. Application Temperatures: Application temperatures for all asphalt materials shall comply with provisions of the Asphalt Institute publications and the applicable ASTM standards.

B. Subgrade: Construct the subgrade for walkway replacement true to grade and compact as required.

C. Base Course
1. Placing: Spread the base course material evenly upon the prepared subgrade, in a layer of such depth that when compacted the layer will be uniform and of the thickness required.
2. Compaction: Immediately following the spreading of the material, compact the base course with equipment to a density as required.

D. Surface Course
1. Placing: Apply prime coat, and allow it to cure. The placing of the mixture shall be continuous. Paint all contact surfaces of previously constructed sidewalk with a tack coat of rapid-setting liquid asphalt just before the fresh mixture is placed.

2. Forms: Set forms with the upper edge true to line and hold grade rigidly in place by stakes placed on the outside of the forms and set flush with the top edge of the forms.
3. Compaction: Immediately following the placement of the asphalt concrete mixture, compact the surface course with equipment to a density as required.
4. Backfilling: After removing the forms and debris, backfill the exposed or excavated area adjoining the sidewalk with granular material, grade, and compact to conform to the surrounding area.

E. Patching
1. For Repair Operations Involving Raveling, Heaving, Spalling, and Alligatoring: Cut asphalt concrete paving back to solid material, making cut area rectangular with vertical sides. Remove deteriorated pavement including base material if required. Replace base course, compact, and tack coat the base material and the vertical surfaces of cut area. Fill area with new asphalt concrete and compact level with existing walkway. Dust patched area with sand or mineral dust.
2. Pothole Repair: Cut rectangular hole around pothole back to solid pavement leaving straight, vertical edges. Remove loose material and water to firm base. Fill holes and compact to within 3 inches of the surface in layers not exceeding 6 inches with either base material or asphalt mixture. Apply tack coat to base material and vertical edges. On the surface layer, fill with asphalt mixture and mound to such height that when compacted the mix will be level with surrounding walkway surface. Dust patched area with sand or mineral dust.
3. Low Spot or Depression Repair: Determine limits of depression with straightedge, and mark outline with crayon. Apply tack coat, 0.05 to 0.15 gallon per square yard, to the cleaned area, and allow to cure. Spread area with asphalt concrete mix and feather edge by raking and manipulation of the material. Roll and compact area to surrounding walkway level. Recheck with straightedge. Apply a sand seal to the patched area to prevent entrance of water.
4. Polished Aggregate Repair: Clean and dry area thoroughly. Apply tack coat at a rate of 0.05 to 0.15 gallon per square yard; overlay area with new asphalt concrete mix to a minimum 1-1/2 inch thickness and feather to adjoining walkway surfaces. Roll with pneumatic or steel rollers.
5. Damaged Edging Repair: Remove damaged or deteriorated edging materials and replace.
6. Prime Coat: Prime new base course with MC-70 liquid asphalt at a rate of 0.20 to 0.30 gallon per square yard. Take care to apply to more asphalt than will penetrate into the base course during curing. Blot excess prime with sand before the surfacing material is applied.
7. Tack Coat: Surfaces and cut edges of existing asphalt concrete shall be given a tack coat of MC-70 liquid asphalt at a rate of 0.05 to 0.15 gallon per square yard. After application of the tack coat, allow time for the material to cure before surfacing and patching material is placed.
8. Seal Coat Spray Application: Walkway surfaces that are to be sealed shall receive a liquid asphalt coat applied at a rate of 0.15 to 0.20 gallon per square yard, along with a fine aggregate at a rate of 15 to 20 pounds per square yard.

F. Crack Repair: Fill cracks after drying with liquid asphalt, sand asphalt emulsion water mixture, or slurry seal. After thorough cleaning, work the mixture into cracks by broom or squeegee. Cracks 1/8 to 1/2 inch width shall be slurry sealed and filled with liquid asphalt. Dust repaired cracks with fine aggregate or mineral dust to prevent cracking. Final thickness of the slurry seal shall be 1/8 inch minimum.

END OF SECTION 02630

SECTION 02630a - MISCELLANEOUS SIDEWALKS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of miscellaneous sidewalks. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Aggregate shall comply with the following:
1. Surface Course Aggregates shall be well-graded, crushed stone, 3/4- to 1-1/4 inch size, consisting of clean, sound, durable particles.
2. Masonry Grout Aggregate: ASTM C 404, Size 2.

B. Base Course: Base course material shall be a granular dense-graded, high-quality compactable material.

C. Ready-Mixed Concrete: Ready-mixed concrete shall comply with ASTM C 94. The concrete shall attain a minimum compressive strength of 3,000 psi at 28 days.

D. Portland Cement Concrete: Cement shall comply with ASTM C 150.

E. Joint Filler: Masonry joint filler shall be Portland cement concrete mix with cement complying with ASTM C 150.

F. Masonry Units: Color and texture shall match the existing as nearly as is practicable.

G. Wood and Preservatives: Footboards and supports shall be 1-1/2 inch thick Number 1 dense Douglas fir or yellow pine lumber, pressure-treated with chromated copper arsenate (CCA) preservative complying with applicable ASTM Standards. Retention shall be a minimum of 0.25 pounds per cubic foot.

1.3 EXECUTION

A. Base Course Repair: Remove material in soft spots to such depth required to provide a firm foundation for surface materials and fill with granular material of a quality that will compact when moistened. Roll or tamp this material to obtain the proper density.

B. Surface Repair
1. Aggregate Walkways: Spread the surface material evenly on the base course in a layer of such depth that when compacted, the layer will be uniform with a minimum thickness of 4 inches.
2. Joint Filling: Completely remove and clean the joint of all loose joint material, dirt, clay, or other foreign matter. Fill the joint flush with concrete to provide a uniform surface.
3. Wood Walkways: Secure wood members with galvanized nails, screws, bolts, or other approved fasteners to ensure tight joints.

4. Masonry Walkways: New or salvaged masonry units will be placed on a 3/4-inch mortar setting bed with mortar joints matching the existing walkway. Place the setting bed on a fresh 3-inch thick Portland cement concrete slab.

END OF SECTION 02630a

SECTION 02630b - PRECAST SIDEWALKS AND PAVERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of precast sidewalks and pavers. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.
   a. For stone varieties proposed for use on Project, include data on physical properties specified or required by referenced ASTM standards.
2. Stone Samples: For each color, grade, finish, and variety of stone required.

1.2 PRODUCTS

A. Precast Concrete Patio Blocks: ASTM C 936. Natural or colored, minimum 2 inches thick.

B. Exposed Aggregate or Granite: ASTM C 615 and National Building Granite Quarries Association, Inc.
1. Exposed Limestone: Limestone (Oolitic), ASTM C 568, Category II.
2. Exposed White Tumblestone Aggregate: As required to meet project requirements.

C. Stone Pavers
1. Bluestone Flagging Paver: Irregular cut, 1 inch thick.
2. White Marble, Crushed Stone: ASTM C 503 and Marble Institute of America (MIA), 3 inches thick.
3. Bluestone, Crushed Stone: 3 inches thick.
4. Natural Cleft Slate: ASTM C 629, 3/4-inch irregular cut, 1/2-inch random rectangular cut, or 1/4-inch random rectangular butted joints.

D. Granite Blocks: Blocks shall be 3 to 5 inches thick and comply with requirements of ASTM C 615 and National Building Granite Quarries Association, Inc. Sizes shall be 3-1/2 inches square; 4 to 12 inches by 3 to 5 inches; and 6 to 15 inches by 3 to 6 inches.

E. Mortar and Grout
1. Portland Cement: ASTM C 150 and the staining requirements of ASTM C 91.
2. Masonry Cement: ASTM C 91, non-staining.
3. Hydrated Lime: ASTM C 207, Type S.
4. Sand: ASTM C 144.
   a. White Pointing Mortar: Natural white sand or ground white stone.
   b. Colored Pointing Mortar: Marble, granite, or sound stone.

1.3 EXECUTION

A. Preparation
1. Clean stone or concrete block with clear water.
2. Ferrous Metal: Apply a heavy coat of bituminous paint on metal surfaces in contact with block.

B. Installation
1. Expansion Joints: Install continuous strips of preformed joint filler.

2. Clean sub-base and saturate with clean water.
3. Slush Coat: Apply 1/16-in. thick slush coat of cement grout over concrete sub-base about 15 minutes prior to placing setting bed.
4. Setting Bed: Mix one 94-lb. bag of cement to 3 cu. ft. of sand. Use only enough water to produce a moist surface when setting bed is ready for setting of stone. Spread and screed to a uniform thickness.
5. Set stone or concrete block before initial set of cement bed occurs. Wet stone or block thoroughly before setting. Apply a thin layer of neat cement paste 1/32-in. to 1/l6-in. thick to setting bed, or bottom of stone or block.
6. Grout joints as soon as possible after initial set of setting bed and tool slightly concave. Use grout mix of one bag Portland cement to 2 cu. ft. sand. Cure grout by maintaining in a moist condition for 7 days. Do not permit traffic on surface during setting of units or for at least 24 hours after final grouting of joints.

END OF SECTION 02630b

SECTION 02630c - EXTERIOR PLANTS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for exterior plants. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Plants.
   b. Planting soils.
   c. Tree stabilization.
   d. Landscape edgings.
   e. Tree grates.

C. Definitions
1. Backfill: The earth used to replace or the act of replacing earth in an excavation.
2. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with ball size not less than sizes indicated **OR** diameter and depth recommended by ANSI Z60.1 for type and size of plant required, **as directed**; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.
3. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than sizes indicated **OR** diameter and depth recommended by ANSI Z60.1 for type and size of plant required, **as directed**.
4. Bare-Root Stock: Plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than minimum root spread according to ANSI Z60.1 for type and size of plant required.
5. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.
6. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.
7. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.
8. Finish Grade: Elevation of finished surface of planting soil.
9. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
10. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
11. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
12. Planting Area: Areas to be planted.

13. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
14. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.
15. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
16. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.
17. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
18. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
19. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

D. Submittals
1. Product Data: For each type of product indicated, including soils.
2. Samples of mineral mulch.
3. Product certificates.
4. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of plants during a calendar year.

E. Quality Assurance
1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
   a. Pesticide Applicator: State licensed, commercial.
2. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory.
   a. The soil-testing laboratory shall oversee soil sampling.
   b. Report suitability of tested soil for plant growth.
      1) State recommendations for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
      2) Report presence of problem salts, minerals, or heavy metals; if present, provide additional recommendations for corrective action.
3. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.
4. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws if applicable.
2. Bulk Materials:
   a. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
   b. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
   c. Accompany each delivery of bulk fertilizers, lime, and soil amendments with appropriate certificates.
3. Deliver bare-root stock plants freshly dug. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting.

4. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
5. Handle planting stock by root ball.
6. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F (16 to 18 deg C) until planting.
7. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.
    a. Heel-in bare-root stock. Soak roots that are in dry condition in water for two hours. Reject dried-out plants.
    b. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
    c. Do not remove container-grown stock from containers before time of planting.
    d. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly-wet condition.

G. Warranty
1. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
    a. Failures include, but are not limited to, the following:
        1) Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner, or incidents that are beyond Contractor's control.
        2) Structural failures including plantings falling or blowing over.
        3) Faulty performance of tree stabilization, edgings, or tree grates.
        4) Deterioration of metals, metal finishes, and other materials beyond normal weathering.
    b. Warranty Periods from Date of Planting Completion **OR** Substantial Completion, **as directed**:
        1) Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
        2) Ground Covers, Biennials, Perennials, and Other Plants: 12 **OR** Nine **OR** Six **OR** Three, **as directed**, months.
        3) Annuals: Three **OR** Two, **as directed**, months.

H. Maintenance Service
1. Initial Maintenance Service: Provide maintenance by skilled employees of landscape Installer. Maintain as required in Part 1.3. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than maintenance period below.
    a. Maintenance Period for Trees and Shrubs: 12 **OR** Six **OR** Three, **as directed**, months from date of planting completion **OR** Substantial Completion, **as directed**.
    b. Maintenance Period for Ground Cover and Other Plants: Six **OR** Three, **as directed**, months from date of planting completion **OR** Substantial Completion, **as directed**.
2. Continuing Maintenance Proposal: From Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1.2 PRODUCTS

A. Plant Material

1. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule or Plant Legend shown on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
   a. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch (19 mm) in diameter; or with stem girdling roots will be rejected.
   b. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.
2. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1. Root flare shall be visible before planting.
3. Annuals and Biennials: Provide healthy, disease-free plants of species and variety shown or listed, with well-established root systems reaching to sides of the container to maintain a firm ball, but not with excessive root growth encircling the container. Provide only plants that are acclimated to outdoor conditions before delivery and that are in bud but not yet in bloom.

B. Inorganic Soil Amendments
1. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
   a. Class: T, with a minimum of 99 percent passing through No. 8 (2.36-mm) sieve and a minimum of 75 percent passing through No. 60 (0.25-mm) sieve.
      OR
      Class: O, with a minimum of 95 percent passing through No. 8 (2.36-mm) sieve and a minimum of 55 percent passing through No. 60 (0.25-mm) sieve.
   b. Provide lime in form of ground dolomitic limestone **OR** calcitic limestone **OR** mollusk shells, **as directed**.
2. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent sulfur, with a minimum of 99 percent passing through No. 6 (3.35-mm) sieve and a maximum of 10 percent passing through No. 40 (0.425-mm) sieve.
3. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
4. Aluminum Sulfate: Commercial grade, unadulterated.
5. Perlite: Horticultural perlite, soil amendment grade.
6. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 (0.30-mm) sieve.
7. Sand: Clean, washed, natural or manufactured, and free of toxic materials.
8. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.
   OR
   Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

C. Organic Soil Amendments
1. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch (25-mm) **OR** 3/4-inch (19-mm) **OR** 1/2-inch (13-mm), **as directed**, sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
   a. Organic Matter Content: 50 to 60 percent of dry weight.
   b. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
2. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or granular texture, with a pH range of 3.4 to 4.8.

3. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.
4. Wood Derivatives: Decomposed, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.
   a. In lieu of decomposed wood derivatives, mix partially decomposed wood derivatives with ammonium nitrate at a minimum rate of 0.15 lb/cu. ft. (2.4 kg/cu. m) of loose sawdust or ground bark, or with ammonium sulfate at a minimum rate of 0.25 lb/cu. ft. (4 kg/cu. m) of loose sawdust or ground bark.
5. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, debris, and material harmful to plant growth.

D. Fertilizers
1. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 1 **OR** 4, **as directed**, percent nitrogen and 10 **OR** 20, **as directed**, percent phosphoric acid.
2. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
3. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
   a. Composition: 1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m) of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
   b. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.
4. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
   a. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
   b. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.
5. Planting Tablets: Tightly compressed chip type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.
   a. Size: 5-gram **OR** 10-gram **OR** 21-gram, **as directed**, tablets.
   b. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.
6. Chelated Iron: Commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.

E. Planting Soils
1. Planting Soil: ASTM D 5268 topsoil, with pH range of 5.5 to 7, a minimum of 2 percent organic material content **OR** Existing, native surface topsoil formed under natural conditions with the duff layer retained during excavation process **OR** Existing, in-place surface soil **OR** Imported topsoil or manufactured topsoil from off-site sources; do not obtain from agricultural land, bogs or marshes, **as directed**. Verify suitability of soil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clods, clay lumps, pockets of coarse sand, concrete slurry, concrete layers or chunks, cement, plaster, building debris, and other extraneous materials harmful to plant growth. Mix soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:
   a. Ratio of Loose Compost to Topsoil by Volume: 1:4 **OR** 1:3 **OR** 1:2, **as directed**.
   b. Ratio of Loose Sphagnum **OR** Muck, **as directed**, Peat to Topsoil by Volume: as directed by the Owner.
   c. Ratio of Loose Wood Derivatives to Topsoil by Volume: as directed by the Owner.
   d. Weight of Lime per 1000 Sq. Ft. (92.9 Sq. m): as directed by the Owner.

e. Weight of Sulfur **OR** Iron Sulfate **OR** Aluminum Sulfate, **as directed**, per 1000 Sq. Ft. (92.9 Sq. m): as directed by the Owner.
f. Weight of Agricultural Gypsum per 1000 Sq. Ft. (92.9 Sq. m): as directed by the Owner.
g. Volume of Sand Plus 10 Percent Diatomaceous Earth **OR** Zeolites, **as directed**, per 1000 Sq. Ft. (92.9 Sq. m): as directed by the Owner.
h. Weight of Bonemeal per 1000 Sq. Ft. (92.9 Sq. m): as directed by the Owner.
i. Weight of Superphosphate per 1000 Sq. Ft. (92.9 Sq. m): as directed by the Owner.
j. Weight of Commercial Fertilizer per 1000 Sq. Ft. (92.9 Sq. m): as directed by the Owner.
k. Weight of Slow-Release Fertilizer per 1000 Sq. Ft. (92.9 Sq. m): as directed by the Owner.

F. Mulches
1. Organic Mulch: Shredded hardwood **OR** Ground or shredded bark **OR** Wood and bark chips **OR** Pine straw **OR** Salt hay or threshed straw **OR** Pine needles **OR** Peanut, pecan, and cocoa-bean shells, **as directed**.
2. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch (25-mm) sieve; soluble salt content of 2 to 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings.
3. Mineral Mulch: Rounded riverbed gravel or smooth-faced stone **OR** Crushed stone or gravel **OR** Marble chips **OR** Granite chips, **as directed**.
   a. Size Range: 1-1/2 inches (38 mm) maximum, 3/4 inch (19 mm) minimum **OR** 3/4 inch (19 mm) maximum, 1/4 inch (6.4 mm) minimum, **as directed**.
   b. Color: Uniform tan-beige color range acceptable to Owner **OR** Readily available natural gravel color range, **as directed**.

G. Weed-Control Barriers
1. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, 3 oz./sq. yd. (101g/sq. m) minimum, composed of fibers formed into a stable network so that fibers retain their relative position. Fabric shall be inert to biological degradation and resist naturally-encountered chemicals, alkalis, and acids.
2. Composite Fabric: Woven, needle-punched polypropylene substrate bonded to a nonwoven polypropylene fabric, 4.8 oz./sq. yd. (162 g/sq. m).

H. Pesticides
1. General: Pesticide registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
2. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
3. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

I. Tree Stabilization Materials
1. Stakes and Guys:
   a. Upright and Guy Stakes: Rough-sawn, sound, new hardwood **OR** softwood with specified wood pressure-preservative treatment, **as directed**, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal (38-by-38-mm actual) by length indicated, pointed at one end.
   b. Wood Deadmen: Timbers measuring 8 inches (200 mm) in diameter and 48 inches (1200 mm) long, treated with specified wood pressure-preservative treatment.
   c. Flexible Ties: Wide rubber or elastic bands or straps of length required to reach stakes or turnbuckles **OR** compression springs, **as directed**.
   d. Guys and Tie Wires: ASTM A 641/A 641M, Class 1, galvanized-steel wire, two-strand, twisted, 0.106 inch (2.7 mm) in diameter.

e. Tree-Tie Webbing: UV-resistant polypropylene or nylon webbing with brass grommets.
f. Guy Cables: Five-strand, 3/16-inch- (4.8-mm-) diameter, galvanized-steel cable, with zinc-coated turnbuckles **OR** compression springs, **as directed**, a minimum of 3 inches (75 mm) long, with two 3/8-inch (10-mm) galvanized eyebolts.
g. Flags: Standard surveyor's plastic flagging tape, white, 6 inches (150 mm) long.
h. Proprietary Staking-and-Guying Devices: Proprietary stake and adjustable tie systems to secure each new planting by plant stem; sized as indicated and per manufacturer's written recommendations.

2. Root-Ball Stabilization Materials:
a. Upright Stakes and Horizontal Hold-Down: Rough-sawn, sound, new hardwood or softwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal (38-by-38-mm actual) by length indicated; stakes pointed at one end.
b. Wood Screws: ASME B18.6.1.
c. Proprietary Root-Ball Stabilization Devices: Proprietary at- or below-grade stabilization systems to secure each new planting by root ball; sized per manufacturer's written recommendations unless otherwise indicated.

3. Palm Bracing: Battens or blocks, struts, straps, and protective padding as indicated.
a. Battens or Blocks and Struts: Rough-sawn, sound, new hardwood or softwood, free of knots, holes, cross grain, and other defects, 2-by-4-inch nominal (38-by-89-mm actual) by lengths indicated.
b. Straps: Adjustable steel or plastic package banding straps.
c. Padding: Burlap.
d. Proprietary Palm-Bracing Devices: Proprietary systems to secure each new planting by trunk; sized per manufacturer's written recommendations unless otherwise indicated.

J. Landscape Edgings
1. Wood Edging: Of sizes shown on Drawings, and wood stakes as follows:
a. Species: Western red cedar, all heart **OR** Southern pine with specified wood pressure-preservative treatment, **as directed**.
b. Stakes: Same species as edging, 1-by-2-inch nominal (19-by-38-mm actual) by 18 inches (450 mm) long, with galvanized nails for anchoring edging.

2. Steel Edging: Standard commercial-steel edging, rolled edge, fabricated in sections of standard lengths, with loops stamped from or welded to face of sections to receive stakes.
a. Edging Size: 3/16 inch (4.8 mm) wide by 4 inches (100 mm) deep **OR** 1/4 inch (6.4 mm) wide by 5 inches (125 mm) deep **OR** 1/4 inch (6.4 mm) wide by 4 inches (100 mm) deep **OR** 1/8 inch (3.2 mm) wide by 4 inches (100 mm) deep **OR** 1/8 inch (3.2 mm) wide by 6 inches (150 mm) deep **OR** 0.1 inch (2.5 mm) wide by 4 inches (100 mm) deep, **as directed**.
b. Stakes: Tapered steel, a minimum of 12 inches (300 mm) **OR** 15 inches (380 mm), **as directed**, long.
c. Accessories: Standard tapered ends, corners, and splicers.
d. Finish: Standard paint **OR** Zinc coated **OR** Unfinished, **as directed**.
e. Paint Color: Black **OR** Green **OR** Brown, **as directed**.

3. Aluminum Edging: Standard-profile extruded-aluminum edging, ASTM B 221 (ASTM B 221M), Alloy 6063-T6, fabricated in standard lengths with interlocking sections with loops stamped from face of sections to receive stakes.
a. Edging Size: 3/16 inch (4.8 mm) wide by 5-1/2 inches (140 mm) deep **OR** 3/16 inch (4.8 mm) wide by 4 inches (100 mm) deep **OR** 1/8 inch (3.2 mm) wide by 5-1/2 inches (140 mm) deep **OR** 1/8 inch (3.2 mm) wide by 4 inches (100 mm) deep, **as directed**.
b. Stakes: Aluminum, ASTM B 221 (ASTM B 221M), Alloy 6061-T6, approximately 1-1/2 inches (38 mm) wide by 12 inches (300 mm) long.
c. Finish: Manufacturer's standard paint **OR** Powder-coat paint **OR** Mill (natural aluminum) **OR** Black anodized, **as directed**.
d. Paint Color: Black **OR** Green **OR** Brown, **as directed**.

4. Plastic Edging: Standard black polyethylene or vinyl edging, V-lipped bottom **OR** horizontally grooved, **as directed**, extruded in standard lengths, with 9-inch (225-mm) steel angle **OR** plastic, **as directed**, stakes.
   a. Edging Size: 0.1 inch (2.5 mm) wide by 5 inches (125 mm) deep **OR** 0.07 inch (1.8 mm) wide by 5 inches (125 mm) deep, **as directed**.
   b. Top Profile: Straight, with top 2 inches (50 mm) being 1/4 inch (6.4 mm) thick.
   c. Top Profile: Round top, 1/2 inch (13 mm) **OR** 1 inch (25 mm), **as directed**, in diameter.
   d. Accessories: Manufacturer's standard alignment clips or plugs.

K. Tree Grates
1. Tree Grates and Frames: ASTM A 48/A 48M, Class 35 (Class 250) or better, gray-iron castings of shape, pattern, and size indicated.
   OR
   Tree Grates and Frames: ASTM A 48/A 48M, Class 35 (Class 250) or better, gray-iron castings and ASTM A 36/A 36M steel-angle frames of shape, pattern, and size indicated; steel frames hot-dip galvanized.
2. Shape and Size: As indicated **OR** Round, 36 inches (914 mm) in diameter **OR** Round, 72 inches (1828 mm) in diameter **OR** 48 inches (1219 mm) square **OR** 60 inches (1524 mm) square **OR** Rectangular, 36 by 60 inches (914 by 1524 mm) **OR** Rectangular, 48 by 72 inches (1219 by 1828 mm), **as directed**.
3. Finish: As fabricated **OR** Powder-coat finish, **as directed**.
   a. Color: Low-gloss black **OR** dark brown **OR** dark green **OR** dark gray, **as directed**.

L. Miscellaneous Products
1. Wood Pressure-Preservative Treatment: AWPA C2, with waterborne preservative for soil and freshwater use, acceptable to authorities having jurisdiction, and containing no arsenic; including ammoniacal copper arsenate, ammoniacal copper zinc arsenate, and chromated copper arsenate.
2. Root Barrier: Black, molded, modular panels manufactured with 50 percent recycled polyethylene plastic with ultraviolet inhibitors, 85 mils (2.2 mm) thick, with vertical root deflecting ribs protruding 3/4 inch (19 mm) out from panel, and each panel 18 inches (457 mm) **OR** 24 inches (610 mm), **as directed**, wide.
3. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.
4. Burlap: Non-synthetic, biodegradable.
5. Planter Drainage Gravel: Washed, sound crushed stone or gravel complying with ASTM D 448 for Size No. 8.
6. Planter Filter Fabric: Woven **OR** Nonwoven, **as directed**, geotextile manufactured for separation applications and made of polypropylene, polyolefin, or polyester fibers or combination of them.
7. Mycorrhizal Fungi: Dry, granular inoculant containing at least 5300 spores per lb (0.45 kg) of vesicular-arbuscular mycorrhizal fungi and 95 million spores per lb (0.45 kg) of ectomycorrhizal fungi, 33 percent hydrogel, and a maximum of 5.5 percent inert material.

1.3 EXECUTION

A. Preparation
1. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.
2. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
3. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.

4. Lay out plants at locations directed by Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.
5. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.
   a. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.
6. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

B. Planting Area Establishment
1. Loosen subgrade of planting areas to a minimum depth of 4 inches (100 mm) **OR** 6 inches (150 mm) **OR** 8 inches (200 mm) **OR** 12 inches (300 mm), **as directed**. Remove stones larger than 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
   a. Apply superphosphate fertilizer directly to subgrade before loosening.
   b. Thoroughly blend planting soil off-site before spreading or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil.
      1) Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
      2) Mix lime with dry soil before mixing fertilizer.
   c. Spread planting soil to a depth of 4 inches (100 mm) **OR** 6 inches (150 mm) **OR** 8 inches (200 mm) **OR** 12 inches (300 mm), **as directed**, but not less than required to meet finish grades after natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
      1) Spread approximately one-half the thickness of planting soil over loosened subgrade. Mix thoroughly into top 2 inches (50 mm) **OR** 4 inches (100 mm), **as directed**, of subgrade. Spread remainder of planting soil.
2. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.
3. Before planting, obtain the Owner's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.
4. Application of Mycorrhizal Fungi: At time directed by the Owner, broadcast dry product uniformly over prepared soil at application rate indicated on Drawings.

C. Excavation For Trees And Shrubs
1. Planting Pits and Trenches: Excavate circular planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are not acceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
   a. Excavate approximately three times as wide as ball diameter for balled and burlapped **OR** balled and potted **OR** container-grown **OR** fabric bag-grown, **as directed**, stock.
   b. Excavate at least 12 inches (300 mm) wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
   c. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
   d. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
   e. Maintain required angles of repose of adjacent materials as shown on the Drawings. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
   f. Maintain supervision of excavations during working hours.
   g. Keep excavations covered or otherwise protected overnight **OR** after working hours **OR** when unattended by Installer's personnel, **as directed**.

h. If drain tile is shown on Drawings or required under planting areas, excavate to top of porous backfill over tile.

2. Subsoil and topsoil removed from excavations may **OR** may not, **as directed**, be used as planting soil.
3. Obstructions: Notify the Owner if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
   a. Hardpan Layer: Drill 6-inch- (150-mm-) diameter holes, 24 inches (600 mm) apart, into free-draining strata or to a depth of 10 feet (3 m), whichever is less, and backfill with free-draining material.
4. Drainage: Notify the Owner if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.
5. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

D. Tree, Shrub, And Vine Planting
1. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.
2. Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.
3. Set balled and burlapped stock plumb and in center of planting pit or trench with root flare 1 inch (25 mm) above **OR** 2 inches (50 mm) above, **as directed**, adjacent finish grades.
   a. Use planting soil for backfill.
   b. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
   c. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
   d. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside the root ball about 1 inch (25 mm) from root tips; do not place tablets in bottom of the hole.
   e. Continue backfilling process. Water again after placing and tamping final layer of soil.
4. Set balled and potted **OR** container-grown, **as directed**, stock plumb and in center of planting pit or trench with root flare 1 inch (25 mm) above **OR** 2 inches (50 mm) above, **as directed**, adjacent finish grades.
   a. Use planting soil for backfill.
   b. Carefully remove root ball from container without damaging root ball or plant.
   c. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
   d. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside the root ball about 1 inch (25 mm) from root tips; do not place tablets in bottom of the hole.
   e. Continue backfilling process. Water again after placing and tamping final layer of soil.
5. Set fabric bag-grown stock plumb and in center of planting pit or trench with root flare 1 inch (25 mm) above **OR** 2 inches (50 mm) above, **as directed**, adjacent finish grades.
   a. Use planting soil for backfill.
   b. Carefully remove root ball from fabric bag without damaging root ball or plant. Do not use planting stock if root ball is cracked or broken before or during planting operation.
   c. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.

d. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside the root ball about 1 inch (25 mm) from root tips; do not place tablets in bottom of the hole.
e. Continue backfilling process. Water again after placing and tamping final layer of soil.
f. Set and support bare-root stock in center of planting pit or trench with root flare 1 inch (25 mm) above **OR** 2 inches (50 mm) above, **as directed**, adjacent finish grade.

6. Use planting soil for backfill.
   a. Spread roots without tangling or turning toward surface, and carefully work backfill around roots by hand. Puddle with water until backfill layers are completely saturated. Plumb before backfilling, and maintain plumb while working backfill around roots and placing layers above roots.
   b. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside soil-covered roots about 1 inch (25 mm) from root tips; do not place tablets in bottom of the hole or touching the roots.
   c. Continue backfilling process. Water again after placing and tamping final layer of soil.
7. When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

E. Mechanized Tree Spade Planting
1. Trees shall **OR** may, **as directed**, be planted with an approved mechanized tree spade at the designated locations. Do not use tree spade to move trees larger than the maximum size allowed for a similar field-grown, balled-and-burlapped root-ball diameter according to ANSI Z60.1, or larger than the manufacturer's maximum size recommendation for the tree spade being used, whichever is smaller.
2. When extracting the tree, center the trunk within the tree spade and move tree with a solid ball of earth.
3. Cut exposed roots cleanly during transplanting operations.
4. Use the same tree spade to excavate the planting hole as was used to extract and transport the tree.
5. Plant trees as shown on Drawings, following procedures in "Tree, Shrub, and Vine Planting" Article.
6. Where possible, orient the tree in the same direction as in its original location.

F. Tree, Shrub, And Vine Pruning
1. Remove only dead, dying, or broken branches. Do not prune for shape.
2. Prune, thin, and shape trees, shrubs, and vines as directed by Architect.
3. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.
4. Do not apply pruning paint to wounds.

G. Tree Stabilization
1. Install trunk stabilization as follows unless otherwise indicated:
   a. Upright Staking and Tying: Stake trees of 2- through 5-inch (50- through 125-mm) caliper. Stake trees of less than 2-inch (50-mm) caliper only as required to prevent wind tip out. Use a minimum of two stakes of length required to penetrate at least 18 inches (450 mm) below bottom of backfilled excavation and to extend to the dimension shown on Drawings **OR** at least 72 inches (1830 mm) **OR** one-third of trunk height, **as directed**, above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.
   b. Use two stakes for trees up to 12 feet (3.6 m) high and 2-1/2 inches (63 mm) or less in caliper; three stakes for trees less than 14 feet (4.2 m) high and up to 4 inches (100 mm) in caliper. Space stakes equally around trees.

c. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.
OR
Support trees with two strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

2. Staking and Guying: Stake and guy trees more than 14 feet (4.2 m) in height and more than 3 inches (75 mm) in caliper unless otherwise indicated. Securely attach no fewer than three guys to stakes 30 inches (760 mm) long, driven to grade.
   a. Site-Fabricated Staking-and-Guying Method:
      1) For trees more than 6 inches (150 mm) in caliper, anchor guys to wood deadmen buried at least 36 inches (900 mm) below grade. Provide turnbuckle **OR** compression spring, **as directed**, for each guy wire and tighten securely.
      2) Support trees with bands of flexible ties at contact points with tree trunk and reaching to turnbuckle **OR** compression spring, **as directed**. Allow enough slack to avoid rigid restraint of tree.
      3) Support trees with strands of cable or multiple strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk and reaching to turnbuckle **OR** compression spring, **as directed**. Allow enough slack to avoid rigid restraint of tree.
      4) Attach flags to each guy wire, 30 inches (760 mm) above finish grade.
      OR
      Paint turnbuckles **OR** compression springs, **as directed**, with luminescent white paint.
   b. Proprietary Staking and Guying Device: Install staking and guying system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.
3. Root-Ball Stabilization: Install at- or below-grade stabilization system to secure each new planting by the root ball unless otherwise indicated.
   a. Wood Hold-Down Method: Place vertical stakes against side of root ball and drive them into subsoil; place horizontal wood hold-down stake across top of root ball and screw at each end to one of the vertical stakes.
      1) Install stakes of length required to penetrate at least to the dimension shown on Drawings **OR** 18 inches (450 mm), **as directed**, below bottom of backfilled excavation. Saw stakes off at horizontal stake.
      2) Install screws through horizontal hold-down and penetrating at least 1 inch (25 mm) into stakes. Predrill holes if necessary to prevent splitting wood.
      3) Install second set of stakes on other side of root trunk for larger trees as indicated.
   b. Proprietary Root-Ball Stabilization Device: Install root-ball stabilization system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.
4. Palm Bracing: Install bracing system at three or more places equally spaced around perimeter of trunk to secure each palm until established unless otherwise indicated.
   a. Site-Fabricated Palm-Bracing Method:
      1) Place battens over padding and secure battens in place around trunk perimeter with at least two straps, tightened to prevent displacement. Ensure that straps do not contact trunk.
      2) Place diagonal braces and cut to length. Secure upper ends of diagonal braces with galvanized nails into battens or into nail-attached blocks on battens. Do not drive nails, screws, or other securing devices into palm trunk; do not penetrate palm trunk in any fashion. Secure lower ends of diagonal braces with stakes driven into ground to prevent outward slippage of braces.
   b. Proprietary Palm-Bracing Device: Install palm-bracing system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.

H. Root-Barrier Installation
1. Install root barrier where trees are planted within 60 inches (1500 mm) **OR** 48 inches (1200 mm), **as directed**, of paving or other hardscape elements, such as walls, curbs, and walkways unless otherwise shown on Drawings.
2. Align root barrier vertically **OR** with bottom edge angled at 20 degrees away from the paving or other hardscape element, **as directed**, and run it linearly along and adjacent to the paving or other hardscape elements to be protected from invasive roots.
3. Install root barrier continuously for a distance of 60 inches (1500 mm) in each direction from the tree trunk, for a total distance of 10 feet (3 m) per tree. If trees are spaced closer, use a single continuous piece of root barrier.
    a. Position top of root barrier flush with finish grade **OR** 1/2 inch (13 mm) above finish grade **OR** per manufacturer's recommendations, **as directed**.
    b. Overlap root barrier a minimum of 12 inches (300 mm) at joints.
    c. Do not distort or bend root barrier during construction activities.
    d. Do not install root barrier surrounding the root ball of tree.

I. Planting In Planters
1. Place a layer of drainage gravel at least 4 inches (100 mm) thick in bottom of planter. Cover bottom with filter fabric and wrap filter fabric 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, up on all sides. Duct tape along the entire top edge of the filter fabric, to secure the filter fabric against the sides during the soil-filling process.
2. Fill planter with lightweight on-structure planting soil. Place soil in lightly compacted layers to an elevation of 1-1/2 inches (38 mm) below top of planter, allowing natural settlement.

J. Ground Cover And Plant Planting
1. Set out and space ground cover and plants other than trees, shrubs, and vines 9 inches (225 mm) apart **OR** 12 inches (300 mm) apart **OR** 18 inches (450 mm) apart **OR** 24 inches (600 mm) apart **OR** as indicated, **as directed**, in even rows with triangular spacing.
2. Use planting soil for backfill.
3. Dig holes large enough to allow spreading of roots.
4. For rooted cutting plants supplied in flats, plant each in a manner that will minimally disturb the root system but to a depth not less than two nodes.
5. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
6. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
7. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

K. Planting Area Mulching
1. Install weed-control barriers before mulching according to manufacturer's written instructions. Completely cover area to be mulched, overlapping edges a minimum of 6 inches (150 mm) **OR** 12 inches (300mm), **as directed**, and secure seams with galvanized pins.
2. Mulch backfilled surfaces of planting areas and other areas indicated.
    a. Trees and Tree-like Shrubs in Turf Areas: Apply organic **OR** mineral, **as directed**, mulch ring of 2-inch (50-mm) **OR** 3-inch (75-mm), **as directed**, average thickness, with 12-inch (300-mm) **OR** 24-inch (600-mm) **OR** 36-inch (900-mm), **as directed**, radius around trunks or stems. Do not place mulch within 3 inches (75 mm) **OR** 6 inches (150 mm), **as directed**, of trunks or stems.
    b. Organic Mulch in Planting Areas: Apply 2-inch (50-mm) **OR** 3-inch (75-mm), **as directed**, average thickness of organic mulch extending 12 inches (300 mm) beyond edge of individual planting pit or trench and over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches (75 mm) **OR** 6 inches (150 mm), **as directed**, of trunks or stems.
    c. Mineral Mulch in Planting Areas: Apply 2-inch (50-mm) **OR** 3-inch (75-mm), **as directed**, average thickness of mineral mulch extending 12 inches (300 mm) beyond edge of individual planting pit or trench and over whole surface of planting area, and finish level

with adjacent finish grades. Do not place mulch within 3 inches (75 mm) **OR** 6 inches (150 mm), **as directed**, of trunks or stems.

L. Edging Installation
1. Wood Edging: Install edging where indicated. Mitre cut joints and connections at a 45 degree angle. Fasten each cut joint or connection with two galvanized nails. Anchor with wood stakes spaced up to 36 inches (900 mm) apart, driven at least 1 inch (25 mm) below top elevation of edging. Use two galvanized nails per stake to fasten edging, of length as needed to penetrate both edging and stake and provide 1/2-inch (13-mm) clinch at point. Predrill stakes if needed to avoid splitting. Replace stakes that crack or split during installation process.
2. Steel Edging: Install steel edging where indicated according to manufacturer's written instructions. Anchor with steel stakes spaced approximately 30 inches (760 mm) apart, driven below top elevation of edging.
3. Aluminum Edging: Install aluminum edging where indicated according to manufacturer's written instructions. Anchor with aluminum stakes spaced approximately 36 inches (900 mm) **OR** 48 inches (1200 mm), **as directed**, apart, driven below top elevation of edging.
4. Plastic Edging: Install plastic edging where indicated according to manufacturer's written instructions. Anchor with steel stakes spaced approximately 36 inches (900 mm) **OR** 48 inches (1200 mm), **as directed**, apart, driven through upper base grooves or V-lip of edging.
5. Shovel-Cut Edging: Separate mulched areas from turf areas, curbs, and paving with a 45-degree, 4- to 6-inch- (100- to 150-mm-) deep, shovel-cut edge as shown on Drawings.

M. Tree Grate Installation
1. Tree Grates: Set grate segments flush with adjoining surfaces as shown on Drawings. Shim from supporting substrate with soil-resistant plastic. Maintain a 3-inch- (75-mm-) minimum growth radius around base of tree; break away units of casting, if necessary, according to manufacturer's written instructions.

N. Plant Maintenance
1. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease.
2. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.
3. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated past management practices whenever possible to minimize the use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

O. Pesticide Application
1. Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
2. Pre-Emergent Herbicides (Selective and Non-Selective): Apply to tree, shrub, and ground-cover areas in accordance with manufacturer's written recommendations. Do not apply to seeded areas.
3. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

P. Cleanup And Protection
1. During planting, keep adjacent paving and construction clean and work area in an orderly condition.

2. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.
3. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

Q. Disposal
1. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

END OF SECTION 02630c

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Task	Specification	Specification Description
02630	02264b	Unit Pavers
02695	02620a	Porous Unit Paving

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SECTION 02710 - HIGH-SECURITY CHAIN-LINK FENCES AND GATES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for high-security chain-link fences and gates. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. High-security chain-link fences.
b. Gates: Motor operated, horizontal slide and swing.

C. Performance Requirements
1. Delegated-Design Submittal: For chain-link fences and gate framework indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Structural Performance: Chain-link fences and gate framework shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to ASCE/SEI 7:
a. Minimum Post Size: Determine according to ASTM F 1043 for framework up to 12 feet (3.66 m) high, and post spacing not to exceed 10 feet (3 m) for Material Group IA, ASTM F 1043, Schedule 40 steel pipe **OR** Group IC, electric-resistance-welded round steel pipe, **as directed**.
OR
Minimum Post Size and Maximum Spacing: Provide line posts of size and in spacing indicated, but not less than sizes and spacings determined according to ASTM F 1916, including Appendix **OR** CLFMI WLG 2445, **as directed**, based on mesh size and pattern specified and the following:
1) Wind Loads: Determine design wind loads applicable to Project from basic wind speed and exposure category according to CLFMI WLG 2445.
2) Exposure Category: B **OR** C **OR** D, **as directed**.
3) Fence Height: 10 feet (3 m).
4) Material Group: IA, ASTM F 1043, Schedule 40 steel pipe **OR** IC, electric-resistance-welded round steel pipe, **as directed**.
b. Fabric Tension: Provide fences in which fabric deflections do not exceed those indicated in Table X1.1 of ASTM F 1916 when tested by applying a 30-lbf (133-N) force at midpoint between rails and horizontally between posts for every eighth lower panel along the fence line.
c. Fence Post Rigidity: Provide fences in which post deflections do not exceed 3/4 inch (19 mm) when tested according to ASTM F 1916 by applying a 50-lbf (222-N) force at midheight of every eighth post along the fence line.
3. Lightning Protection System: Maximum grounding-resistance value of 25 ohms under normal dry conditions.

D. Submittals
1. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for chain-link fences and gates, **as directed**.
a. Fence and gate posts, rails, and fittings.
b. Chain-link fabric, reinforcements, and attachments.
c. Accessories: Barbed wire **OR** Barbed tape, **as directed**.

d. Gates and hardware.
e. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
f. Wiring Diagrams: For power, signal, and control wiring.

2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Show accessories, hardware, gate operation, and operational clearances.
   a. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
   b. Wiring Diagrams: For power, signal, and control wiring.
3. Samples: Prepared on Samples of size indicated below:
   a. Polymer-Coated Components: In 6-inch (150-mm) lengths for components and on full-sized units for accessories.
4. Delegated-Design Submittal: For chain-link fences and gate framework indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
5. Qualification Data: For qualified professional engineer **OR** testing agency **OR** factory-authorized service representative, **as directed**.
6. Product Certificates: For each type of chain-link fence, operator, **as directed**, and gate, from manufacturer.
7. Product Test Reports: For framing strength according to ASTM F 1043.
8. Field quality-control reports.
9. Soil sterilization certificate of treatment stating materials and quantities used, and date of application.
10. Operation and Maintenance Data: For the following to include in emergency, operation, and maintenance manuals:
    a. Polymer finishes.
    b. Gate hardware.
    c. Gate operator.
11. Warranty: Sample of special warranty.

E. Quality Assurance
1. Testing Agency Qualifications: For testing fence grounding. Member company of NETA or an NRTL.
   a. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Emergency Access Requirements: Comply with requirements of authorities having jurisdiction for automatic gate operators serving as a required means of access.
4. Preinstallation Conference: Conduct conference at Project site.

F. Project Conditions
1. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer **OR** Installer, **as directed**, agrees to repair or replace components of high-security chain-link fences and gates that fail in materials or workmanship within specified warranty period.
   a. Failures include, but are not limited to, the following:
      1) Deflection of fence fabric beyond design limits.

2) Deterioration of metals, metal finishes, and other materials beyond normal weathering.
3) Faulty operation of gate operators and controls.

b. Warranty Period: Five **OR** 15, **as directed**, years from date of Substantial Completion.

1.2 PRODUCTS

A. Chain-Link Fence Fabric

1. Chain-Link Fence Fabric: Provide fabric in one **OR** two, **as directed**,-piece heights measured between top and bottom of outer edge of selvage. Comply with CLFMI Product Manual and with requirements indicated below:
   a. Fabric Height: As indicated on Drawings **OR** As directed.
      1) Steel Wire Fabric: Wire with a diameter of 0.192 inch (4.88 mm) **OR** 0.148 inch (3.76 mm) **OR** 0.120 inch (3.05 mm) **OR** 0.113 inch (2.87 mm), **as directed**.
         a) Mesh Size: 2 inches (51 mm) **OR** 1 inch (25.4 mm) **OR** 3/8 inch (9.5 mm), **as directed**.
   b. Fabric Heights and Overlap: As indicated on Drawings **OR** As directed.
      1) Steel Wire Lower Fabric: Wire with a diameter of 0.192 inch (4.88 mm) **OR** 0.148 inch (3.76 mm) **OR** 0.120 inch (3.05 mm) **OR** 0.113 inch (2.87 mm), **as directed**.
         a) Mesh Size: 2 inches (51 mm) **OR** 1 inch (25.4 mm) **OR** 3/8 inch (9.5 mm), **as directed**.
      2) Steel Wire Upper Fabric: Wire with a diameter of 0.120 inch (3.05 mm).
         a) Mesh Size: 3/8 inch (9.5 mm).
   c. Aluminum-Coated Fabric: ASTM A 491, Type I, 0.40 oz./sq. ft. (122 g/sq. m) **OR** 0.35 oz./sq. ft. (107 g/sq. m) **OR** 0.30 oz./sq. ft. (92 g/sq. m), **as directed**.
   d. Zinc-Coated Fabric: ASTM A 392, Type II, Class 1, 1.2 oz./sq. ft. (366 g/sq. m) **OR** Class 2, 2.0 oz./sq. ft. (610 g/sq. m), **as directed**, with zinc coating applied before **OR** after, **as directed**, weaving.
   e. Zn-5-Al-MM Aluminum-Mischmetal-Coated Fabric: ASTM F 1345, Type III, Class 2, 1.0 oz./sq. ft. (305 g/sq. m).
   f. Polymer-Coated Fabric: ASTM F 668, Class 2b over aluminum **OR** zinc **OR** Zn-5-Al-MM-alloy, **as directed**,-coated steel wire.
      1) Color: Dark green **OR** Olive green **OR** Brown **OR** Black **OR** As selected by the Owner from manufacturer's full range, **as directed**, complying with ASTM F 934.
   g. Coat selvage ends of fabric that is metallic coated before the weaving process with manufacturer's standard clear protective coating.
   h. Selvage: Twisted and barbed top and bottom.

B. Security Fence Framing

1. Posts and Rails: Comply with ASTM F 1043 for framing, including rails, braces, and line; terminal; and corner posts.
   a. Fence Height: 96 inches (2440 mm) **OR** 12 feet (3.66 m) **OR** As indicated on Drawings, **as directed**.
   b. Heavy **OR** Light, **as directed**, Industrial Strength: Material Group IA, round steel pipe, Schedule 40 **OR** Group IC, round steel pipe, electric resistance-welded pipe, **as directed**.
      1) Line Post: 2.375 inches (60 mm) in diameter **OR** 2.875 inches (73 mm) in diameter **OR** 4 inches (100-mm) in diameter **OR** 6.625 inches (168 mm) in diameter **OR** 8.625 inches (168 mm) in diameter **OR** 2.25 by 1.70 inches (67 by 43 mm) **OR** 3.25 by 2.50 inches (83 by 64 mm), **as directed**.
      2) End, Corner, and Pull Post: 2.875 inches (73 mm) in diameter **OR** 4.0 inches (102 mm) in diameter **OR** 6.625 inches (168 mm) in diameter **OR** 8.625 inches (168 mm) in diameter, **as directed**.
   c. Rail Members: Intermediate, top, and brace, **as directed**, rails complying with ASTM F 1043 for Heavy Industrial.
   d. Metallic Coating for Steel Framing:

1) Type A, consisting of not less than minimum 2.0-oz./sq. ft. (0.61-kg/sq. m) average zinc coating per ASTM A 123/A 123M or 4.0-oz./sq. ft. (1.22-kg/sq. m) zinc coating per ASTM A 653/A 653M.
2) Type B, zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film.
3) External, Type B, zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film. Internal, Type D, consisting of 81 percent, not less than 0.3-mil- (0.0076-mm-) thick, zinc-pigmented coating.
4) Type C, Zn-5-Al-MM alloy, consisting of not less than 1.8-oz./sq. ft. (0.55-kg/sq. m) coating.
5) Coatings: Any coating above.

e. Polymer coating over metallic coating.
1) Color: Match chain-link fabric **OR** Dark green **OR** Olive green **OR** Brown **OR** Black **OR** As selected from manufacturer's full range, **as directed**, complying with ASTM F 934.

C. Tension Wire
1. Metallic-Coated Steel Wire: 0.177-inch- (4.5-mm-) diameter, marcelled tension wire complying with ASTM A 817 and ASTM A 824, with the following metallic coating:
a. Type I, aluminum coated (aluminized).
b. Type II, zinc coated (galvanized) by hot-dip **OR** electrolytic, **as directed**, process, with Class 5 minimum coating weight of not less than 2.0 oz./sq. ft. (610 g/sq. m) of uncoated wire surface.
2. Polymer-Coated Steel Wire: 0.177-inch- (4.5-mm-) diameter, tension wire complying with ASTM F 1664, Class 1 **OR** Class 2a **OR** Class 2b, **as directed**, over aluminum **OR** zinc **OR** Zn-5-Al-MM-alloy, **as directed**,-coated steel wire.
a. Color: Match chain-link fabric **OR** Dark green **OR** Olive green **OR** Brown **OR** Black **OR** As selected from manufacturer's full range, **as directed**, complying with ASTM F 934.

D. Swing Gates
1. General: Comply with ASTM F 900 for gate posts and single **OR** double, **as directed**, swing gate types. Provide automated vehicular gates that comply with ASTM F 2200, **as directed**.
a. Gate Leaf Width: 36 inches (914 mm) **OR** As indicated, **as directed**.
b. Gate Fabric Height: 72 inches (1830 mm) or less **OR** More than 72 inches (1830 mm) **OR** As indicated, **as directed**.
2. Pipe and Tubing:
a. Zinc-Coated Steel: Comply with ASTM F 1043 and ASTM F 1083; protective coating and finish to match fence framing **OR** manufacturer's standard protective coating and finish, **as directed**.
b. Aluminum: Comply with ASTM B 429/B 429M; mill **OR** manufacturer's standard, **as directed**, finish.
c. Gate Post Size and Weight: Not less than required by ASTM F 900 **OR** ASTM F 1916, **as directed**.
d. Gate Posts: Round tubular steel **OR** Rectangular tubular steel **OR** Round tubular aluminum **OR** Rectangular tubular aluminum, **as directed**.
e. Gate Frames and Bracing: Round tubular steel **OR** Rectangular tubular steel **OR** Round tubular aluminum **OR** Rectangular tubular aluminum, **as directed**.
3. Frame Corner Construction: Welded **OR** Assembled with corner fittings, **as directed**, and 3/8-inch- (9.5-mm-) diameter, adjustable truss rods for panels 5 feet (1.52 m) or wider.
4. Extended Gate Posts and Frame Members: Extend above top of chain-link fabric at both ends of gate frame 12 inches (300 mm) **OR** as indicated, **as directed**, as required to attach barbed wire **OR** tape, **as directed**, assemblies.
5. Provide separate isolated gate frame according to ASTM F 1916 and as indicated.

a. Separation between Hinge and Latch Post and Fence Termination Post: 2 inches (51 mm) minimum, 2-1/2 inches (63.5 mm) maximum.

6. Hardware: Comply with ASTM F 1916.
   a. Hinges: 180-degree inward **OR** 180-degree outward **OR** 360-degree inward and outward, **as directed**, swing.
   b. Latches permitting operation from one side **OR** both sides, **as directed**, of gate with provision for padlocking accessible from both sides of gate, **as directed-**.
   c. Padlock and Chain: Owner furnished.
   d. Lock: Manufacturer's standard, **as directed**, internal device furnished in lieu of gate latch, **as directed**.
   e. Closer: Manufacturer's standard, **as directed**.
   f. For gates 14 feet (4.27 m) and higher, add locking device to transom.

E. Horizontal-Slide Gates
1. General: Comply with ASTM F 1184 for gate posts and single **OR** double, **as directed**, sliding gate types. Provide automated vehicular gates that comply with ASTM F 2200, **as directed**.
   a. Classification: Type I Overhead Slide.
      1) Gate Leaf Width: As indicated.
      2) Gate Fabric Height: 72 inches (1830 mm) or less **OR** More than 72 inches (1830 mm) **OR** As indicated, **as directed**.
   b. Classification: Type II Cantilever Slide, Class 1 with external **OR** Class 2 with internal, **as directed**, roller assemblies.
      1) Gate Frame Width and Height: 48 inches (1200 mm) wide or less by 72 inches (1830 mm) high or less **OR** More than 48 inches (1200 mm) wide by any height **OR** As indicated, **as directed**.
2. Pipe and Tubing:
   a. Zinc-Coated Steel: Protective coating and finish to match fence framing **OR** Manufacturer's standard protective coating and finish, **as directed**.
   b. Aluminum: Comply with ASTM B 429/B 429M; mill **OR** manufacturer's standard, **as directed**, finish.
   c. Gate Post Size and Weight: Not less than required by ASTM F 1184 **OR** ASTM F 1916, **as directed**.
   d. Gate Frames and Bracing: Round tubular steel **OR** Rectangular tubular steel **OR** Round tubular aluminum **OR** Rectangular tubular aluminum, **as directed**.
3. Frame Corner Construction: Welded **OR** Assembled with corner fittings, **as directed**, and 3/8-inch- (9.5-mm-) diameter, adjustable truss rods for panels 5 feet (1.52 m) or wider.
4. Extended Gate Posts and Frame Members: Extend above top of chain-link fabric at both ends of gate frame 12 inches (300 mm) **OR** as indicated, **as directed**, as required to attach barbed wire **OR** tape, **as directed**, assemblies.
5. Overhead Track Assembly: Manufacturer's standard track, with overhead framing supports, bracing, and accessories, engineered to support size, weight, width, operation, and design of gate and roller assemblies.
6. Hardware:
   a. Latches permitting operation from one side **OR** both sides, **as directed**, of gate with provision for padlocking accessible from both sides of gate, **as directed**.
   b. Padlock and Chain: Owner furnished.
   c. Lock: Manufacturer's standard, **as directed**, internal device furnished in lieu of gate latch, **as directed**.
   d. Hangers, roller assemblies, and stops fabricated from galvanized steel **OR** galvanized malleable iron **OR** mill-finished Grade 319 aluminum-alloy casting with stainless-steel fasteners, **as directed**.

F. Fittings
1. General: Comply with ASTM F 626.
2. Post Caps: Provide for each post.
   a. Provide line post caps with loop to receive tension wire or top rail.

3. Rail and Brace Ends: For each gate, corner, pull, and end post.
4. Rail Fittings: Provide the following:
   a. Top-Rail Sleeves: Pressed steel or round steel tubing not less than 6 inches (152 mm) long.
   b. Rail Clamps: Line and corner boulevard clamps for connecting intermediate and bottom, **as directed**, rails in the fence line to line posts.
5. Tension and Brace Bands, Tension Bars, and Truss Rod Assemblies: Comply with ASTM F 2611.
6. Barbed Wire Arms: Pressed steel or cast iron **OR** Aluminum, **as directed**, with clips, slots, or other means for attaching strands of barbed wire, and means for attaching to posts **OR** integral with post cap, **as directed**; for each post unless otherwise indicated, and as follows:
   a. Provide line posts with arms that accommodate top rail or tension wire.
   b. Provide corner arms at fence corner posts, unless extended posts are indicated.
   c. Type I, single slanted arm.
   d. Type II, single vertical arm.
   e. Type III, V-shaped arm.
   f. Type IV, A-shaped arm.
   g. Bolts or rivets for connection to post.
7. Tie Wires, Clips, and Fasteners: Comply with ASTM F 626 and ASTM F 1916.
   a. High-Security Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, complying with the following:
      1) Metallic-Coated Steel: 0.148-inch- (3.76-mm-) **OR** 0.192-inch- (4.88-mm-), **as directed**, diameter wire; zinc **OR** aluminum, **as directed**, coating.
      2) Stainless steel.
8. Power-Driven Fabric Fasteners: Comply with ASTM F 1916.
9. Finish:
   a. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz. /sq. ft. (366 g/sq. m) of zinc.
      1) Polymer coating over metallic coating.
   b. Aluminum: Mill finish.

G. Barbed Wire
1. Steel Barbed Wire: Comply with ASTM A 121, High Security Grade, for two-strand barbed wire; 0.099-inch- (2.51-mm-) diameter line wire with 0.080-inch- (2.03-mm-) diameter, four-point round barbs spaced not more than 3 inches (76 mm) o.c.
   a. Aluminum Coating: Type A.
2. Polymer-Coated, Galvanized-Steel Barbed Wire: Comply with ASTM F 1665, Type II, for two-strand barbed wire; 0.080-inch- (2.03-mm-) diameter line wire with 0.080-inch- (2.03-mm-) diameter, four-point round aluminum-alloy **OR** galvanized-steel, **as directed**, barbs spaced not more than 3 inches (76 mm) o.c.
   a. Polymer Coating: Class 1 **OR** Class 2a **OR** Class 2b, **as directed**, over aluminum **OR** zinc **OR** Zn-5-Al-MM-alloy, **as directed**,-coated steel wire.
      1) Color: Match chain-link fabric **OR** Dark green **OR** Olive green **OR** Brown **OR** Black **OR** As selected from manufacturer's full range, **as directed**, complying with ASTM F 934.

H. Barbed Tape
1. Wire-Reinforced Tape: ASTM F 1910; with four-point, needle-sharp barbs permanently cold clenched around a core wire.
   a. Core Wire: High-tensile-strength, zinc-coated steel or stainless steel.
2. Clips: Stainless steel, 0.065 inch (1.65 mm) thick by 0.375 inch (9.5 mm) wide; capable of withstanding a minimum 150-lbf (667-N) pull load to limit extension of coil, resulting in a concertina pattern when deployed.
3. Tie Wires: Stainless steel, 0.065 inch (1.65 mm) in diameter.

4. Fabrication: Continuous coils of barbed tape as defined in ASTM F 1379 for the following characteristics:
   a. Configuration: Single **OR** Double, **as directed**, coil.
   b. Style: Helical **OR** Concertina, **as directed**, pattern.
   c. Coil Diameter(s): 18 inches (457 mm) **OR** 24 inches (610 mm) **OR** 24-inch (610-mm) inner coil and 30-inch (762-mm) outer coil **OR** As indicated on Drawings, **as directed**.
   d. Coil Loop Spacing(s): 12 inches (305 mm) **OR** Manufacturer's standard **OR** As indicated on Drawings, **as directed**.
   e. Barb Length Classification: Long, 1.2-inch (30.5-mm) **OR** Medium, 0.4-inch (10.2-mm) **OR** Short, 0.1875-inch (4.76-mm), **as directed**, barb.
   f. Barb Spacing: 4 inches (102 mm) o.c.
   g. Barb Set: Straight **OR** Offset **OR** Manufacturer's standard, **as directed**.
5. Ground Barrier Stakes: 3/8-inch- (9.5-mm-) diameter galvanized reinforcing bar, 18 inches (457 mm) long with 180-degree end hook 3-1/2 inches (89 mm) long.

I. Gate Operators
1. General: Provide factory-assembled automatic operating system designed for gate size, type, weight, and operation frequency. Provide operation control system with characteristics suitable for Project conditions, with remote-control stations, safety devices, and weatherproof enclosures; coordinate electrical requirements with building electrical system.
   a. Provide operator designed so motor may be removed without disturbing limit-switch adjustment and without affecting auxiliary emergency operator.
   b. Provide operator with UL approval **OR** UL-approved components, **as directed**.
   c. Provide electronic components with built-in troubleshooting diagnostic feature.
   d. Provide unit designed and wired for both right-hand/left-hand opening, permitting universal installation.
2. Comply with NFPA 70.
3. UL Standard: Manufacturer and label gate operators to comply with UL 325.
4. Motor Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, within installed environment, with indicated operating sequence, and without exceeding nameplate rating or considering service factor. Comply with NEMA MG 1 and the following:
   a. Voltage: 12-V dc **OR** 120 V **OR** 208-220 V **OR** NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected, **as directed**.
   b. Horsepower: 1/4 **OR** 1/3 **OR** 3/4, **as directed**.
   c. Enclosure: Open dripproof **OR** Totally enclosed **OR** Manufacturer's standard, **as directed**.
   d. Duty: Continuous duty at ambient temperature of 105 deg F (40 deg C) and at altitude of 3300 feet (1005 m) above sea level.
   e. Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.
   f. Phase: One **OR** Polyphase, **as directed**.
5. Gate Operators: Gate **OR** Equipment base/pad **OR** Pedestal post **OR** In ground, **as directed**, mounted and as follows:
   a. Hydraulic Swing **OR** Slide, **as directed**, Gate Operators:
      1) Duty: Medium **OR** Heavy, **as directed**.
      2) Gate Speed: Minimum 45 feet (13.7 m) **OR** 60 feet (18.2 m), **as directed**, per minute.
      3) Maximum Gate Weight: 800 lb (363 kg).
      4) Frequency of Use: 10 cycles per hour **OR** 25 cycles per hour **OR** Continuous duty, **as directed**.
      5) Operating Type: Wheel and rail drive with manual release, **as directed**.
      6) Hydraulic Fluid: Of viscosity required for gate operation at ambient temperature range for Project.
      7) Locking: Hydraulic in both directions.
      8) Heater: Manufacturer's standard track and roller heater with thermostatic control.
   b. Mechanical Swing **OR** Slide, **as directed**, Gate Operators:
      1) Duty: Medium **OR** Heavy **OR** Maximum security, **as directed**.

2) Gate Speed: Minimum 45 feet (13.7 m) per minute **OR** 60 feet (18.2 m) per minute **OR** variable speed, **as directed**.
3) Maximum Gate Weight: 800 lb (363 kg) **OR** 3000 lb (1360 kg), **as directed**.
4) Frequency of Use: 10 cycles per hour **OR** 25 cycles per hour **OR** 60 cycles per hour **OR** Continuous duty, **as directed**.
5) Operating Type: Crank arm **OR** Enclosed **OR** Wheel and rail drive **OR** Roller chain, **as directed**, with manual release, **as directed**.
6) Drive Type: Enclosed worm gear and chain-and-sprocket, **as directed**, reducers, roller-chain drive.
OR
Drive Type: V-belt and worm gear **OR** chain-and-sprocket, **as directed**, reducers, roller-chain drive.

6. Remote Controls: Electric controls separated from gate and motor and drive mechanism, with NEMA ICS 6, Type 1 **OR** NEMA ICS 6, Type 4, **as directed**, enclosure for surface **OR** recessed or flush **OR** equipment base/pad **OR** pedestal, **as directed**, mounting and with space for additional optional equipment. Provide the following remote-control device(s):
a. Control Station: Keyed, two **OR** three, **as directed**,-position switch, located remotely from gate. Provide two keys per station.
OR
Control Station: Momentary contact, single **OR** three, **as directed**,-button operated, located remotely from gate. Key switch to lock out open and close buttons, **as directed**.
1) Function: Open, stop, **as directed**, and close.
b. Card Reader: Functions only when authorized card is presented. Programmable, magnetic multiple **OR** single, **as directed**,-code system, permitting four different access time periods, **as directed**; face-lighted unit fully visible at night, **as directed**.
1) Reader Type: Touch plate **OR** Swipe **OR** Insertion **OR** Proximity, **as directed**.
2) Features: Timed anti-passback **OR** Limited-time usage **OR** Capable of monitoring and auditing gate activity, **as directed**.
c. Digital Keypad Entry Unit: Multiple-code capability **OR** Multiple-programmable code capability, **as directed**, of not less than five **OR** 500 **OR** 2500, **as directed**, possible individual codes, consisting of one- to seven **OR** four **OR** five, **as directed**,-digit codes and permitting four different access time periods, **as directed**.
1) Features: Timed anti-passback **OR** Limited-time usage **OR** Capable of monitoring and auditing gate activity, **as directed**.
2) Face-lighted unit with metal-keyed **OR** keyless-membrane, **as directed**, keypad fully visible at night.
d. Radio Control: Digital system consisting of code-compatible universal receiver for each gate, located where indicated, with remote antenna with coaxial cable and mounting brackets designed to operate gates. Provide one **OR** two, **as directed**, programmable transmitter(s) with multiple-code capability permitting validating or voiding of not less than 1000 **OR** 10,000, **as directed**, codes per channel configured for the following functions:
1) Transmitters: Single **OR** Three, **as directed**,-button operated, with open **OR** open and close, **as directed**, function.
2) Channel Settings: Two **OR** Three **OR** Four, **as directed**, independent channel settings controlling separate receivers for operating more than one gate from each transmitter.
e. Telephone Entry System: Hands-free voice-communication system for connection to building telephone system with digital-entry code activation of gate operator and auxiliary keypad entry, **as directed**.
1) System: Designed to be wired to same line with telephone.
OR
Multiunit System: Designed to be wired to a dedicated telephone line, with capacity to access 20 **OR** 100, **as directed**, telephones and with electronic directory, **as directed**.

f. Vehicle Loop Detector: System including automatic closing timer with adjustable time delay before closing, timer cut-off switch, **as directed**, and loop detector designed to open and close gate **OR** hold gate open until traffic clears **OR** reverse gate, **as directed**. Provide electronic detector with adjustable detection patterns, adjustable sensitivity and frequency settings, and panel indicator light designed to detect presence or transit of a vehicle over an embedded loop of wire and to emit a signal activating the gate operator. Provide number of loops consisting of multiple strands of wire, number of turns, loop size, and method of placement at location shown on Drawings, as recommended in writing by detection system manufacturer for function indicated.

1) Loop: Wire, in size indicated for field assembly, for pave-over **OR** saw-cut with epoxy-grouted, **as directed**, installation.

OR

Loop: Factory preformed in size indicated; style for pave-over **OR** saw-cut with epoxy-grouted, **as directed**, installation.

g. Vehicle Presence Detector: System including automatic closing timer with adjustable time delay before closing, timer cut-off switch, **as directed**, and presence detector designed to open and close gate **OR** hold gate open until traffic clears **OR** reverse gate, **as directed**. Provide retroreflective **OR** emitter/receiver, **as directed**, detector with adjustable detection zone pattern and sensitivity, designed to detect presence or transit of a vehicle in gate pathway when an infrared beam in zone pattern is interrupted, and to emit a signal activating the gate operator.

7. Obstruction Detection Devices: Provide each motorized gate with automatic safety sensor(s). Activation of sensor(s) causes operator to immediately function as follows:
   a. Action: Reverse gate in both opening and closing cycles and hold until clear of obstruction **OR** Stop gate in opening cycle and reverse gate in closing cycle and hold until clear of obstruction, **as directed**.
   b. Internal Sensor: Built-in torque or current monitor senses gate is obstructed.
   c. Sensor Edge: Contact-pressure-sensitive safety edge, profile, and sensitivity designed for type of gate and component indicated, in locations as follows. Connect to control circuit using take-up cable reel **OR** self-coiling cable **OR** gate edge transmitter and operator receiver system, **as directed**.
      1) Along entire gate leaf leading edge (for swing gates and slide gates).
      2) Along entire gate leaf trailing edge (for slide gates).
      3) Across entire gate leaf bottom edge (for vehicular swing and slide gates complying with UL 325 or to suit Project; consider retaining for pedestrian gates).
      4) Along entire length of gate posts (for slide gates; revise for sensor edge at pinch point post of swing gates).
      5) Along entire length of gate guide posts (for Type II Cantilever Slide, Class 1 gates).
      6) Where indicated on Drawings.
   d. Photoelectric/Infrared Sensor: System designed to detect an obstruction in gate's path when infrared beam in the zone pattern is interrupted.
8. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop gate at fully retracted and fully extended positions.
9. Emergency Release Mechanism: Quick-disconnect release of operator drive system of the following type of mechanism, permitting manual operation if operator fails. Design system so control circuit power is disconnected during manual operation.
   a. Type: Integral fail-safe release, allowing gate to be pushed open without mechanical devices, keys, cranks, or special knowledge **OR** Mechanical device, key, or crank-activated release, **as directed**.
10. Operating Features:
   a. Digital Microprocessor Control: Electronic programmable means for setting, changing, and adjusting control features with capability of monitoring and auditing gate activity, **as directed**. Provide unit that is isolated from voltage spikes and surges.
   b. System Integration: With controlling circuit board capable of accepting any type of input from external devices.
   c. Master/Slave Capability: Control stations designed and wired for gate pair operation.

d. Automatic Closing Timer: With adjustable time delay before closing and timer cut-off switch, **as directed**.
e. Open Override Circuit: Designed to override closing commands.
f. Reversal Time Delay: Designed to protect gate system from shock load on reversal in both directions.
g. Maximum Run Timer: Designed to prevent damage to gate system by shutting down system if normal time to open gate is exceeded.
h. Clock Timer: 24-hour **OR** Seven-day, **as directed**, programmable for regular events.

11. Accessories:
a. Warning Module: Audio **OR** Visual, **as directed**, constant **OR** strobe, **as directed**,-light alarm sounding three to five seconds in advance of gate operation and continuing until gate stops moving; compliant with the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.
b. Battery Backup System: Battery-powered drive and access-control system, independent of primary drive system.
1) Fail Safe: Gate opens and remains open until power is restored.
2) Fail Secure: Gate cycles on battery power, then fail safe when battery is discharged.
c. External electric-powered solenoid **OR** magnetic, **as directed**, lock with delay timer allowing time for lock to release before gate operates.
d. Fire **OR** Postal, **as directed**, box.
e. Fire strobe **OR** siren, **as directed**, sensor.
f. Intercom System: As required to meet Project requirements.
g. Instructional, Safety, and Warning Labels and Signs: According to UL 325 **OR** Manufacturer's standard for components and features specified **OR** As indicated on Drawings, **as directed**.
h. Equipment Bases/Pads: Precast concrete, depth not less than 12 inches (305 mm), dimensioned and reinforced according to gate operator component manufacturer's written instructions and as indicated on Drawings.

J. Grout And Anchoring Cement
1. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout, recommended in writing by manufacturer, for exterior applications.
2. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer for exterior applications.

K. Fence Grounding
1. Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.
a. Material above Finished Grade: Copper **OR** Aluminum, **as directed**.
b. Material on or below Finished Grade: Copper.
c. Bonding Jumpers: Braided copper tape, 1 inch (25.4 mm) wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.
2. Connectors and Grounding Rods: Listed in UL 467.
a. Connectors for Below-Grade Use: Exothermic welded type.
b. Grounding Rods: Copper-clad steel, 5/8 by 96 inches (16 by 2440 mm).

L. Soil Sterilization
1. Soil Sterilant: Type approved by authorities having jurisdiction.
2. Polyethylene Sheeting: 6 mils (0.15 mm) thick, black, and serving as soil separation fabric.
3. Stone Ground Cover: 3/4- to 2-inch (19- to 51-mm) crushed stone or washed gravel.

1.3 EXECUTION

A. Examination
1. Examine areas and conditions, with Installer present, for compliance with requirements for a verified survey of property lines and legal boundaries, **as directed**, site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.
a. Do not begin installation before final grading is completed unless otherwise permitted by the Owner.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet (152 m) or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

C. Installation, General
1. Install chain-link fencing to comply with ASTM F 567 **OR** ASTM F 1916, **as directed**, and more stringent requirements specified.
a. Install fencing on established boundary lines inside property line.

D. Chain-Link Fence Installation
1. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.
2. Post Setting: Set posts in concrete **OR** with mechanical anchors **OR** by mechanically driving into soil, **as directed**, at indicated spacing into firm, undisturbed soil.
a. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
b. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
1) Exposed Concrete: Extend 2 inches (51 mm) above grade or to same elevation as concrete grade beam, **as directed**; shape and smooth to shed water.
2) Concealed Concrete: Top 2 inches (51 mm) below grade as indicated on Drawings to allow covering with surface material.
3) Posts Set into Concrete in Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout **OR** anchoring cement, **as directed**, mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.
4) Posts Set into Voids in Concrete: Form or core drill holes not less than 5 inches (127 mm) deep and 3/4 inch (19 mm) larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout **OR** anchoring cement, **as directed**, mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.
3. Terminal Posts: Locate and install terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more, at any abrupt change in grade, and at intervals not greater than 500 feet (152 m). For runs exceeding 500 feet (152 m), space pull posts an equal distance between corner or end posts.
4. Line Posts: Space line posts uniformly at 96 inches (2440 mm) **OR** 10 feet (3 m), **as directed**, o.c.
5. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.

a. Locate horizontal braces at midheight of fabric 72 inches (1830 mm) or higher, on fences with top rail and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

6. Barbed Wire Arms: Bolt or rivet to top of post. Angle single arms away from approach side of fence.
7. Tension Wire: Install according to ASTM F 567 and ASTM F 1916, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch- (3.05-mm-) diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches (610 mm) o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:
   a. Extended along top and bottom, **as directed**, of fence fabric. Install top tension wire through post cap loops. Install bottom tension wire within 6 inches (152 mm) of bottom of fabric and tie to each post with not less than same diameter and type of wire.
   b. Extended along top of barbed wire arms **OR** extended posts, **as directed**, and top of fence fabric for supporting barbed tape.
   c. As indicated.
8. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended by fencing manufacturer.
9. Bottom Rails: Install and secure to posts with fittings; anchor rail at midspan to concrete footing **OR** continuous grade beam, **as directed**.
10. Chain-Link Fabric: Apply fabric on the approach side of fence, inside of enclosing framework. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.
    a. Leave 1-1/2 inches (38 mm) **OR** 2 inches (51 mm), **as directed**, between finish grade or surface and bottom selvage unless otherwise indicated.
    b. Where indicated, bury an 18-inch- (457-mm-) wide, polymer-coated fabric 12 inches (305 mm) into trench; overlap above-grade fabric 6 inches (152 mm) and secure to bottom rail with tie wires. Backfill and compact trench.
    c. Overlapping Fabric: At or between post or rail according to ASTM F 1916, with wire ties or steel strap method.
11. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches (381 mm) o.c.
12. Tie Wires: Power-fastened or manually fastened ties configured to wrap a full 360 degrees around rail or post and a minimum of one complete diamond of fabric. Twist ends one and one-half machine twists or three full manual twists, and cut off protruding ends to preclude untwisting by hand.
    a. Maximum Spacing: Tie fabric to line posts at 12 inches (305 mm) o.c. and to braces at 24 inches (610 mm) o.c.
13. Power-Driven Fasteners: Fasten 0.192- or 0.148-inch (4.87- or 3.76-mm) wire fabric with 2- or 1-inch (51- or 25.4-mm) mesh size.
    a. Fasten fabric to line posts 12 inches (305 mm) o.c. and to braces 24 inches (610 mm) o.c.
14. Fasteners: Install nuts for tension bands and carriage bolts on the side of fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts, **as directed**.
15. Barbed Wire: Install barbed wire uniformly spaced as indicated on Drawings **OR** as directed. Pull wire taut, install securely to extension arms, and secure to end post or terminal arms.
16. Barbed Tape: Comply with ASTM F 1911. Install barbed tape uniformly in configurations indicated and fasten securely to prevent movement or displacement.
17. Ground Barrier Stakes: Stake coils at 10 feet (3 m) o.c., driven to full depth.

E. Gate Installation
   1. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-

resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

F. Gate Operator Installation
1. General: Install gate operators according to manufacturer's written instructions, aligned and true to fence line and grade.
2. Excavation for Support Posts **OR** Pedestals **OR** Equipment Bases/Pads, **as directed**: Hand-excavate holes for bases/pads, in firm, undisturbed soil to dimensions and depths and at locations as required by gate operator component manufacturer's written instructions and as indicated.
3. Vehicle Loop Detector System: Cut grooves in pavement and bury **OR** Bury, **as directed**, and seal wire loop according to manufacturer's written instructions. Connect to equipment operated by detector.
4. Comply with NFPA 70 and manufacturer's written instructions for grounding of electric-powered motors, controls, and other devices.

G. Grounding And Bonding
1. Fence Grounding: Install at maximum intervals of 100 feet (30 m) except as follows:
   a. Gates and Other Fence Openings: Ground fence on each side of opening.
      1) Bond metal gates to gate posts.
      2) Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches (457 mm) below finished grade.
2. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet (45 m) on each side of crossing.
3. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless otherwise indicated.
4. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches (152 mm) below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location, including the following:
   a. Make grounding connections to each barbed wire strand with wire-to-wire connectors designed for this purpose.
   b. Make grounding connections to each barbed tape coil with connectors designed for this purpose.
5. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.
6. Connections: Make connections to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
   a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
   b. Make connections with clean, bare metal at points of contact.
   c. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
   d. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
   e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
7. Bonding to Lightning Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor complying with NFPA 780.

H. Soil Sterilization
1. General: Comply with ASTM F 1916.
2. Apply sterilant after completing grounding and other below-grade electrical work along fence line and within zone between double-row chain-link fence installation.

3. Install soil separation fabric continuously between double-row chain-link fence installation, overlapping punctures and joints 6 inches (152 mm).
4. Lay continuous 3-inch- (75-mm-) deep bed of crushed stone or washed gravel over soil separation fabric.
5. Extend soil sterilization 4 feet (1.2 m) **OR** 6 feet (1.8 m), **as directed**, beyond outside and inside of fence.

I. Field Quality Control
1. Fabric Testing: Test fabric tension according to ASTM F 1916.
2. Fence Post Rigidity Testing: Test line posts for rigidity according to ASTM F 1916.
3. Grounding-Resistance Testing: Engage a qualified testing agency to perform tests and inspections.
   a. Grounding-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure grounding resistance no fewer than two full days after last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural grounding resistance. Perform tests by two-point method according to IEEE 81.
   b. Excessive Grounding Resistance: If resistance to grounding exceeds specified value, notify the Owner promptly. Include recommendations for reducing grounding resistance and a proposal to accomplish recommended work.
   c. Report: Prepare test reports, certified by testing agency, of grounding resistance at each test location. Include observations of weather and other phenomena that may affect test results.

J. Adjusting
1. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
2. Automatic Gate Operator: Energize circuits to electrical equipment and devices. Adjust operators, controls, safety devices, alarms, **as directed**, and limit switches.
   a. Hydraulic Operator: Purge operating system, adjust pressure and fluid levels, and check for leaks.
   b. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   c. Test and adjust controls, alarms, **as directed**, and safeties. Replace damaged and malfunctioning controls and equipment.
3. Lubricate hardware, gate operator, **as directed**, and other moving parts.

K. Demonstration
1. Train Owner's personnel to adjust, operate, and maintain high-security chain-link fences and gates.

END OF SECTION 02710

Task	Specification	Specification Description
02710	01352	No Specification Required
02711	01352	No Specification Required
02711	02244	Tree Protection And Trimming
02711	02710	High-Security Chain-Link Fences And Gates

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SECTION 02712 - FARM-TYPE WIRE FENCING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of farm-type wire fencing. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Fabric shall be galvanized steel wire complying with ASTM A 116.

B. Framework
1. Steel
a. Posts shall comply with ASTM A 702, T-section, zinc-coated.
b. Stays shall be 9-1/2 gauge twisted wire, galvanized in compliance with ASTM A 641, Class 3.
2. Wood: Posts shall be cut from cedar, Douglas fir, pine, or other approved species of timber. Posts shall be peeled, treated, dressed, and cured and shall contain no unsound knots. All posts shall match existing post dimensions. All wood posts and braces shall be given a pressure preservative treatment in a closed retort. The treatment shall comply with AWPA C2.
a. Preservative. Wood cut or sawed after treatment shall have the cut surfaces well-coated with the preservative used in the treatment. All wood shall be pressure treated in accordance with AWPA C1 or AWPA C2, as applicable.

C. Braces: Steel braces shall have the same configuration as line posts and uprights without the anchor plate. Braces shall meet all of the requirements for wood posts.

D. Connectors
1. Wire for Attaching Fabric to Posts shall be 12-1/2 gauge or coarser, galvanized in compliance with ASTM A 641, Class 3.
2. Staples and Nails shall comply with Fed. Spec. FF-N-105. Staples and nails shall be zinc-coated and of sufficient length for purpose required.

E. Gates
1. Tubular Steel:
a. Frame shall be a minimum of 1-3/8 inch outside diameter tubular steel, braced with a sturdy center bar and diagonal adjustable brace wire to prevent sagging. Gates shall be fitted with hinges. All material shall be hot-dipped zinc-coated.
b. Fabric for Gates shall be as specified for the fence and shall be securely tied to the framework at top, bottom, and sides with 9-gauge wire.
2. Angle Iron
a. Frame shall be fabricated of angle iron with cross ties and stays of light angle iron. Frame shall be zinc-coated in compliance with ASTM A 120 or A 153.
b. Fabric for Gates shall be as specified for the fence and shall be securely tied to the framework at top, bottom, and sides with 9-gauge wire.
3. Wood: Provide a 3/8-inch minimum diameter galvanized steel truss rod and turnbuckle.

F. Barbed Wire shall comply with ASTM A 121 and shall be made from 2 strands of 12-1/2 gauge galvanized steel wire, twisted, with four-point barbs spaced five inches apart. Wire shall have Class 2 zinc coating.

G. Hardware:
1. Gate Hardware shall include the following:
   a. Bottom Hinge shall be designed to carry the weight of the gate.
   b. The Upper Hinge shall be adjustable.
   c. Lock with Chain shall be 1-3/4 inch size complying with ASTM F 883.
   d. Keeper shall automatically engage and hold the gate leaf open until manually released.
   e. Center Plunger Rod.
   f. Center Stop.
   g. Vertical Lift.
   h. Sliding Track.
2. Lightning Arresters, Insulators and Insulator Clamps, Fasteners, Signs, and Other Accessories shall be provided and installed as required.

1.3 EXECUTION

A. Installation
1. Wood Posts: Hold in line in a true vertical position by temporary bracing until backfilling is completed. Compact by hand tamping or other suitable methods to a density comparable to that of adjacent ground. Refasten all braces, gates, hardware, fabric, and other accessories.
2. Steel Posts: Steel posts shall be held in a vertical position and driven to the required depths by an approved post driver. Tops of posts shall not be damaged by driving operation.
3. Corner, Brace, or End Panels: Corner, brace, or end panels shall be constructed at the beginning and terminal ends, at gate openings, at all intersections, at all corners or changes in horizontal alignment of fences, in existing fence on both sides of junction with new fence, (except when junction is at a corner already braced), and on both sides of cattle guards.
4. Pull Posts shall be constructed when the distance of unbraced fencing exceeds 640 feet. Pull posts shall be spaced equidistant in the fence at intervals of 640 feet or less.
5. Wire Installation: Barbed and/or woven wire fabric shall be stretched to proper tension and securely fastened to posts. Top and bottom wires of fabric shall be tied or stapled to each post. Tie or staple every other wire to alternating posts. Every wire shall be tied to corner, pull, end, and gate posts. Wire for tying woven wire fabric and barbed wire shall be 9-gauge.
6. Restretching Existing Fabric: Fabric indicated to be restretched shall be restretched to proper tension and refastened to posts. Excess fabric extending beyond the post shall be removed.
7. Alignment: Finished fencing shall be plumb and in proper alignment with posts, and all wire work shall be taut.

END OF SECTION 02712

SECTION 02712a - SNOW AND OTHER TEMPORARY FENCING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of snow and other temporary fencing. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.
2. Shop drawings shall be submitted for approval.

1.2 PRODUCTS

A. Pickets:
1. Size: Wood pickets shall be 3/8 inch thick, 1-1/2 inches wide, and 48 inches high.
2. Coating: Red oil paint or stain.
3. Spacing: Approximately 2 inches apart.
4. Attachment: Bind together with 3 double strands of wire.

B. Framework:
1. Materials: Wire shall be 13 ga. galvanized steel, complying with ASTM A 641.
2. Types: The framework shall consist of 3 parallel double strands of wire twisted between pickets to hold them securely in place.
3. Wire Connectors: Wire for attaching fabric to metal posts shall be 9 ga.
4. Staples and Nails shall comply with Fed. Spec. FF-N-105. Staples and nails shall be zinc-coated and of sufficient length for purpose required.

C. Gates:
1. Frame: Frame shall consist of 2 parallel horizontal wooden members with pickets attached at two-inch spacing.
2. Bracing: 2 wooden members laced diagonally on the gate between the frame boards.
3. Hardware shall include 2 strap hinges, latching device, and stop bar, all of zinc-coated steel, in compliance with ASTM A 153.

D. Supports:
1. Steel: Line posts and uprights shall be drive type, T sections, and provided with suitable anchor plate. The sections shall be hot-rolled steel complying with ASTM A 702, galvanized in compliance with ASTM A 123. The T sections shall have the following minimum sizes:

Post Length (Feet)	Post Weight (Pounds)
5	7.32
5 1/2	7.99
6	8.65
6 1/2	9.32
7	9.98
7 1/2	10.64
8	11.31
9	12.64
10	13.97

2. Wood: Posts shall be cut from cedar, Douglas fir, pine, or other approved species of timber. Posts shall be peeled, treated, dressed, and cured. All wood posts and braces shall be given a pressure preservative treatment in a closed retort. The treatment shall comply with Fed. Spec. TT-W-571. Wood cut or sawed after treatment shall have the cut surfaces well brush-coated with the preservative used in the treatment.
3. Braces: Steel braces shall have same configuration as line posts and uprights without the anchor plate. Wood braces shall be treated No. 2 or better grade, Douglas fir or southern yellow pine. Braces shall meet all of the requirements for wood posts.
4. Location: Posts shall be evenly spaced to adequately support the fence framework.

1.3 EXECUTION

A. Installation
1. Wood Posts: Hold in line in a true vertical position by temporary bracing until backfilling is completed. Compact by hand tamping or other suitable methods to a density comparable to that of adjacent ground.
2. Steel Posts: Hold in a vertical position and drive to the required depths by an approved post driver. Post tops shall not be damaged during driving.
3. Corner, Brace, Or End Panels: Construct corner, brace, or end panels at the beginning and terminal ends, at gate openings, at all intersections, and at all corners or changes in horizontal alignment of fences, in existing fence on both sides of junction with new fence (except when junction is at a corner already braced).
4. Pull Posts shall be constructed when the distance of unbraced fencing exceeds 640 feet. Pull posts shall be spaced equidistant in the fence at intervals of 640 feet or less.
5. Framework Installation: Stretch to proper tension and securely fasten to posts. Top and bottom wires of fabric shall be tied or stapled to each post. Tie or staple every other wire to alternating posts. Every wire shall be tied or stapled to corner, pull, end, and gate posts. Wire for tied fabrics shall be 9 ga.
6. Picket Replacement: Where required, new pickets shall be securely fastened into the existing wire framework using 13 ga. galvanized wire.
7. Restretching Existing Fabric: Fabric designated to be restretched shall be restretched to proper tension and refastened to posts. Excess fabric extending beyond the post shall be removed.

END OF SECTION 02712a

Task	Specification	Specification Description
02713	01352	No Specification Required

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SECTION 02719 - SEGMENTAL RETAINING WALLS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for segmental retaining walls. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes single- and multiple- depth segmental retaining walls with and without soil reinforcement.

C. Performance Requirements
1. Basis of Design: Design of segmental retaining walls is based on products indicated. If comparable products of other manufacturers are proposed, provide engineering design for proposed products, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Delegated Design: Design segmental retaining walls, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
3. Structural Performance: Engineering design shall be based on the following loads and be according to NCMA's "Design Manual for Segmental Retaining Walls."
4. Gravity loads due to soil pressures resulting from grades and sloped backfill indicated.
   a. Superimposed loads (surcharge) indicated on Drawings.
5. Seismic Performance: Engineering design shall be based on the following loads and factors and be according to NCMA's "Segmental Retaining Walls - Seismic Design Manual."
   a. Gravity loads due to soil pressures resulting from grades and sloped backfill indicated.
   b. Superimposed loads (surcharge) indicated on Drawings.
   c. Horizontal Peak Ground Acceleration (A) for Project: **As directed**.

D. Preconstruction Testing
1. Preconstruction Testing Service: Engage a qualified testing agency to perform the following preconstruction testing:
   a. Test soil reinforcement and backfill materials for pullout resistance according to ASTM D 6706.
   b. Test soil reinforcement and backfill materials for coefficient of friction according to ASTM D 5321.

E. Submittals
1. Product Data: For each type of product indicated.
2. Samples: For each color and texture of concrete unit required. Submit full-size units **OR** sections of units not less than 3 inches (75 mm) square, **as directed**.
   a. Include one full-size unit for each type of concrete unit required.
3. Delegated-Design Submittal: For segmental retaining walls indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   a. Compliance Review: Qualified professional engineer responsible for segmental retaining wall design shall review and approve submittals and source and field quality-control reports for compliance of materials and construction with design.
4. Product Certificates: For segmental retaining wall units and soil reinforcement, from manufacturer.

a. Include test data for shear strength between segmental retaining wall units according to ASTM D 6916.
b. Include test data for connection strength between segmental retaining wall units and soil reinforcement according to ASTM D 6638.

5. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for segmental retaining wall units and soil reinforcement.
   a. Include test data for freeze-thaw durability of segmental retaining wall units.
   b. Include test data for shear strength between segmental retaining wall units according to ASTM D 6916.
   c. Include test data for connection strength between segmental retaining wall units and soil reinforcement according to ASTM D 6638.

F. Quality Assurance
1. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Store and handle concrete units and accessories to prevent deterioration or damage due to contaminants, breaking, chipping, or other causes.
2. Store geosynthetics in manufacturer's original packaging with labels intact. Store and handle geosynthetics to prevent deterioration or damage due to sunlight, chemicals, flames, temperatures above 160 deg F (71 deg C) or below 32 deg F (0 deg C), and other conditions that might damage them. Verify identification of geosynthetics before using and examine them for defects as material is placed.

1.2 PRODUCTS

A. Segmental Retaining Wall Units
1. Concrete Units: ASTM C 1372, Normal Weight, except that maximum water absorption shall not exceed 7 percent by weight and units shall not differ in height more than plus or minus 1/16 inch (1.6 mm) from specified dimension.
   a. Provide units that comply with requirements for freeze-thaw durability.
   b. Provide units that interlock with courses above and below by means of integral lugs or lips, pins, clips, or hollow cores filled with drainage fill.
2. Color: As selected from manufacturer's full range.
3. Shape and Texture: Provide units of basic shape and dimensions indicated with machine-split textured **OR** smooth, **as directed**, exposed faces.
4. Shape and Texture: Provide units matching basic shape, dimensions, and face texture indicated by referencing manufacturer's pattern designation.
5. Shape and Texture: Provide units of any basic shape and dimensions that will produce segmental retaining walls of dimensions and profiles indicated without interfering with other elements of the Work and with machine-split textured, flat exposed face **OR** shaped exposed face with deeply beveled vertical edges, **as directed**.
6. Batter: Provide units that offset from course below to provide at least 1:24 **OR** 1:16 **OR** 1:14 **OR** 1:8 **OR** 1:5, **as directed**, batter.
7. Cap Units: Provide cap units of shape indicated **OR** same shape as other units, **as directed**, with smooth, as-cast top surfaces without holes or lugs.
8. Special Units: Provide corner units, end units, and other shapes as needed to produce segmental retaining walls of dimensions and profiles indicated and to provide texture on exposed surfaces matching face **OR** as indicated, **as directed**.

B. Installation Materials
1. Pins: Product supplied by segmental retaining wall unit manufacturer for use with units provided, made from nondegrading polymer reinforced with glass fibers.

2. Clips: Product supplied by segmental retaining wall unit manufacturer for use with units provided, made from nondegrading polymer reinforced with glass fibers.
3. Cap Adhesive: Product supplied or recommended by segmental retaining wall unit manufacturer for adhering cap units to units below.
4. Leveling Base: Comply with requirements in Division 02 Section "Earthwork" for base material **OR** Division 02 Section "Subdrainage" for drainage fill, **as directed**.
   a. Leveling Course: Lean concrete with a compressive strength of not more than 500 psi (3.4 MPa).
5. Drainage Fill: Comply with requirements in Division 02 Section "Subdrainage".
6. Reinforced-Soil Fill: ASTM D 2487; GW, GP, SW, SP, and SM soil classification groups or a combination of these groups; free of debris, waste, frozen materials, vegetation, and other deleterious matter; meeting the following gradation according to ASTM C 136: 20 to 100 percent passing No. 4 (4.75-mm) sieve, 0 to 60 percent passing No. 40 (0.425-mm) sieve, 0 to 35 percent passing No. 200 (0.075-mm) sieve, and with fine fraction having a plasticity index of less than 20.
7. Nonreinforced-Soil Fill: Comply with requirements in Division 02 Section "Earthwork" for satisfactory soils.
8. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent.
   a. Apparent Opening Size: No. 70 to 100 (0.212- to 0.150-mm) sieve, maximum; ASTM D 4751.
   b. Minimum Grab Tensile Strength: 110 lb (49.9 kg); ASTM D 4632.
   c. Minimum Weight: 4 oz./sq. yd. (132 g/sq. m).
9. Subdrainage Pipe and Filter Fabric: Comply with requirements in Division 02 Section "Subdrainage".
   a. Product Type: Knitted or woven geogrid made from polyester yarns with a protective coating **OR** Molded geogrid made from high-density polyethylene **OR** Woven geotextile made from polyamides, polyesters, or polyolefins, **as directed**.

C. Source Quality Control
1. Direct manufacturer to test and inspect each roll of soil reinforcement at the factory for minimum average roll values for geosynthetic index property tests, including the following:
   a. Weight.
   b. Roll size.
   c. Grab or single-rib strength.
   d. Aperture opening.
   e. Rib or yarn size.

1.3 EXECUTION

A. Examination
1. Examine areas and conditions, with Installer present, for compliance with requirements for excavation tolerances, condition of subgrades, and other conditions affecting performance of segmental retaining walls.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Retaining Wall Installation
1. General: Place units according to NCMA's "Segmental Retaining Wall Installation Guide" and segmental retaining wall unit manufacturer's written instructions.
   a. Lay units in running bond **OR** bond pattern indicated, **as directed**.
   b. Form corners and ends by using special units **OR** cutting units with motor-driven saw **OR** splitting units with mason's hammer and chisel, **as directed**.
2. Leveling Base: Place and compact base material to thickness indicated and with not less than 95 percent maximum dry unit weight according to ASTM D 698.

a. Leveling Course: At Contractor's option, unreinforced lean concrete may be substituted for upper 1 to 2 inches (25 to 50 mm) of base **OR** Place unreinforced lean concrete over leveling base 1 to 2 inches (25 to 50 mm) thick, **as directed**. Compact and screed concrete to a smooth, level surface.

3. First Course: Place first course of segmental retaining wall units for full length of wall. Place units in firm contact with each other, properly aligned and level.
   a. Tamp units into leveling base as necessary to bring tops of units into a level plane.
4. Subsequent Courses: Remove excess fill and debris from tops of units in course below. Place units in firm contact, properly aligned, and directly on course below.
   a. For units with lugs designed to fit into holes in adjacent units, lay units so lugs are accurately aligned with holes, and bedding surfaces are firmly seated on beds of units below.
   b. For units with lips at front of units, slide units as far forward as possible for firm contact with lips of units below.
   c. For units with lips at bottom rear of units, slide units as far forward as possible for firm contact of lips with units below.
   d. For units with pins, install pins and align units.
   e. For units with clips, install clips and align units.
5. Cap Units: Place cap units and secure with cap adhesive.

C. Fill Placement
1. General: Comply with requirements in Division 02 Section "Earthwork", NCMA's "Segmental Retaining Wall Installation Guide," and segmental retaining wall unit manufacturer's written instructions.
2. Fill voids between and within units with drainage fill. Place fill as each course of units is laid.
3. Place, spread, and compact drainage fill and soil fill in uniform lifts for full width and length of embankment as wall is laid. Place and compact fills without disturbing alignment of units. Where both sides of wall are indicated to be filled, place fills on both sides at same time. Begin at wall and place and spread fills toward embankment.
   a. Use only hand-operated compaction equipment within 48 inches (1200 mm) of wall, or one-half of height above bottom of wall, whichever is greater.
   b. Compact reinforced-soil fill to not less than 95 percent maximum dry unit weight according to ASTM D 698.
      1) In areas where only hand-operated compaction equipment is allowed, compact fills to not less than 90 percent maximum dry unit weight according to ASTM D 698.
      2) In areas where fill height exceeds 15 feet (4.5 m), compact reinforced-soil fill that will be more than 15 feet (4.5 m) below finished grade to not less than 98 percent maximum dry unit weight according to ASTM D 698.
      3) In areas where fill height exceeds 30 feet (9 m), compact reinforced-soil fill that will be more than 30 feet (9 m) below finished grade to not less than 100 percent maximum dry unit weight according to ASTM D 698.
   c. Compact nonreinforced-soil fill to comply with Division 02 Section "Earthwork".
4. Place drainage geotextile against back of wall and place layer of drainage fill at least 12 inches (300 mm) **OR** 6 inches (150 mm), **as directed**, wide behind drainage geotextile to within 12 inches (300 mm) of finished grade. Place another layer of drainage geotextile between drainage fill and soil fill.
5. Place a layer of drainage fill at least 12 inches (300 mm) **OR** 6 inches (150 mm), **as directed**, wide behind wall to within 12 inches (300 mm) of finished grade. Place a layer of drainage geotextile between drainage fill and soil fill.
6. Wrap subdrainage pipe with filter fabric and place in drainage fill as indicated, sloped not less than 0.5 percent to drain.
7. Place impervious fill over top edge of drainage fill layer.
8. Slope grade at top of wall away from wall unless otherwise indicated. Slope grade at base of wall away from wall. Provide uniform slopes that will prevent ponding.

9. Place soil reinforcement in horizontal joints of retaining wall where indicated and according to soil-reinforcement manufacturer's written instructions. Embed reinforcement a minimum of 8 inches (200 mm) into retaining wall and stretch tight over compacted backfill. Anchor soil reinforcement before placing fill.
    a. Place additional soil reinforcement at corners and curved walls to provide continuous reinforcement.
    b. Place geosynthetics with seams, if any, oriented perpendicular to segmental retaining walls.
    c. Do not dump fill material directly from trucks onto geosynthetics.
    d. Place at least 6 inches (150 mm) of fill over reinforcement before compacting with tracked vehicles or 4 inches (100 mm) before compacting with rubber-tired vehicles.
    e. Do not turn vehicles on fill until first layer of fill is compacted and second layer is placed over each soil-reinforcement layer.

D. Construction Tolerances
1. Variation from Level: For bed-joint lines along walls, do not exceed 1-1/4 inches in 10 feet (32 mm in 3 m), 3 inches (75 mm) maximum.
2. Variation from Indicated Batter: For slope of wall face, do not vary from indicated slope by more than 1-1/4 inches in 10 feet (32 mm in 3 m).
3. Variation from Indicated Wall Line: For walls indicated as straight, do not vary from straight line by more than 1-1/4 inches in 10 feet (32 mm in 3 m).

E. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Comply with requirements in Division 02 Section "Earthwork" for field quality control.
    a. In each compacted backfill layer, perform at least 1 field in-place compaction test for each 150 feet (45 m) or less of segmental retaining wall length.
    b. In each compacted backfill layer, perform at least 1 field in-place compaction test for each 24 inches (600 mm) of fill depth and each 50 feet (15 m) or less of segmental retaining wall length.

F. Adjusting
1. Remove and replace segmental retaining wall construction of the following descriptions:
    a. Broken, chipped, stained, or otherwise damaged units. Units may be repaired if the Owner approves methods and results.
    b. Segmental retaining walls that do not match approved Samples.
    c. Segmental retaining walls that do not comply with other requirements indicated.
2. Replace units so segmental retaining wall matches approved Samples and mockups, complies with other requirements, and shows no evidence of replacement.

END OF SECTION 02719

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SECTION 02719a - MODULAR RETAINING WALL

1.1 GENERAL

A. Description
1. This specification covers the furnishing and installation of materials for modular retaining wall, and furnishing and installing accessories, all as indicated. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Definitions
1. Block Facing Units - Hollow concrete structural retaining wall units, plant cast from Portland cement, water, and mineral aggregates with or without the inclusion of other materials. The units are intended for use in the construction of mortarless, segmental retaining walls.
2. Geogrid - A geosynthetic formed by a regular network of integrally connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock, or earth and function primarily as reinforcement.
3. Unit Fill - Compacted fill for the voids in the precast concrete wall units.
4. Wall Fill - Compacted soil which is within the geogrid reinforced soil mass.
5. Retained backfill - Any compacted soil which is behind the reinforced wall fill.
6. Foundation Soil - Compacted or in-situ soil beneath the entire wall.

C. Submittals
1. Product Data: For each type of product indicated.
2. Submittals: Shop drawings shall be submitted for approval.

D. Quality Control
1. Test units for 28-day strength in accordance with ASTM C 140. Average compressive strength shall be not less than 3000 psi (210 kg/sq cm).
2. Test units for freeze/thaw protection in accordance with ASTM C 90, and for water retention in accordance with ASTM C 941.
3. After unit samples have been accepted, erect and clean sample wall, of minimum of 15 sq ft (1.4 sq m), of each type of retaining wall. Sample wall shall be representative of retaining wall exposed in finished areas. Each sample wall will be checked for shade range, texture, soundness of construction, surface cleanliness, and conformity with other requirements of this Section. Secure acceptance of each cleaned sample wall from the Owner before starting work. Protect wall from damage. Remove sample wall after retaining walls have been accepted.

E. Job Conditions
1. Protect surfaces of weather-exposed units at end of each day and at start of each shut-down period with nonstaining waterproof cover extending at least two feet down on all sides of structure.
2. Protect surfaces and products adjacent to work that could possibly be damaged by water and cleaner.

F. Delivery, Storage And Handling
1. Retaining Wall Facing Units:
a. Contractor shall check the units and connection accessories upon delivery to ensure that proper materials have been received.
b. Contractor shall prevent excessive mud, wet cement, epoxy, and like materials from coming in contact with and affixing to the units.
c. Contractor shall protect the units from damage (i.e. cracks, chips, spalls). Damaged units shall be evaluated for usage in the wall according to ASTM C 90 and ASTM C 145.

2. Geogrid
   a. Contractor shall check the geogrid upon delivery to ensure that the proper material has been received.
   b. Geogrids shall be stored above -20ºF (-29ºC).
   c. Contractor shall prevent excessive mud, wet cement, epoxy, and like materials from coming in contact with and affixing to the geogrid material.
   d. Rolled geogrid material may be laid flat or stood on end for storage.

1.2 PRODUCTS

A. Concrete Retaining Wall Units
   1. Modular unit face dimensions of 8 in. (200 mm) thick by 18 in. (450 mm) long. Depth dimensions shall be no less than 20 in. (500 mm). Dry unit weight of wall units shall be no less than 90 lbs (35 kg). When tested in accordance with ASTM C 426, average linear shrinkage of three specimens shall be less than 0.045 percent. Color of faces and texture exposed to view shall be determined by the Owner.
      a. Standard modular units: ASTM C 90, lightweight, two-cell type. Aggregate: ASTM C 331 (C 33).
      b. Solid mini or cap units: ASTM C145, lightweight type. Aggregate: ASTM C 331 (C 33).
   2. Connecting Pins: Poltruded polyester resin rods with fiberglass reinforcement; minimum flexural strength 100,000 psi (7 030 kg/sq cm).
   3. Geogrid: The geogrids shall be a regular grid structure of select high density polyethylene or polypropylene resin and meet or exceed the design pullout test values required to stabilize and retain the fill above retaining wall.
   4. Unit Fill: Gradation Size No. 67, or crushed stone drainage material acceptable to modular unit manufacturer.
   5. Base Material: Material shall consist of compacted sand, gravel, crushed rock or leveling concrete (non-reinforced) as shown on construction drawing. The compacted leveling pad shall be a minimum 6 in. (150 mm) thick.
   6. Backfill, Foundation Backfill And Wall Fill: As specified in Division 02 Section "Earthwork".
   7. Underdrain: As specified in Division 02 Section "Subdrainage".
   8. Cleaner: ProSoCo, Inc.'s Sure Klean, or accepted equivalent. Cleaner shall be capable of removing contaminants without damaging units.

1.3 EXECUTION

A. Installation
   1. Place base material to a minimum of 6 in. (150 mm) of compacted thickness. Material shall be compacted so as to provide a level hard surface on which to place the first course of units. Compaction shall be to 95% of standard proctor for sand or gravel type materials. For crushed rock, material shall be densely compacted. Grade top of base to plus/minus 1/4 in. (6 mm) of indicated level. Install underdrain UNDERDRAIN SYSTEMS.
   2. Install first course of units in full contact with base, with vertical joints butted and top dead level; align unit faces. Install connecting pins, if required, and fill voids; tamp void fill and sweep top of units clean.
   3. Lay successive units locking onto laid course at prescribed batter. Fill voids as work progresses.
   4. Place geogrid on compacted, level backfill at indicated elevations and orientation. Hook leading edge over connecting pins and pull taut; anchor before placing additional backfill. Tracked mechanical equipment is not permitted on geogrid. Compaction of fill within 3 ft (1 m) of wall face shall be by hand operated equipment.
   5. Tolerances
      a. Variation from designed incline lines and controlling surface of walls: within 2 in. (50 mm) in 20 ft (6 m) vertical.

b. Variation from conspicuous vertical lines: within 1 in. (25 mm) of 20 ft (6 m) vertical.
c. Variation from level and other conspicuous horizontal lines: within 1 in. (25 mm) in 20 ft (6 m) horizontal, and within 2 in. (50 mm) in 40 ft (12 m), and more, horizontal.
d. Variation of linear wall lines from established position in plan: within 1 in. (25 mm) in 20 ft (12 m), and within 2 in. (50 mm) in 40 ft (24 m), and more.

B. Cleaning
1. Clean installed work after completion of setting and backfill.
2. Before cleaning, protect adjacent surfaces and plants sensitive to masonry cleaner.
3. Wet wall and apply cleaner in accordance with cleaner manufacturer's printed instructions. Rinse units with clean water to remove masonry cleaner and sand. Installed work shall be clean and free from discoloration, stains, and smears.

END OF SECTION 02719a

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SECTION 02720 - MISCELLANEOUS SITE AND STREET FURNISHINGS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of miscellaneous site and street furnishings. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Shop Drawings: Fabrication and installation drawings for each type of product indicated.
2. Product Data: For each type of product indicated.

C. Qualification Of Welders
1. Qualify welders in accordance with AWS D1.1 using procedures, materials, and equipment of the type required for the work.

D. Delivery, Storage, And Protection
1. Protect from corrosion, staining, and other types of damage. Store items in an enclosed area free from contact with soil and weather. Remove and replace damaged items with new items.

1.2 PRODUCTS

A. Precast Benches
1. Design precast benches in accordance with manufacturer's standards, size as indicated. Finish and color as indicated selected from manufacturer's standards.
2. Glass Fiber Reinforced Concrete (GFRC) Benches
   a. Provide glass fiber reinforced concrete (GFRC) benches at locations as directed. Comply with PCI MNL-128 recommended practice for glass fiber reinforced concrete, including Appendix G, Polymer Modified Glass Fiber Reinforced Concrete Panels.
   b. Design precast benches to sustain a live load of not less than 200 pounds per square foot (10 kPa), constructed of minimum 3000 psi concrete with ASTM C 150 cement, white or grey color consistent with final finish, using alkali resistant (AR) glass fibers produced specifically for use in glass fiber reinforced concrete, minimum three percent glass fiber content. Aggregate shall be clear silica sand aggregate; washed, dried and free from deleterious materials. Provide type with successful history of uses in GFRC fabrication standard with the manufacturer. Provide manufacturer's standard acrylic thermoplastic copolymer admixture.
   c. Provide factory finished units standard with the manufacturer; texture and color as selected.
3. Precast Concrete/Cast Stone Benches
   a. Provide reinforced precast concrete benches consisting of a mixture of cement, aggregates and mineral colors suitable for exterior use, located as directed.
   b. Design benches to sustain a live load of not less than 200 pounds per square foot (10 kPa).
      1) Portland cement: ASTM C150 Type I, II, or III.
      2) Aggregate: ASTM C33, maximum size 3/4 inch (19 mm).
      3) Reinforcing steel: ASTM A615/A615M
      4) Galvanized wire mesh: ASTM A185
      5) Integral color: ASTM C979, pure mineral oxide, limeproof and non-fading.
      6) Provide minimum 5000 psi (35 MPa) 28 day compressive strength concrete, maximum five percent absorption.

7) Admixture: ASTM C260 for air-entraining.

B. Precast Concrete Bicycle Rack
1. Provide one-piece precast concrete bicycle rack base with embedded galvanized metal hitching loops. Design bicycle rack with wheel notches for bike support and wheel locking device.

C. Precast Concrete Bollards
1. Provide reinforced concrete bollards 12 inch (300 mm) **OR** 18 inch (450 mm), **as directed**, square **OR** round, **as directed**, height as indicated, suitable for ground mount installation. Provide exposed aggregate or sandblast finish as indicated; manufacturer's standard clear acrylic sealer.
   a. Portland cement: ASTM C150, Type I II or III.
   b. Aggregate: ASTM C33, maximum size 3/4 inch (19 mm).
   c. Reinforcing steel: ASTM A615/A615M.
   d. Integral color: ASTM C979, pure mineral oxide, limeproof and non-fading.
   e. Concrete strength: 5000 psi (35 MPa), 28 day minimum compressive strength.
   f. Admixture: ASTM C260 for air-entraining.

D. Planters, Receptacles, Ash Receptacles
1. Provide for waste receptacles spun aluminum **OR** reinforced fiberglass, **as directed**, flat **OR** domed, **as directed**, tops and removable semi-rigid plastic liner insert. Provide top-mounted ash trays for ash receptacles.
2. Glass Fiber Reinforced Concrete (GFRC) Precast:
   a. Provide glass fiber reinforced concrete (GFRC) precast planters/waste receptacles/ash receptacles at locations as directed. Comply with PCI MNL-117 and PCI MNL-128.
   b. Materials: Provide manufacturer's standard shell thickness of 3/8 to 5/8 inch (9 to 16 mm).
      1) Cement: ASTM C150, use only one brand and type of cement throughout the Project.
      2) Glass Fibers: Alkali resistant (AR) glass fibers produced specifically for use in glass fiber reinforced concrete. Glass content of GFRC unit to be a minimum of three percent.
      3) Aggregates: clear silica sand; washed, dried, and free from deleterious materials; provide type with successful history of use in GFRC and as standard with the manufacturer.
      4) Compressive Strength: Minimum 3000 psi (20/25 MPa) 28 day strength.
      5) Density: Approximately 120 pcf (1921 kg/cu. m).
      6) Polymer Admixture: Manufacturer's standard acrylic thermoplastic copolymer.
   c. Finishes: Provide factory finished units with manufacturer's standard texture or sandblasted finish as selected.
      1) Cement: White or grey as consistent with final finish.
3. Precast Concrete/Cast Stone Planters
   a. Provide reinforced precast concrete planters/waste receptacles/ash receptacles consisting of a mixture of cement, aggregates, and mineral colors suitable for exterior use as located on the drawings. Provide manufacturer's standard exposed aggregate or sandblast finish (with clear acrylic coating) as selected.
      1) Portland Cement: ASTM C150, gray, Type I.
      2) Aggregate: ASTM C33, crushed limestone and sand.
      3) Galvanized Steel Mesh: ASTM A185.
      4) Integral Color: ASTM C979, pure mineral oxide, limeproof and non-fading.
      5) Concrete Strength: 4000 psi (30 MPa) minimum compressive strength at 28 days.
      6) Admixture: ASTM C260 for air-entraining.
4. Wood Planters
   a. Provide manufacturer's standard wood planter/waste receptacle/ash receptacles fabricated of 3/4 inch (19 mm) thick tongue and grooved wood slats permanently bonded with

fiberglass interior shell. Provide wood top trim for square planters and fiberglass top trim for round planters.

1) Wood Species: As directed.
2) Fiberglass: Molded with multiple laminations of glass fiber impregnated with polyester isophthalic thermosetting resins with a finish of 12-15 mil (0.30-0.38 mm) color impregnated polyester gel coat.
3) Metal Frame: Black color-coated steel frame.

5. Wood Planters with Metal Frames
   a. Provide manufacturer's standard wood planter/waste receptacle/ash receptacle with galvanized steel welded frames, and nominal 2 inch (50 mm) tongue and grooved, beveled or square cut wood staves. Attach wood staves to metal frame from inside with steel plated screws.
      1) Wood species: Kiln dried, maximum 19 percent moisture content, species as directed.
      2) Metal frame: Reinforced with steel bars as per manufacture's standard construction, black color factory finish coated.
      3) Bottom: 1/4 inch (6.25 mm) exterior grade redwood with drain holes.
      4) Liners: Removable galvanized steel or manufacturer's standard.
      5) Tops: Hinged top opening, spun aluminum open top with molded rim, ash top.
6. Fiberglass Planters/Waste Receptacles/Ash Receptacles
   a. Provide reinforced fiberglass planters/waste receptacles/ash receptacles molded with multiple laminations of glass fiber impregnated with polyester isophthalic thermosetting resins; with 12-15 mil (0.30-0.38 mm) color impregnated polyester gel coat finish; minimum thickness of 1/4 inch (6.25 mm); color as selected.
   b. Receptacles:
      1) Shall be manufactured by Maglin,
      2) Color: Malaga Green

E. Shelters
1. AISC S342L; AISC S335. Provide prefabricated shelter systems to meet design conditions indicated. Shelter design shall conform to all applicable State and Local Building Codes and shall meet manufacturer's standards of construction and materials. Shelter systems shall be preglazed, pre-drilled and pre-cut, shipped with all hardware and accessories necessary for complete field assembly.
2. Framing Systems: Framing system; columns, rafters, ridge, purlins and other structural framing members shall be aluminum/steel/wood as indicated. Manufacturer shall provide shop drawings and calculations prepared by a structural engineer.
   a. Extruded aluminum alloy tubing shall conform to ASTM B429 6063-T5 or 3003-H14, anodized or powder coat finish, color as directed. Framing sizes and configurations shall be as required for size of structure indicated meeting manufacturer's standards and applicable building codes.
   b. Structural steel shall conform to ASTM A36/A36M or ASTM A500, 36,000 psi (248 MPa) yield strength and 58,000 psi (400 MPa) tensile strength, factory finished with rust inhibited primer and powder coat conforming to ASTM D3451. Framing sizes and configurations shall be as required for size of structure indicated meeting manufacturer's standard and applicable building codes.
   c. Wood framing system shall consist of surfaced four sides (S4S), #2 grade southern yellow pine solid timber columns with eased edges, pressure treated CCA (Copper Chrome Arsinate) 0.6 PCF (9.6 kg/cu.m) against decay, fungi and insect infestation, surfaced four sides (S4S), #1 grade, southern pine, glue-laminated columns manufactured in accordance with ANSI/AITC A190.1 and AITC certified glue-laminated structural grade southern yellow pine beams, rafters and purlins, factory sealed and individually wrapped for protection during shipment. Factory stain all wood members prior to shipment.
3. Roof Panels/Decking: Provide manufacturer's standard molded acrylic translucent roof panel, OR standing seam metal roof panel, OR wood decking, OR V-beam aluminum roof panels, OR

FRP roof panels, as indicated. Materials shall be factory finished and shipped with all necessary fasteners and accessories as required for complete site assembly.

4. Glazing: Factory installed in separate structural window frames, gasketed and glazed as per manufacturer's standard, interchangeable, glazing system. Provide 1/4 inch (6.25 mm) acrylic sheet, OR tempered glass, OR polycarbonate plastic sheet OR mar-resistant polycarbonate plastic sheet, clear OR color.

F. Tables

1. Precast Concrete Tables: Provide reinforced precast concrete tables with smooth tops; minimum 4500 psi (35 MPa) concrete, 28 day minimum compressive strength, consisting of a mixture of cement, aggregates, and mineral colors suitable for exterior use as located on the drawings. Provide manufacturer's standard exposed aggregate or sandblast finish with clear acrylic coating.
   a. Portland cement: ASTM C150, gray, Type I.
   b. Aggregate: ASTM C33, washed limestone and sand.
   c. Galvanized wire mesh: 14 gage (1.9 mm), 2 by two inch (50 by 50 mm).
   d. Welded wire fabric: ASTM A185.
   e. Reinforcing steel: ASTM A615/A615M.
   f. Integral color: ASTM C979, pure mineral oxide, limeproof and non-fading.
   g. Admixture: ASTM C260 for air-entraining..
2. Fiberglass Tables: Provide reinforced fiberglass table tops molded with multiple laminations of glass fiber impregnated with polyester isophthalic thermosetting resins, minimum thickness of 1/4 inch (6.25 mm) with 12-15 mil (0.30-0.38 mm) thickness color impregnated polyester gel coat, color as selected.
   a. Steel pedestal base: ASTM A53 Schedule 40 steel pipe.
   b. Mounting: Type as indicated.
   c. Metal finish: Powder coating conforming to ASTM D3451 testing.
3. Perforated Steel Tables: Provide 14 gage (1.9 mm) **OR** 16 gage (1.6 mm), **as directed**, perforated steel sheet table tops with solid metal edges as per manufacturer's standard. Weld tops to base as required for frame support.
   a. Steel pedestal base: ASTM A53 Schedule 40 steel pipe, 2 3/8 inch (60 mm) O.D.
   b. Mounting: Type as indicated.
   c. Hardware: Zinc or cadium plated nuts, bolts, screws, and lock washers.
   d. Metal finish: Powder coating conforming to ASTM D3451 testing.
4. Wood Seats and Tables
   a. Provide manufacturer's standard wood seats and tables, minimum 1-5/8 inches (40 mm) thick with rounded edges, with wood or metal bases as indicated. Provide fasteners and accessories required for on site assembly. Kiln dry and pressure treat wood components to manufacturer's standard, maximum 19 percent moisture content. Pre-treat metal components and provide manufacturer's standard primer and powder coat finish complying with ASTM D3451, color as selected.
      1) Design wood tables to sustain a live load of not less than 200 pounds per square foot (10 kPa).
      2) Provide kiln dried, surfaced four sides (S4S), clear all sides wood slats of species and sizes indicated.
         a) Species: As directed.
         b) Nominal wood slat sizes: As directed.
   b. Support Base: Provide wood or metal support bases as per manufacturer's standard.
      1) Wood: Match in species, grade, grain, color and finish of the wood slats.
      2) Steel: ASTM A653/A653M.
      3) Cast grey iron: ASTM A 48/A48M, Class 30 or recycled cast grey iron ASTM A48/A48M, Class 25.
      4) Cast aluminum: ASTM B26/B26M or ASTM B108 as applicable.
      5) Design bases to support the loads imposed in the design of the tables.

G. Grates

1. Provide cast aluminum **OR** cast iron **OR** cast bronze **OR** punched steel **OR** stainless steel, **as directed**, tree grates in round **OR** square, **as directed**, model of sizes indicated on the drawings. Furnish complete with angle steel frames with finish to match tree grates.

H. Fabrication Finishes
1. Galvanizing: Hot-dip galvanize items specified to be zinc-coated, after fabrication where practicable. Galvanizing: ASTM A123/A123M, ASTM A153/A153M or ASTM A653/A653M, as applicable.
2. Galvanize: Anchor bolts, grating fasteners, washers, and parts or devices necessary for proper installation, unless indicated otherwise.
3. Repair of Zinc-Coated Surfaces: Repair damaged surfaces with galvanizing repair method and paint conforming to ASTM A780 or by the application of stick or thick paste material specifically designed for repair of galvanizing, as approved. Clean areas to be repaired and remove the slag from the welds. Heat surfaces to which stick or paste material is applied, with a torch to a temperature sufficient to melt the metallics in stick or paste; spread the molten material uniformly over surfaces to be coated and wipe the excess material off.
4. Pretreatment, Priming and Painting: Apply pretreatment, primer, and paint in accordance with manufacturer's printed instructions. On surfaces concealed in the finished construction or not accessible for finish painting, apply an additional prime coat to a minimum dry film thickness of 1.0 mil (0.03 mm). Tint additional prime coat with a small amount of tinting pigment.
5. Nonferrous Metal Surfaces: Protect by plating, anodic, or organic coatings.
6. Aluminum Surfaces
   a. Surface Condition: Before finishes are applied, remove roll marks, scratches, rolled-in scratches, kinks, stains, pits, orange peel, die marks, structural streaks, and other defects which will affect uniform appearance of finished surfaces.

1.3 EXECUTION

A. Installation
1. Install items at locations indicated, according to manufacturer's instructions. Items listed below require additional procedures.
   a. Assembly and Erection of Components: Items shall be shipped knocked-down (KD) ready for site assembly. Packaged components shall be complete including all accessories and hardware. Follow manufacturer's instructions for assembly and erection. Provide mounting bolts or hardware for mounting items to substrate.

B. Anchorage, Fastenings, And Connections
1. Provide anchorage where necessary for fastening furniture or furnishings securely in place. Include for anchorage not otherwise specified or indicated slotted inserts, expansion shields, and powder-driven fasteners, when approved for concrete; toggle bolts and through bolts for masonry; machine and carriage bolts for steel; through bolts, lag bolts, and screws for wood. Do not use wood plugs in any material. Provide non-ferrous attachments for non-ferrous metal. Make exposed fastenings of compatible materials, generally matching in color and finish, to which fastenings are applied. Conceal fastenings where practicable.

C. Built-In-Work
1. Form for anchorage metal work built-in with concrete or masonry, or provide with suitable anchoring devices as indicated or as required. Furnish metal work in ample time for securing in place as the work progresses.

D. Welding
1. Perform welding, welding inspection, and corrective welding, in accordance with AWS D1.1. Use continuous welds on all exposed connections. Grind visible welds smooth in the finished installation.

E. Finishes: Dissimilar Materials
   1. Where dissimilar metals are in contact, protect surfaces with a coat conforming to FS TT-P-664 to prevent galvanic or corrosive action. Where aluminum is in contact with concrete, mortar, masonry, wood, or absorptive materials subject to wetting, protect with ASTM D1187, asphalt-base emulsion.

F. Bollards
   1. Install in pipe sleeves embedded in concrete and filled with non-shrink grout or quick setting anchoring cement.

G. Shelters
   1. Secure to the adjacent construction with the clip angles attached to the concrete. Secure to concrete with not less than two 1/2 inch (12 mm) diameter expansion bolts.
      a. Glazing: Factory install windows into separate structural frame. Miter corners and connect internally by extruded aluminum corner keys or screw bosses with tamper-proof stainless steel screws. Provide continuous gasketing around windows set to metal frames. Provide 1/2 to 3/4 inch (13 to 19 mm) deep pocket for polycarbonate glazing. Fully gasket and frame in independent interchangable factory assembled units. Affix to shelter frame with 3/16 inch (5 mm) shallow head aluminum rivets at approximately 13 1/4 inches (331 mm) on centers for full 360 degrees (6.28 rad), rivet from inside of shelter.
      b. Roof: Provide manufacturer's standard roof system including facia **OR** gutter, **as directed**, assembly, ensuring a weather-tight seal and installation.

END OF SECTION 02720

Task	Specification	Specification Description
02720	02612	Asphalt Paving

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SECTION 02721 - BEAM-TYPE GUARDRAIL

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for beam-type guardrail. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.
2. Shop drawings shall be submitted for approval.

1.2 PRODUCTS

A. Rail Elements, End Sections, and Fasteners
1. ARTBA technical bulletin No. 268-B.
2. Provide galvanized steel W-beam in accordance with AASHTO M-180, class A, type 1.
3. Shop curve rail elements when required radius of installation on horizontal curve is 150 ft (46 m) or less. Provide W-beam rail (ARTBA RE-3) with a flared end section (ARTBA RE-5), rounded end section (ARTBA RE-6) at each end of installations.
4. Provide standard back-up plates behind rail elements at all intermediate, non-splice posts when steel posts and blocks are used.
5. Galvanize the rail sections, including end sections, in accordance with ASTM A 525, coating G-210.

B. Posts
1. Wood: Provide wood posts with blocks, size as required by State DOT. Rough sawn or S4S timber of Douglas Fir or any other locally approved species that is either No. 1 grade or Select Structural grade when graded in accordance with the requirements for Timber and Posts as set forth in WWPA-01 may be used. Give all wood posts and blocks a preservative treatment in accordance with the requirements of AASHTO M-133. Cut to length and bore posts and blocks for bolt holes before treatment.
2. Steel: Provide steel posts with blocks. Fabricate posts and blocks from W6X9 structural steel shapes complying with the requirements of ASTM A 36. Fabricate in the shop, grind smooth all corners and edges, galvanize posts and blocks after fabrication in accordance with ASTM A 123.

C. Bolts, Nuts, and Washers
1. Provide galvanized bolts, nuts, and washers that meet common ARTBA standards, designed to develop the required joint strength. Provide bolts with rounded heads to provide minimum obstruction.
2. Provide galvanized steel bolts conforming to the requirements of ASTM A 307, nuts conforming to the requirements of ASTM A 563, Grade A or better and galvanized steel washers, all galvanized in accordance with the requirements of ASTM A 153. Provide high strength bolts conforming to the requirements of ASTM A 325 where needed.

D. Reflectors: Provide guardrail reflectors as indicated. Place the galvanized steel tabs with reflective sheeting at every post except no reflectors are to be placed along the guardrail end flares.

E. Breakaway Cable Terminal (BCT) Assemblies: Provide BCT assemblies in accordance with the ARTBA details and standards referenced on the details.

F. Concrete and Reinforcement for the Post Footings: In accordance with applicable sections of Division 03 Section "Cast-in-place Concrete".

1.3 EXECUTION

A. Guardrail: Erect steel beam-type guardrail in locations and to lines and grades as directed and in accordance with details indicated.

B. Erection
1. Firmly set posts spaced at 6 ft. 3 in. (1.9 m) centers to the required depth. Set posts by placing in hand or mechanically dug holes or by driving, with or without pilot holes. Backfill gaps around posts with approved material that is moistened and thoroughly compacted. Repair damaged roadway surfacing where pavement is disturbed.
2. Position the top of W-beam rail at 27 in. (0.69 m) above the finished roadway surface. Align rail both vertically and horizontally within 1/4-in. (6 mm) from the theoretical alignments. Lap the rail sections at posts, in the direction of traffic in the adjacent lane, and lap end sections on the face of the rail.
3. Exercise care to avoid damage to treated wood and galvanized steel parts. Repair or replace damaged parts at the Contractor's expense. Securely tighten all bolts in the finished guardrail. Toenail the wood blocks to wood posts with two 16 penny galvanized nails, one on each side of the top of the block.

END OF SECTION 02721

Task	Specification	Specification Description
02721	01352	No Specification Required

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SECTION 02722 - TRAFFIC SIGNS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of traffic signs. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 PRODUCT

A. Sign Foundations:
1. Replacement Foundation Footing Concrete shall be a mixture of cement complying with ASTM C 150 and aggregate complying with ASTM C 33. Compressive strength shall be 2,800 psi at 28 days.
2. Sulfur Mortar shall comply with ASTM C 287.
3. Reinforcing Steel shall comply with ASTM A 615.

B. Sign Supports shall be of the "break-away" type. Supports shall be strong enough to resist applicable wind forces without damage, but shall be designed to experience a brittle rupture type failure or a "quick separation" type joint.
1. Sign Support, Aluminum:
a. Replacement Castings shall be Alloy A356.0-T6 in compliance with ASTM B 108.
b. Replacement Structural Members shall comply with ASTM B 308.
c. Replacement Bars, Rods, Shapes, and Tubes shall comply with ASTM B 221, alloy 6061-T6.
d. Replacement Bolts, Nuts, and Screws shall match items being replaced and shall be alloy 2024-T4 with anodic coating complying with ASTM B 580, or 6061-T6 in compliance with ASTM B 211. Bolt heads shall be hexagon. Bolt threads shall be Class 2, 2A, or 2B in compliance with ANSI B18.2.1. Nuts shall be hexagon shaped in compliance with ANSI B18.2.2.
e. Replacement washers shall be furnished from sheet metal complying with ASTM B 209, alloy Alclad 2024-T3 or T4.
2. Sign Support, Steel:
a. Replacement Structural Members shall comply with ASTM A 36.
b. Replacement Bars shall comply with ASTM A 108.
c. Replacement Pipe shall comply with ASTM A 53 standard weight.
d. Replacement Fasteners shall comply with ASTM A 307 and ASTM A 325.
e. Replacement Anchor Bolts for anchoring base plates to concrete bases and nuts and washers shall be galvanized in compliance with ASTM A 153.
3. Sign Support, Wood:
a. Replacement Wood Sign Post shall be of the species listed in AASHTO M168, dressed four sides and having a pyramidal top cut before being treated.
b. Replacement Sign Post shall be pressure treated with creosote or creosote-tar solution complying with AWPB LP-55.

C. Sign Face:
1. Replacement Plywood Sign Face shall be grade HDOAB G-1 EXTERIOR, in compliance with DOC PS 1. Material shall be cut to size in compliance with ANSI D6.1E.
2. Replacement Galvanizing Steel Sign Face shall comply with USDOT FHA MUTCD.

D. Reflective Sheeting shall be enclosed lens unless otherwise directed by the Owner.

1. Enclosed Lens Reflective Sheeting shall comply with Fed. Spec. L-S-300.
2. Reflective Sheeting shall comply with FP-79 minimum reflective intensity. Measurements shall comply with Fed. Spec. L-S-300.
3. Color shall be matched visually and within the limits shown on the Color Tolerance Charts issued by the Federal Highway Administration. The diffuse day color of the reflective sheeting shall be determined in compliance with ASTM E 97.
4. Film:
   a. General: Reflective sheeting shall be sufficiently flexible to be easily cut to shape and permit application over, and conformance to, moderate shallow embossing characteristic of certain sign borders and symbols.
   b. Surface: Sheeting surface shall be smooth and flat, shall facilitate cleaning and wet performance, and shall exhibit 85 degrees glossmeter rating of not less than 40, as specified in ASTM D 523. The sheeting surface shall withstand cleaning with gasoline, VM&P Naphtha, mineral spirits, turpentine, methanol, and xylol.

E. Demountable Sign Face Materials:
1. Acrylic Plastic Reflectors: Replacement demountable sign letters, digits, arrows, borders, and alphabet accessories shall be reflectorized and shall consist of acrylic plastic reflectors supported by embossed aluminum frames. They shall comply with the Standard Alphabet for Highway Signs, of the Federal Highway Administration, Series E.
2. Design and Fabrication: The letters shall be modified as necessary to accommodate the required reflectors. All items except border strips shall be fabricated from 0.040-inch minimum sheet aluminum. Border strips shall be of 0.032-inch minimum sheet aluminum. Mounting holes shall be provided within the frames to permit the use of screws, rivets or other acceptable fasteners. The size and spacing of the reflector holes shall provide maximum night legibility and visibility of the finished cutout figure.
3. General Requirements: The reflectors shall be of acrylic plastic meeting the requirements of Fed. Spec. L-P-380, Type I, Class 3. The reflectors shall be yellow or colorless. The lens shall consist of a smooth front surface, free from projections or indentations other than for identification, and a rear surface bearing a prismatic configuration that will effect total internal reflection of light.
4. Reflective Sheeting:
   a. Demountable Sign Letters, Digits, Arrows, Borders, and Alphabet Accessories, when so specified, shall be reflectorized with reflective sheeting supported by flat aluminum backing and shall comply with the Standard Alphabet Highway Signs of the Federal Highway Administration.
   b. Design and Fabrication: Letter design shall be Series E, modified for legibility. All items except border strips shall be fabricated from 0.040-inch sheet aluminum, 6061-T6 alloy, with mounting holes to permit use of screws, rivets, or other acceptable fasteners.

F. Highway Delineators, Enclosed Lens Type: Replacement reflectors shall be of acrylic plastic and a minimum of 3 inches in diameter. They shall be mounted in a heavy-duty housing with a back plate. The reflector shall consist of a clear and transparent plastic lens, which shall be colorless, and a plastic back of the same material, fused to the lens under heat and pressure around the entire perimeter to form a homogeneous unit, permanently sealed against dust, water, and water vapor. The acrylic plastic shall comply with Fed. Spec. L-P-380, Type I, Class 3.

G. Highway Delineators, High Intensity Type:
1. Replacement Reflectorized Delineators shall consist of a reflective sheeting compound of glass spheres, embedded in a weatherproof, synthetic, noncellulose material. The overall size of the plastic reflectors shall be 4 inches by 5 inches, with a reflective area of at least 17.5 square inches.
2. Delineators shall be silver-white when viewed with reflected light.

H. Highway Delineators Including Posts and Attachments:

1. Reflective Sheeting: Replacement reflective sheeting for delineators shall match delineators being replaced.
2. Delineator Posts and Accessories shall be of steel or aluminum. They shall have the necessary holes for attachment of the delineator housing. The assembly shall be furnished with the necessary bolts, nuts, and washers for attaching to the posts.
3. Insulating Materials: Neoprene, for separation of aluminum and steel parts, shall contain at least 60 percent, by volume, of pure neoprene. Other material may be used, subject to the approval of the Owner as to pliability and ability to withstand wear caused by stretching or distortion.
4. Reflector Units for guardrail installation shall match existing reflector being replaced in size and color.
5. Highway Delineators shall be supplemented with directional guidance signs as directed by the Owner. Signs shall be the chevron alignment type and shall comply with ANSI D6.1E, Type W 1-8.

I. Painting Panels for Nonreflectorized Background:
1. Replacement Metal Panels for sign categories not required to be reflectorized shall have a nonreflectorized background composed of one spray coat of primer and two finish coats of baked enamel.
2. Finish Coats shall be baked alkyd resin enamels meeting Fed. Spec. TT-E-529, Class B, of a composition that affects the finished background surface. When thoroughly dry, the colors shall match those described in the current Highway Blue Color Tolerance Chart, PR Color No. 3, or in Highway Green Color Tolerance Chart, PR Color No. 4, of the Federal Highway Administration.
3. Wood Signs shall have two coats of oil paint complying with Fed. Spec. TT-P-52. Message paint shall be a single coat of oil paint. All colors shall comply with ANSI D6.1E.

J. Sign Wash Detergent shall comply with ASTM D 3399.

K. Street, Wayside, Utility Location, And Parking Lot Signs; Decals
1. Blanks: aluminum of type, size, and shape indicated.
2. Reflective sheeting: Type 1 sheeting having Level A reflective intensity.
3. Silk screen lettering paint and transparent process colors: as directed by the Owner.
4. Posts
   a. Drive type: as directed by the Owner.
   b. Pipe type: Two-inch inside diameter.
5. Hardware: as directed by the Owner.
6. Fabrication
   a. Dimensions, colors, and reflectorizing: As indicated, and in accordance with MUTCD.
   b. Size, style, and spacing of letters, numerals, symbols, and borders: As indicated, and the Owner; as supplemented by DOT/FHA's publication entitled Standard Highway Signs as specified in MUTCD 1978.
   c. Workmanship: as directed by the Owner.

1.3 EXECUTION

A. Footings for Signs, Posts, and Supports:
1. Backfill Material shall be at or near optimum moisture and neither dry nor saturated. It shall be tamped thoroughly in place.
2. Concrete Footings may be cast in place or precast. Hand mixing of concrete will be permitted where the quantity does not exceed one-half cubic yard.

B. Erection of Signs and Sign Supports: Sign posts shall be erected vertically. Posts erected in sleeves shall be anchored with sulphur mortar. Mortar shall comply with ASTM C 287. Sign faces shall be positioned to be generally perpendicular to the line-of-sight for the observer. Reflectorized signs shall

be inspected at night. If specular reflection is apparent on any sign, its position shall be adjusted by the Contractor to eliminate the condition.

C. Delineators and Hazard Markers: Delineator posts shall be driven to a depth of 30 inches.

D. Removal of Existing Signs and Posts:
   1. Damaged, Obsolete, or Change of Purpose Signs and Posts shall be removed and delivered to a storage area designated by the Owner. Post hole shall be backfilled, tamped, and made level with the adjacent surface. Disturbed paving, sidewalks, and grassed areas shall be replaced with matching material of same quality and quantity as existing.
   2. Signs and Posts to be Replaced shall be removed and replaced by new signs and posts in identical locations. Backfill around post shall be thoroughly compacted to hold posts securely in a vertical position.

E. Installation: Install in accordance with manufacturer's recommendations and as directed by the Owner. Unless otherwise indicated, install not more than one sign on each post.

END OF SECTION 02722

SECTION 02725 - PARKING CONTROL EQUIPMENT

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for parking control equipment. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Automatic barrier gates.
   b. Vehicle detectors.
   c. Traffic controllers.
   d. Entry terminal ticket dispensers.
   e. Exit terminals.
   f. Pay stations.
   g. Fee computers.
   h. Parking facility management software.
   i. Access control units.

C. System Description
1. Parking Control System: Intended to be used for the following types of parking management:
   a. Transient Parking: Hourly rated parking, with fee paid while entering **OR** exiting, **as directed**.
   b. Monthly Parking: Monthly rated parking, with fee paid by the month and access gained by access control card.
   c. Flat-Rate Parking: Unlimited-duration parking, with free gate entry and fixed-fee amount paid while exiting.
   d. Special-Event Parking: Duration-of-event parking, with fee paid while entering with gates up or down.
   e. Limited Date(s) and Time(s) Parking: Limited-duration parking, with predetermined fee access control card.
   f. Merchant Validated Parking: Fee set, reduced, or waived by merchant validation, with free gate entry and fee paid while exiting.
   g. Valet Parking: Assisted parking, with fee paid while entering or exiting.
   h. Hotel Guest Parking: Unlimited access for duration of stay, with access gained by access control card.

D. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: For parking control equipment. Include plans, elevations, sections, details, and attachments to other work.
   a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   b. Wiring Diagrams: For power, signal, and control wiring.
3. Field quality-control reports.
4. Operation and Maintenance Data: For parking control equipment to include in emergency, operation, and maintenance manuals.
5. Software and Firmware Operational Documentation:
   a. Software operating and upgrade manuals.
   b. Program Software Backup: On magnetic media or compact disk, complete with data files.
   c. Device address list.

d. Printout of software application and graphic screens.

E. Quality Assurance
1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Preinstallation Conference: Conduct conference at Project site.

F. Software Service Agreement
1. Technical Support: Beginning with Substantial Completion, provide software support for two, **as directed**, years.
2. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two, **as directed**, years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
a. Provide 30, **as directed**, days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.2 PRODUCTS

A. Materials
1. Aluminum: Alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated, and as follows:
a. Sheet: ASTM B 209 (ASTM B 209M).
b. Extruded Shapes: ASTM B 221 (ASTM B 221M).
2. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.
3. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, commercial quality, with G60 (Z180) coating designation; mill phosphatized.
4. Stainless-Steel Sheet: ASTM A 666, Type 304.
5. Anchorages: Anchor bolts, hot-dip galvanized according to ASTM A 153/A 153M and ASTM F 2329.

B. Automatic Barrier Gates
1. General: Provide UL-approved parking control device consisting of operator and controller housed in a weathertight, tamper-resistant cabinet enclosure with gate arm. Device shall be activated by a signal from access or revenue control device. Fabricate unit with gate-arm height in down position of not more than 35 inches (889 mm) above pavement to prevent even small vehicles from passing under gate arm.
2. Standard: Provide barrier gates and gate operators that are listed and labeled according to UL 325 by a qualified testing agency. Provide barrier gates that comply with ASTM F 2200, **as directed**.
3. Controller: Factory-sealed, solid-state, plug-in type, with galvanized-steel box for wiring connections.
a. Type: Noncommunicating.
1) Capable of logic for one- and two-way lanes.
2) Separate momentary contacts for transient patrons, monthly patrons, vehicle entries, and vehicle exits.
b. Type: Communicating.
1) Real-time communication of lane counts, status messages, and execute commands.
2) Monitor illegal entries and exits, tailgates, tickets, monthlies, and backouts.
3) Status messages for gate up too long, backouts, ticket in chute, and gate-arm rebound.

4) Communication commands for resetting loops, turning "Full" signs on/off, raising and lowering gate arm, and disabling ticket dispensers **OR** card readers, **as directed**.

c. Features: Equip unit with the following:
1) Able to store successive inputs and sequentially processing each one.
2) Automatic instant-reversing obstacle detector mechanism that stops downward motion of gate arm if arm contacts or nears an object and that immediately returns arm to upward position. Include a 0- to 60-second, variable-time reset device.
3) On-off power supply switch.
4) Automatic-manual switch.
5) Differential counter.
6) Directional arming logic.
7) RS-422 communication port.
8) Broken gate-arm monitoring.
9) Programmable automatic, **as directed**, timer.
10) Internal resettable **OR** non-resettable, **as directed**, counters.
11) Thermal-overload protection with manual reset.
12) Plug-in connectors for two **OR** three, **as directed**, vehicle loop detectors.
13) Thermostatically controlled heater with on/off/auto switch.
14) Diagnostic mode for on-site testing, with LEDs for inputs and outputs, **as directed**.
15) Automatic and continuous testing of inputs and outputs.
16) Switch to test motor and limit switches.
17) Emergency manual disconnect.
18) Battery backup.
19) Single, 115-V ac grounded power receptacle.
20) Reversible arm capability for right- or left-handed operation.

4. Cabinets: Fabricated from metal sheet with seams welded and ground smooth; approximately 15 inches square by 40 inches tall (381 mm square by 1016 mm tall). Provide single, gasketed access door for each cabinet with flush-mounted locks. Furnish two keys for each lock, all locks keyed alike, **as directed**. Fabricate cabinet with internal reinforcing and four mounting holes accessible only from inside cabinet.
a. Material: Not less than 0.097-inch- (2.5-mm-) thick, galvanized-, **as directed**, steel sheet or 0.125-inch- (3.2-mm-) thick aluminum sheet.
1) Finish cabinet, interior and exterior, with manufacturer's standard white **OR** yellow, **as directed**, baked-enamel finish over primer.
b. Material: Not less than 0.109-inch- (2.8-mm-) thick, stainless-steel sheet.
1) Finish cabinet exterior with No. 4 finish.
OR
Finish cabinet, interior and exterior, with manufacturer's standard white **OR** yellow, **as directed**, baked-enamel finish over primer.

5. Straight Gate Arm: 1-by-4-inch nominal- (19-by-89-mm actual-) size pine or redwood **OR** 0.097-inch- (2.5-mm-) thick steel **OR** Fiberglass, PVC, or polycarbonate **OR** Aluminum, **as directed**, with painted finish and black diagonal stripes on traffic-side face. Provide mounting flange with breakaway feature to ensure clean break if arm is struck by vehicle.
a. Length: 10 feet (3.0 m) **OR** 12 feet (3.7 m) **OR** As indicated on Drawings, **as directed**.

6. Folding Gate Arm: Two pieces of 1-by-4-inch nominal- (19-by-89-mm actual-) size pine or redwood joined together with metal side brackets; with painted finish and black diagonal stripes on traffic-side face. Provide mounting flange with breakaway feature to ensure clean break if arm is struck by vehicle.
a. Length: 10 feet (3.0 m) **OR** 12 feet (3.7 m) **OR** As indicated on Drawings, **as directed**.

7. Straight Gate Arm with Counterbalance: 1-by-6-inch nominal- (19-by-140-mm actual-) size pine or redwood with steel counterweights; with painted finish and black diagonal stripes on traffic-side face. Provide mounting flange with breakaway feature to ensure clean break if arm is struck by vehicle.
a. Length: 16 feet (4.9 m) **OR** As indicated on Drawings, **as directed**.

8. Wishbone-Style Gate Arm: 1-by-4-inch nominal- (19-by-89-mm actual-) size pine or redwood **OR** 0.097-inch- (2.5-mm-) thick steel, **as directed**, formed into wishbone configuration, with steel

counterweights; with painted finish and black diagonal stripes on traffic-side face. Provide mounting flange with breakaway feature to ensure clean break if arm is struck by vehicle.
   a. Length: 14 feet (4.3 m) **OR** As indicated on Drawings, **as directed**.
9. Operator: 1/3 **OR** 1/2, **as directed**, hp; 60-Hz, single-phase, instant-reversing, continuous-duty motor for operating gate arm. Transmit power to gate-arm drive shaft through speed reducer to harmonic-acting crank and connecting rod. Fabricate crank, rod, and drive shaft of galvanized solid bar steel. Provide an operable cam for adjusting arm travel.
   a. Opening Time: Three **OR** Six, **as directed**, seconds.
   b. Inherently adjustable torque limiting clutch for safety.
10. Accessories:
   a. Audible alarm that activates as part of a safety device system.
   b. Additional obstruction detector; noncontact infrared **OR** photoelectric **OR** radio-frequency barrier, **as directed**.
   c. Barrier-arm warning safety signs on both sides of unit limiting traffic to vehicular traffic.
   d. Low-voltage yellow **OR** red, **as directed**, warning lights that illuminate when gate is in down position.
   e. Low-voltage light on cabinet top that flashes or changes from red to green when barrier gate is operating.
   f. Manually operated crank for emergency operation.
   g. Local authorities' emergency access as directed by the Owner.
   h. Gate-arm tip support with electromagnetic lock, **as directed**.

C. Vehicle Detectors
1. Vehicle Loop Detector System: Provide self-tuning electronic presence detector with adjustable detection patterns, adjustable sensitivity and frequency settings, and panel indicator light designed to detect presence or transit of a vehicle over an embedded loop of wire and to emit signal activating gate-arm operator. Include automatic closing timer with adjustable time delay before closing, timer cut-off switch, **as directed**, and vehicle loop detector designed to open and close gate arm **OR** hold gate arm open until traffic clears, **as directed**. Provide number of loops consisting of multiple strands of wire, number of turns, loop size, and method of placement at location shown on Drawings, as recommended in writing by detection system manufacturer for function indicated.
   a. Field-Assembled Loop: Wire, in size indicated for field assembly, and sealant; style for pave-over **OR** saw-cut, **as directed**, installation.
   b. Factory-Formed Loop: Wire, preformed in size indicated; style for pave-over **OR** saw-cut, **as directed**, installation.
   c. System Performance: Capable of the following:
      1) Recognize two vehicles within 6 inches (152 mm) of each other on standard-sized loop.
      2) Recognize vehicle direction by detecting vehicle moving from one loop to another.
      3) Generate reverse count if vehicle backs up after generating directional count in forward direction.
      4) Continuous diagnostic monitoring for intermittently operating and failed loops.
      5) Crosstalk test between adjacent loops.
2. Active Infrared Vehicle Detector: Provide retroreflective **OR** emitter/receiver, **as directed**,-type presence detector with adjustable detection zone pattern and sensitivity, designed to detect the presence or transit of vehicle in gate-arm pathway by interrupting infrared beam in zone pattern and to emit signal activating gate-arm operator. Include automatic closing timer with adjustable time delay before closing, timer cut-off switch, **as directed**, and vehicle presence detector designed to open and close gate arm **OR** hold gate arm open until traffic clears, **as directed**.

D. Traffic Controllers
1. Penetrating Type: Provide directional enforcement system consisting of multiple raised teeth that allow vehicular traffic in one direction and that puncture tires of vehicular traffic in the other direction. Fabricate system from steel plate contained in welded steel frame.

a. Mounting: Surface **OR** Recessed, **as directed**.
b. Operation: Manual, with each tooth controlled by torsion spring **OR** Electromechanical **OR** Hydraulic, **as directed**.
c. Latch Down: Allow disarming for two-way traffic flow. Provide one, **as directed**, tool(s) for latch-down operation.
d. Illuminated Warning Signs: Single **OR** Double, **as directed**,-faced warning signs consisting of fluorescent lamps with cold-start ballasts contained in welded steel bodies with baked-enamel finish and fiberglass sign faces. Provide base sleeves and posts for post mounting, **as directed**.
1) Sign Copy: "Wrong Way, Stop, Severe Tire Damage" **OR** "Warning, Do Not Back Up, Tire Damage," **as directed**.

2. Nonpenetrating Type: Provide directional enforcement system consisting of spring-activated steel curb that allows traffic in only one direction. Fabricate system from steel plate contained in welded steel frame.
a. Mounting: Surface **OR** Recessed, **as directed**.
b. Operation: Manual **OR** Electromechanical **OR** Hydraulic, **as directed**.

E. Entry Terminal Ticket Dispensers
1. General: Provide entry terminal ticket dispensers, consisting of ticket-printing and issuing mechanisms, ticket magazines, thermal printers, and controllers housed in cabinet enclosures.
a. Features: Include the following:
1) Time and date display.
2) Time Indicator: 24-hour cycle with A.M. and P.M. **OR** military-time, **as directed**, clock mechanism.
3) Voice annunciation.
4) Tickets: Standard paper **OR** Magnetic-stripe **OR** Barcode, **as directed**, type.
5) Removable ticket tray with capacity of 5000, **as directed**, fan-folded tickets.
6) Operation: Standalone **OR** Online communication to remote computer, **as directed**.
7) Battery backup for clock and RAM memory.
8) RS-422 communication port.
9) Thermostatically controlled heater with on/off/auto switch.
10) Access **OR** Credit, **as directed**, card acceptance with activation slot and "Insert Ticket/Card" message.
11) License plate recognition.
12) Multiple ticket option for valet parking.
13) Intercom.

2. System Performance: Activation by button with "Push for Ticket" message **OR** vehicle detector **OR** card reader, **as directed**. On activation, unit automatically records entry time and date on ticket, sounds buzzer, **as directed**, and dispenses ticket.
a. Automatic ticket validation.
b. Program ticket numbering.
c. Low-ticket alarm.
d. Out-of-ticket alarm.
e. Ticket jam detection.
f. Print test ticket.

3. Cabinets: Fabricated from metal sheet with seams welded and ground smooth, approximately 15 inches square by 40 inches tall (381 mm square by 1016 mm tall); consisting of base and top components. Provide single, gasketed access door for each base component with flush-mounted locks. Furnish two keys for each lock, all locks keyed alike, **as directed**. Fabricate cabinet with internal reinforcing and four mounting holes accessible only from inside cabinet. Fabricate top component so it can be unlocked and opened for ticket loading and maintenance. Include flush-mounted lock in rear of top, keyed the same as base component lock.
a. Material: Not less than 0.097-inch- (2.5-mm-) thick, galvanized-, **as directed**, steel sheet or 0.125-inch- (3.2-mm-) thick aluminum sheet.
1) Finish cabinet, interior and exterior, with manufacturer's standard white **OR** yellow, **as directed**, baked-enamel finish over primer.

b. Material: Not less than 0.109-inch- (2.8-mm-) thick, stainless-steel sheet.
1) Finish cabinet exterior with No. 4 finish.
OR
Finish cabinet, interior and exterior, with manufacturer's standard white **OR** yellow, **as directed**, baked-enamel finish over primer.

4. Ticket-Dispensing Mechanisms: Removable assembly, with self-sharpening ticket cutter or ticket burster and plug-in controller.

F. Exit Terminals
1. General: Provide exit terminals consisting of ticket collectors, magnetic-stripe ticket readers, LCD, **as directed**, displays, thermal printers, and controllers housed in cabinet enclosures. Provide "Please Insert Ticket" sign on side of cabinet visible to driver.
a. Features: Include the following:
1) Operation: Standalone **OR** Online communication to remote computer, **as directed**.
2) Battery backup for clock and RAM memory.
3) Thermostatically controlled heater with on/off/auto switch.
4) RS-422 communication port.
5) Access **OR** Credit, **as directed**, card acceptance with activation slot and "Insert Ticket/Card" message.
6) Intercom.
2. System Performance: Capable of the following:
a. Activated by vehicle detector **OR** card reader, **as directed**.
b. Print receipts on demand.
c. Voice annunciation.
d. Program facility code.
e. Program grace period.
f. Program display.
g. Program timer for closing barrier gate.
h. Reports for events and exception events.
i. Built-in service diagnostics.
3. Operation: Inserting exit ticket into exit ticket reader results in the following actions:
a. Valid Exit Ticket: Exit ticket reader captures ticket and automatically sends signal to raise barrier gate.
b. Invalid Exit Ticket: Exit ticket reader rejects ticket and displays "Pay Cashier First" message.
c. Exit Ticket with Elapsed Grace Time: Exit ticket reader rejects ticket and displays "Return to Cashier" message.
4. Cabinets: Fabricated from metal sheet with seams welded and ground smooth; approximately 15 inches square by 40 inches tall (381 mm square by 1016 mm tall). Provide single, gasketed access door for each cabinet with flush-mounted locks. Furnish two keys for each lock, all locks keyed alike, **as directed**. Fabricate cabinet with internal reinforcing and four mounting holes accessible only from inside cabinet.
a. Material: Not less than 0.097-inch- (2.5-mm-) thick, galvanized-, **as directed**, steel sheet or 0.125-inch- (3.2-mm-) thick aluminum sheet.
1) Finish cabinet, interior and exterior, with manufacturer's standard white **OR** yellow, **as directed**, baked-enamel finish over primer.
b. Material: Not less than 0.109-inch- (2.8-mm-) thick, stainless-steel sheet.
1) Finish cabinet exterior with No. 4 finish.
OR
Finish cabinet, interior and exterior, with manufacturer's standard white **OR** yellow, **as directed**, baked-enamel finish over primer.

G. Pay Stations
1. General: Provide self-contained cashiering central **OR** entry **OR** exit, **as directed**, pay stations designed for self-service operation; consisting of magnetic-stripe ticket dispensers and, **as**

directed, readers/validators, LCD, **as directed**, displays, fee computers, controllers, **as directed**, and thermal printers housed in a combined enclosure.

a. Features: Include the following:
   1) Operation: Standalone **OR** Online communication to remote computer, **as directed**.
   2) Battery backup for clock and RAM memory.
   3) Thermostatically controlled heater with on/off/auto switch.
   4) Access card acceptance.
   5) Intercom.

2. System Performance: Capable of the following:
   a. Compute multiple parking fees based on entry times on ticket from ticket dispenser.
   b. Compute multiple taxes by percent and fixed amount.
   c. Program lost ticket function.
   d. Display fee.
   e. Accept payment by cash credit card **OR** debit card **OR** merchant ticket, **as directed**.
   f. Compute change.
   g. Print receipts on demand.
   h. Print validation on ticket.
   i. Voice annunciation.
   j. Print audit trail.
   k. Program six, **as directed**, fee structures.
   l. Program time.
   m. Program merchant validations.
   n. Test mode to verify accuracy of fee structure program.
   o. Built-in service diagnostics.
   p. Print cash audit, revenue, operational, and statistical reports on demand.
   q. Duress alarm output for emergencies.
   r. Battery backup.
3. +Cabinets: Fabricated from cold-rolled steel sheet with seams welded and ground smooth, approximately 36 inches wide by 18 inches deep by 60 inches tall (914 mm wide by 457 mm deep by 1524 mm tall). Provide single, gasketed access door with flush-mounted locks. Furnish two keys for each lock, all locks keyed alike, **as directed**. Fabricate cabinet with internal reinforcing and four mounting holes accessible only from inside cabinet.
   a. Finish cabinet, interior and exterior, with manufacturer's standard white **OR** yellow, **as directed**, baked-enamel finish over primer.

H. Fee Computers
1. Fee Computer System: Provide modular PC-based, **as directed**, system consisting of fee computer terminal, cash drawer, **OR** two cash drawers, **as directed**, standard ticket reader, **OR** magnetic-stripe ticket reader, **OR** barcode ticket reader, **as directed**, and detachable printer. Register permanent record of each transaction in computer's memory.
   a. Features: Provide the following:
      1) Battery backup for clock and RAM memory.
      2) RS-422 communication port.
      3) Keyed **OR** Keyless-membrane, **as directed**, keypad.
2. System Performance: Capable of the following:
   a. Compute multiple parking fees based on entry times on ticket from ticket dispenser.
   b. Compute multiple taxes by percent and fixed amount.
   c. Program lost ticket function.
   d. Display fee on remote fee display device.
   e. Accept payment by cash check **OR** credit card **OR** debit card **OR** merchant ticket, **as directed**.
   f. Control independent cash drawer.
   g. Compute change.
   h. Print receipts.
   i. Print validation on ticket.
   j. Print audit trail.

k. Interface to automatic barrier gate.
l. Program six, **as directed**, fee structures.
m. Program time.
n. Program keys.
o. Program special events validations.
p. Program automatic activation for limited date(s) and time(s) validations.
q. Program merchant validations.
r. Program valet parking.
s. Program hotel guest parking.
t. Three levels of security, including cashier, supervisor, and master.
u. Recall last transaction.
v. Test mode to verify accuracy of fee structure program.
w. Built-in service diagnostics.
x. View cash audit, revenue, operational, and statistical reports on screen or print on demand.
y. Duress alarm output for emergencies.
z. Battery backup.

3. Cash Drawer: Fabricated with a removable tray and drawer, with five compartments for paper currency and five compartments for coins.
4. Remote Fee Display: Single-faced signs designed for use with fee computer, consisting of 1-inch- (25-mm-) tall, LCD or LED displays contained in welded steel bodies with baked-enamel finish.
   a. Messages: Amount due, "Thank You," "Closed," and time in A.M./P.M. format.
   b. Mounting: Front of cashier's booth **OR** 42-inch- (1067-mm-) high pedestal, **as directed**.

I. Miscellaneous Parking Control Equipment
1. Lot "Full" Signs: Single-faced signs consisting of illumination source contained in welded steel bodies with extended hood and baked-enamel finish. Sign copy shall be 4 inches (102 mm), **as directed**, tall.
   a. Type: Flashing **OR** Nonflashing, **as directed**.
   b. Operation: Manual by push button **OR** Automatic by barrier gate controller, **as directed**.
   c. Illumination: Traffic signal lamps and colored **OR** Neon tube and clear, **as directed**, fiberglass sign face.
   d. Mounting: Top of barrier gate cabinet **OR** 42-inch- (1067-mm-) high pedestal, **as directed**.

J. Parking Facility Management Software
1. General: Manufacturer's standard software that is compatible with security access control system and that provides automatic facility monitoring, supervision, and remote control of parking control equipment from one or more locations.
   a. System Performance: Capable of the following:
      1) Collect data for revenue and activity reporting.
      2) Collect data for access and space control.
      3) Track tickets.
      4) Program parking control equipment.

K. Access Control Units
1. General: Provide access control unit that activates barrier gates.
   a. Unit Housing: Fabricate from welded cold-rolled steel or aluminum sheet **OR** plastic, **as directed**, with weatherproof front access panel equipped with flush-mounted lock and two keys. Provide face-lighted unit fully visible at night.
      1) Steel Finish: Manufacturer's standard baked-enamel coating system.
2. Card Reader Controlled Unit: Functions only when authorized card is presented.
   a. System: Magnetically coded, single-code system activated by coded card **OR** Programmable, multiple-code capability permitting validating or voiding of individual cards, **as directed**.
      1) Permit four different access time periods.

b. Reader: Swipe type for magnetic-stripe **OR** barcode **OR** Wiegand, **as directed**, cards.
OR
Reader: Insertion type for magnetic-stripe **OR** barcode **OR** Wiegand, **as directed**, cards.
OR
Reader: Proximity type for proximity cards.

c. Operation: Standalone **OR** Online communication to remote parking control system computer **OR** Online communication to remote security access control system computer, **as directed**.

d. Features: Timed antipassback **OR** Limited-time usage **OR** Capable of monitoring and auditing barrier gate activity **OR** LCD display **OR** Programmable by PDA (personal digital assistant) by infrared interface, **as directed**.

e. Mounting: With pedestal **OR** Wall **OR** In enclosed cabinet **OR** As indicated on Drawings, **as directed**.

f. Cards: Provide number as directed by the Owner..
1) Imprint cards: as directed by the Owner.

3. Digital Keypad Controlled Unit: Functions only when authorized code is entered on keyed **OR** keyless-membrane, **as directed**, keypad.
a. System: Multiple-code capability of not less than five **OR** 100 **OR** 500, **as directed**, possible individual codes.
OR
System: Programmable, multiple-code capability permitting validating or voiding of not less than 100 **OR** 2500 **OR** 10,000, **as directed**, possible individual codes, consisting of one to six, **as directed**, digits, and permitting four different access time periods, **as directed**.
b. Operation: Standalone **OR** Online communication to remote parking control system computer **OR** Online communication to remote security access control system computer, **as directed**.
c. Features: Timed antipassback **OR** Limited-time usage **OR** Capable of monitoring and auditing barrier gate activity, **as directed**.
d. Mounting: With pedestal **OR** Wall **OR** As indicated on Drawings, **as directed**.

4. Radio-Controlled System: Digital access control system consisting of code-compatible universal coaxial receiver, one per barrier gate, **OR**, where indicated on Drawings, **as directed**, remote antenna with coaxial cable and mounting brackets, and one permanently mounted **OR** four portable, **as directed**, transmitter(s) per receiver designed to operate barrier gates. Provide programmable transmitter with multiple-code capability permitting validating or voiding of not less than 1000 **OR** 10,000, **as directed**, codes per channel configured for the following functions:
a. Transmitters: Single-button operated, with open **OR** open and close, **as directed**, functions.
OR
Transmitters: Triple-button operated, with open, close, and stop functions.
1) Provide transmitters featuring two **OR** three **OR** four, **as directed**, independent channel settings controlling separate receivers for operating more than one barrier gate from each transmitter.

L. Aluminum Finishes
1. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
a. Color and Gloss: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.

M. Steel Finishes
1. Galvanizing: Hot-dip galvanize items as indicated to comply with the following:
a. ASTM A 123/A 123M for iron and steel parking control equipment.
b. ASTM A 153/A 153M and ASTM F 2329 for iron and steel hardware for parking control equipment.

2. Galvanized-Steel and Steel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.

N. Stainless-Steel Finishes
1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
   a. Run grain of directional finishes with long dimension of each piece.
   b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

1.3 EXECUTION

A. Preparation
1. Excavation for Traffic Controllers: Saw cut existing pavement for recessed traffic controllers and hand-excavate recesses to dimensions and depths and at locations as required by traffic controller manufacturer's written instructions and as indicated on Drawings.

B. Installation
1. General: Install parking control equipment as required for a complete and integrated installation.
   a. Rough-in electrical connections according to requirements specified in Division 15..
2. Automatic Barrier Gates: Anchor cabinets to concrete bases with anchor bolts or expansion anchors and mount barrier gate arms.
   a. Install barrier gates according to UL 325.
3. Vehicle Loop Detectors: Cut grooves in pavement and bury **OR** Bury, **as directed**, and seal wire loop at locations indicated on Drawings according to manufacturer's written instructions. Connect to parking control equipment operated by detector.
4. Traffic Controllers: Anchor controllers to recessed concrete bases **OR** driveway surfaces, **as directed**, with anchor bolts or expansion anchors.
5. Entry Terminal Ticket Dispensers, Pay Stations and Exit Terminals: Attach cabinets to concrete bases with anchor bolts or expansion anchors.
   a. Connect equipment to remote computer.
   b. Load ticket dispenser with supply of tickets.
6. Fee Computers: Install computers at locations indicated, including connecting to peripheral equipment and remote computers, **as directed**.
7. Connect wiring according to Division 16 Section "Conductors And Cables".
8. Ground equipment according to Division 16 Section "Grounding And Bonding".

C. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
3. Perform tests and inspections.
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
4. Tests and Inspections:
   a. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   b. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

c. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

5. Parking control equipment will be considered defective if it does not pass tests and inspections.
6. Prepare test and inspection reports.

D. Adjusting
1. Adjust parking control equipment to function smoothly and lubricate as recommended by manufacturer.
2. Confirm that locks engage accurately and securely without forcing or binding.
3. After completing installation of exposed, factory-finished parking control equipment, inspect exposed finishes and repair damaged finishes.

E. Protection
1. Remove barrier gate arms during the construction period to prevent damage, and install them immediately before Substantial Completion.

END OF SECTION 02725

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SECTION 02725a - PREFABRICATED CONTROL BOOTHS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for prefabricated control booths. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes prefabricated steel and aluminum control booths.

C. Definition
1. ADA-ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines."

D. Performance Requirements
1. Structural Performance: Control booths shall withstand the effects of gravity loads and the loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

E. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
3. Samples: For control booths with factory-applied color finishes.
4. Delegated-Design Submittal: For control booths indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
5. Welding certificates.
6. Maintenance data.
7. Warranty: Sample of special warranty.

F. Quality Assurance
1. Welding Qualifications: Qualify procedures and personnel according to the following:
   a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   b. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
   c. AWS D1.3, "Structural Welding Code - Sheet Steel."
2. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. Safety Glazing Products: Category II materials complying with testing requirements in 16 CFR 1201.
5. Preinstallation Conference: Conduct conference at Project site.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair finish or replace wall panels that fail in materials or workmanship within five years from date of Substantial Completion.

1.2 PRODUCTS

A. Materials
1. Aluminum: Alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated, and as follows:
   a. Sheet: ASTM B 209 (ASTM B 209M).
   b. Extruded Shapes: ASTM B 221 (ASTM B 221M).
   c. Rolled Tread Plate: ASTM B 632/B 632M, Alloy 6061-T4 or Alloy 6061-T6.
2. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, commercial quality, G90 (Z275) coating designation; mill phosphatized.
3. Galvanized, Rolled Steel Tread Plate: ASTM A 786/A 786M, rolled from steel plate complying with ASTM A 572/A 572M, Grade 55 (380); hot-dip galvanized according to ASTM A 123/A 123M.
4. Steel Structural Tubing: ASTM A 500, Grade B.
5. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
6. Steel Mechanical Tubing: ASTM A 513, welded steel mechanical tubing.
7. Zinc-Coated (Galvanized) Steel: Hot-dip galvanized according to ASTM A 123/A 123M.
8. Stainless-Steel Sheet: ASTM A 666, Type 304.
9. Plastic Laminate: NEMA LD 3, HGS or HGL grade.
10. Plywood: DOC PS 1, Exterior grade.
11. Particleboard: ANSI A208.1, Grade M-2.
12. Clear Float Glass: ASTM C 1036, Type I, Class 1, Quality q3.
13. Clear Tempered Float Glass: ASTM C 1048, Kind FT, Condition A, Type I, Class 1, and Quality q3.
14. Insulating Glass: Units complying with ASTM E 774 for Class CBA and consisting of two lites of 2.5-mm-thick clear float glass and dehydrated air space, with a total overall unit thickness of 7/16 inch (11 mm) and with manufacturer's standard dual seal.
15. Ballistics-Resistant Glazing: Comply with requirements specified in Division 08 Section "Security Glazing".
16. Anchorages: Anchor bolts; hot-dip galvanized according to ASTM A 153/A 153M or ASTM F 2329 **OR** stainless steel, **as directed**.

B. Prefabricated Control Booths, General
1. General: Provide a complete, integrated set of mutually dependent components that form a completely assembled, prefabricated control booth, ready for installation on Project site.
   a. Building Style: Standard square corners **OR** Radius corners **OR** Round corners **OR** Butt-glazed corners **OR** Wraparound type, with single rounded building end **OR** Wraparound type, with both building ends rounded **OR** As indicated on Drawings, **as directed**.
   b. Doors: Sliding door on one side **OR** Sliding doors on both sides **OR** Swinging door on back **OR** As indicated on Drawings, **as directed**.
2. Windows: Extruded-aluminum sash frames glazed with 6-mm-thick, clear tempered glass **OR** clear insulating glass **OR** ballistics-resistant glazing, UL 752 Level **as directed**.
   a. Frame Finish: Mill **OR** Clear anodic, **as directed**.
   b. Provide insect screens for each operable window.
   c. Provide galvanized-steel security screens for each window.
   d. Corner Shape: Square **OR** Round, **as directed**.
3. Horizontal Sliding Windows: Extruded-aluminum sash frames glazed with 3-mm-thick, clear tempered float glass. Equip windows with cam locks, weather stripping, and stainless-steel **OR** nylon, **as directed**, ball-bearing rollers.
   a. Frame Finish: Mill **OR** Clear anodic, **as directed**.
   b. Provide insect screens for each operable window.
   c. Corner Shape: Square **OR** Round, **as directed**.
4. Work Counters: Full width of control booth, reinforced; with 16-inch- (406-mm-) wide storage **OR** cash, **as directed**, drawer below each counter, and an access opening for electrical cords at each rear corner of counter.

a. Material: 0.078-inch- (1.98-mm-) thick, stainless-steel sheet **OR** 0.079-inch (2.01-mm) nominal-thickness, galvanized-steel sheet **OR** 1/2-inch- (13-mm-) thick particleboard with plastic-laminate finish, **as directed**.
b. Depth: 22 inches (559 mm) **OR** 20 inches (508 mm) **OR** 18 inches (457 mm), **as directed**.

5. Electrical Power Service: 125-A, 120/240-V ac, single-phase, three-wire load center, with no fewer than four open circuits **OR** service with 8-16 circuit-breaker panel, **as directed**; located under one end of work counter. Run copper wiring in 1/2-inch (13-mm) EMT conduit.
   a. Provide one 120-V ground-fault circuit interrupter (GFCI) power receptacle(s).
6. Lighting Fixtures: One **OR** Two, **as directed**, ceiling-mounted fluorescent lighting fixture(s), 48 inches (1219 mm) long, with acrylic lens and two 40-W lamps in each fixture. Provide single-pole switch mounted adjacent to door to control lighting fixture.
7. Heating Unit: Wall-mounted **OR** Roof-mounted, **as directed**, thermostatically controlled, 110-V, 1500-W electric heater with fan-forced operation and with capacity of not less than 5000 Btu/h (1465 W). Enclose in enameled-steel cabinet and mount under work counter.
8. Cooling Unit: Wall-mounted **OR** Roof-mounted, **as directed**, thermostatically controlled air conditioner with cooling capacity of not less than 13,500 Btu/h (3956 W). Enclose in enameled-steel cabinet.
9. Accessories: Provide the following for each control booth:
   a. Through-wall transaction drawers and speaking apertures complying with requirements specified in Division 08 Section "Security Windows".
   b. Antifatigue mats.
   c. Exterior stainless-steel counter.
   d. Floor-mounted **OR** Wall-mounted, **as directed**, safe.
   e. Signage: <**Insert requirements**>.
   f. Ventilation fan.
   g. Intercom.
   h. Traffic control lights.

C. Prefabricated Steel Control Booths
1. Structural Framework: Fabricated from 2-by-2-by-0.075-inch (50-by-50-by-1.90-mm) steel structural or mechanical tubing. Connect framework by welding.
2. Base/Floor Assembly: 4-inch- (102-mm-) **OR** 3-inch- (76-mm-), **as directed**, high assembly consisting of perimeter frame welded to structural framework of booth. Fabricate frame from 2-by-4-inch (51-by-102-mm) galvanized-steel structural tubing; 0.108-inch (2.74-mm) nominal-thickness, C-shaped, galvanized-steel sheet channels; or galvanized structural-steel angles. Include anchor clips fabricated from 1/4-inch- (6-mm-) thick galvanized-steel plate, predrilled and welded to exterior of integral floor frame.
   a. Finished Floor: 0.108-inch (2.74-mm) nominal-thickness, galvanized, rolled steel tread plate.
   b. Subfloor and Finished Floor: Assembly consisting of 0.079-inch (2.01-mm) nominal-thickness, galvanized-steel sheet underside with rigid insulation core; covered by 0.125-inch- (3.18-mm-) thick, aluminum rolled tread plate; with overall assembly thickness of 2 inches (51 mm).

      OR

      Subfloor and Finished Floor: Assembly consisting of one **OR** two, **as directed**, layer(s) of 3/4-inch- (19-mm-) thick plywood or oriented strand board with 0.125-inch- (3.18-mm-) thick, aluminum rolled tread plate **OR** vinyl composition flooring **OR** carpeting, **as directed**.

   OR

   Base/Floor Assembly: No perimeter frame, with finished floor fabricated from 0.108-inch (2.74-mm) nominal-thickness, galvanized, rolled steel tread plate.

   OR

   Base/Floor Assembly: No perimeter frame, with surface of supporting concrete base as finished floor.
3. Wall Panel Assembly: Assembly consisting of exterior face panel fabricated from 0.079-inch (2.01-mm) nominal-thickness, galvanized-steel sheet; and interior face panel fabricated from 0.064-inch (1.63-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal-thickness, galvanized-

steel sheet; with 2-inch- (51-mm-) **OR** 3-inch- (76-mm-), **as directed**, thick, rigid fiberglass or polystyrene board insulation in cavity between exterior and interior face panels.
   a. Thermal Resistance Value (R-Value): R-7.

4. Flat Roof/Ceiling Assembly: Consisting of exterior roof panels, interior ceiling panels, and insulation between exterior and interior panels; sloped to drain at booth perimeter.
   a. Exterior Roof Panel: Fabricated from 0.079-inch (2.01-mm) **OR** 0.064-inch (1.63-mm), **as directed**, nominal-thickness, galvanized-steel sheet; with painted finish **OR** EPDM membrane, **as directed**, continuously welded seams, and full-perimeter gutter.
   b. Interior Ceiling Panel: Fabricated from 0.079-inch (2.01-mm) nominal-thickness, galvanized-steel sheet; with fiberglass insulation in cavity between ceiling and roof.
      1) Thermal Resistance Value (R-Value): R-17.
   c. Insulated Exterior/Interior Panel: Fabricated from 0.028-inch (0.71-mm) nominal-thickness, galvanized-steel **OR** 0.032-inch- (0.81-mm-) thick, aluminum, **as directed**, sheet faces and expanded-foam insulation core.
      1) Thermal Resistance Value (R-Value): R-17.
   d. Canopy Fascia: Fabricated from 0.079-inch (2.01-mm) nominal-thickness, galvanized-steel sheet, of manufacturer's standard design **OR** custom design indicated on Drawings, **as directed**.
      1) Height: 6 inches (152 mm) **OR** 8 inches (203 mm), **as directed**.
      2) Overhang: 3 inches (76 mm) beyond **OR** Flush with, **as directed**, face of walls below.
   e. Downspouts: Integral, extending 3 inches (76 mm) beyond booth walls.
   f. Roof scuppers.
   g. Rooftop finial.

5. Sliding Door: Top suspended from aluminum track with ball-bearing rollers; 1-3/4 inches (44 mm) thick; tubular-frame design fabricated from clear-anodized aluminum **OR** galvanized steel, **as directed**; with top half of door glazed. Equip door with deadlock, lock support, guide hardware, and full weather stripping.
   a. Glazing: Fixed **OR** Horizontal sliding, **as directed**, unit with 6-mm-thick, clear tempered float glass.
   b. Deadlock: Mortised, laminated-hook bolt type with removable cylinder capable of being master keyed.

6. Swinging Door: 1-3/4 inches (44 mm) thick; tubular-frame design fabricated from clear-anodized aluminum **OR** galvanized steel, **as directed**; with top half of door glazed. Equip door with deadlock, three butt hinges, closer, and full weather stripping.
   a. Glazing: Fixed **OR** Horizontal sliding, **as directed**, unit with 6-mm-thick, clear tempered float glass.
   b. Deadlock: Mortised, with lever handle and removable cylinder capable of being master keyed.

7. Finish: Finish exposed metal surfaces, including structural framework, walls, canopy, and ceiling with rust-inhibitive primer and one finish coat of industrial air-dry acrylic **OR** polyurethane, **as directed**, enamel.
   a. Color: As selected from manufacturer's full range.

D. Prefabricated Aluminum Control Booths
   1. Structural Framework: Fabricated from 2-by-2-by-0.125-inch (51-by-51-by-3.18-mm) aluminum tubing, channel, angle, or tee extrusions; with clear **OR** color, **as directed**, anodic finish. Connect framework with exposed, **as directed**, mechanical fasteners.
   2. Base/Floor Assembly: 4-inch- (102-mm-) high assembly consisting of perimeter frame welded to structural framework of booth. Fabricate frame from 2-by-4-by-0.125-inch (51-by-102-by-3.18-mm) aluminum tubing or aluminum angles. Include anchor clips fabricated from 1/4-inch- (6-mm-) thick aluminum, predrilled and welded to exterior of integral floor frame.
      a. Subfloor and Finished Floor: Assembly consisting of 0.032-inch- (0.81-mm-) thick, aluminum sheet underside, plywood and rigid insulation core; covered by 0.125-inch-

(3.18-mm-) thick, aluminum rolled tread plate; with overall assembly thickness of 2 inches (51 mm).

OR

Subfloor and Finished Floor: Assembly consisting of one **OR** two, **as directed**, layer(s) of 3/4-inch- (19-mm-) thick plywood or oriented strand board with 0.125-inch- (3.18-mm-) thick, aluminum rolled tread plate **OR** vinyl composition flooring **OR** carpeting, **as directed**.

OR

Base/Floor Assembly: No perimeter frame, with surface of supporting concrete base as finished floor.

3. Wall Panel Assembly: Assembly consisting of exterior face panel fabricated from 0.032-inch- (0.81-mm-) **OR** 0.063-inch- (1.60-mm-), **as directed**, thick aluminum sheet, and interior face panel fabricated from 0.032-inch- (0.81-mm-) **OR** 0.050-inch- (1.27-mm-), **as directed**, thick aluminum sheet; with 2-inch- (51-mm-) thick, polystyrene or polyisocyanurate board insulation in cavity between exterior and interior face panels.
   a. Thermal Resistance Value (R-Value): R-7.
4. Flat Roof/Ceiling Assembly: Consisting of exterior roof panels, interior ceiling panels, and insulation between exterior and interior panels; sloped to drain at booth perimeter.
   a. Exterior Roof Panel: Fabricated from 0.032-inch- (0.81-mm-) thick aluminum sheet with protective plastic sheet finish and full-perimeter gutter.
   b. Interior Ceiling Panel: Fabricated from 0.125-inch- (3.18-mm-) thick hardboard; with polyisocyanurate board insulation in cavity between ceiling and roof.
      1) Thermal Resistance Value (R-Value): R-19.
   c. Insulated Exterior/Interior Panel: Fabricated from 0.032-inch- (0.81-mm-) thick, aluminum **OR** 0.021-inch (0.53-mm) nominal-thickness, galvanized-steel, **as directed**, sheet faces and expanded-foam insulation core.
      1) Thermal Resistance Value (R-Value): R-19.
   d. Canopy Fascia: Fabricated from 0.063-inch- (1.60-mm-) thick aluminum sheet, of manufacturer's standard design **OR** custom design indicated on Drawings, **as directed**.
      1) Height: 6 inches (152 mm) **OR** 8 inches (203 mm), **as directed**.
      2) Overhang: 3 inches (76 mm) beyond **OR** Flush with, **as directed**, face of walls below.
   e. Downspouts: Integral, extending 3 inches (76 mm) beyond booth walls.
   f. Roof scuppers.
   g. Rooftop finial.
5. Sliding Door: Top suspended from aluminum track with ball-bearing rollers; 1-3/4 inches (44 mm) thick; tubular-frame design fabricated from aluminum matching exterior and interior wall panels; with top half of door glazed and with extruded-aluminum door frame. Equip door with deadlock, lock support, guide hardware, and full weather stripping.
   a. Glazing: Fixed **OR** Horizontal sliding, **as directed**, unit with 6-mm-thick, clear tempered float glass.
   b. Deadlock: Mortised, laminated-hook bolt type with removable cylinder capable of being master keyed.
6. Swinging Door: 1-3/4 inches (44 mm) thick; tubular-frame design fabricated from aluminum matching exterior and interior wall panels; with top half of door glazed and with extruded-aluminum door frame. Equip door with deadlock, three butt hinges, closer, and full weather stripping.
   a. Glazing: Fixed **OR** Horizontal sliding, **as directed**, unit with 6-mm-thick, clear tempered float glass.
   b. Deadlock: Mortised, with lever handle and removable cylinder capable of being master keyed.
7. Finish: Finish exposed metal surfaces, including structural framework, walls, canopy, and ceiling with clear anodizing **OR** color anodizing **OR** baked enamel or powder coat, **as directed**.
   a. Color: As selected from manufacturer's full range.

E. Fabrication
   1. Fabricate control booths completely in factory.

2. Preglaze windows and doors at factory.
3. Prewire control booths at factory, ready for connection to service at Project site.
4. Fabricate control booths with forklift pockets in base of booth **OR** removable lifting eye centered in roof, **as directed**.
5. Accessible Control Booths: Where indicated to be accessible, fabricate control booths as follows:
   a. Provide service windows located no higher than 34 inches (865 mm) above exterior grade.
   b. Provide door opening with minimum 32-inch (813-mm) clear width.
   c. Provide minimum 60-inch (1525-mm) clear turning spacing within the booth.
   d. Provide minimum 27-inch (685-mm) clearance beneath interior work surfaces. Locate work surfaces 28 inches (710 mm) minimum and 34 inches (865 mm) maximum above the floor.
   e. Locate controls and operable parts no lower than 15 inches (381 mm) and no higher than 48 inches (1219 mm) above the floor where reach is unobstructed. Where side reach is obstructed, locate controls and operable parts no lower than 15 inches (381 mm) and no higher than 46 inches (1219 mm) above the floor.

F. General Finish Requirements
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

G. Finishes
1. Steel and Galvanized-Steel Factory Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
   a. Color and Gloss: As selected from manufacturer's full range.

H. Aluminum Finishes
1. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
2. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
   a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As selected from full range of industry colors and color densities, **as directed**.
3. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
   a. Color and Gloss: As selected from manufacturer's full range.

1.3 EXECUTION

A. Installation
1. Install control booths according to manufacturer's written instructions.
2. Accessible Control Booths: Install with interior floor surface at same elevation as adjacent paved surfaces.
3. Set control booths plumb and aligned. Level baseplates true to plane with full bearing on concrete bases.
4. Fasten control booths securely to cast-in anchor bolts **OR** concrete bases with expansion anchors, **as directed**.
5. Connect electrical power service to power distribution system according to requirements specified in Division 15.

B. Adjusting
   1. Adjust doors, operable windows, and hardware to operate smoothly, easily, properly, and without binding. Confirm that locks engage accurately and securely without forcing or binding.
   2. Lubricate hardware and other moving parts.
   3. After completing installation, inspect exposed finishes and repair damaged finishes.

END OF SECTION 02725a

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SECTION 02726 - ACTIVE VEHICLE BARRIERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for active vehicle barriers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Shop Drawings: Installation, Equipment, and Electrical Work
a. Detail drawings containing complete wiring and schematic diagrams, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including foundation and clearances for maintenance and operation. For Federal work, detail drawings shall include a copy of the Department of State certificate of barrier performance.
2. Product Data:
a. Vehicle Barriers: A complete list of equipment, materials, including industrial standards used and how they apply to the applicable component and manufacturer's descriptive data and technical literature, catalog cuts, and installation instructions. Information necessary to document a minimum 1-year successful field operation performance history for each type of vehicle barrier installed.
b. Spare Parts: Spare parts data for each different item of material and equipment used, after approval of the detail drawings. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.
3. Test Reports
a. Field Testing: Test reports in booklet form showing all field tests, including component adjustments and demonstration of compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall indicate the final position of controls.
4. Operation and Maintenance Data
a. Vehicle Barriers: Operating and Maintenance Instructions
1) Six copies of operation and maintenance manuals, a minimum of 2 weeks prior to field training. One complete set prior to performance testing and the remainder upon acceptance. Manuals shall be approved prior to acceptance. Operation manuals shall outline the step-by-step procedures required for system startup, operation, and shutdown. The manuals shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals shall include routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals shall include piping layout, equipment layout, and simplified wiring and control diagrams of the system as installed. The manuals shall also include synthetic biodegradable hydraulic oil types to be used for ambient temperature ranges of minus 30 degrees F (minus 34 degrees C) to 150 degrees F (plus 66 degrees C) to cover winter operation, summer operation, and ambient temperature ranges in between.

C. General Requirements
1. Performance levels shall be based on the following:
a. The Department of State (DOS) publication SD-SDT-02.01 Specification for Vehicle Crash Testing of Perimeter Barriers and Gates (April 1985) in which:
1) Impact Conditions:

Condition Designation	Vehicle Weight	Impact Speed	Kinetic Energy
K4	15,000 lb (6,800 kg)	30 mph (48 km/h)	450,000 ft-lb (610 kJ)
K8	15,000 lb (6,800 kg)	40 mph (65 km/h)	800,000 ft-lb (1084 kJ)
K12	15,000 lb (6,800 kg)	50 mph (80 km/h)	1,250,000 ft-lb (1695 kJ)

2) Performance Levels:
   a) L 3.0 Vehicle and cargo are to be stopped although vehicle partial penetration and/or barrier deflection of up to 3 feet (1 m) permitted.
   b) L 2.0 Vehicle and cargo are to be stopped although vehicle partial penetration and/or barrier deflection of up to 20 feet (6 m) is permitted.
   c) L 1.0 Vehicle is disabled and does not travel more than 50 feet (15 m) after impact.

2. Vehicle Barriers furnished shall in all respects be identical to the unit tested and certified except for the width of the vehicle barrier, which is as indicated and except for bollards which have a diameter based on a required crash rating. Crash test shall be performed and data compiled by an approved independent testing agency. Test vehicle shall not vault or penetrate the barrier during the test. The design and structural materials of the vehicle barrier furnished shall be the same as those used in the crash tested barrier.

D. Nameplates
1. Nameplate data shall be permanently attached to each vehicle barrier. The data shall be legibly marked on corrosion-resistant metal plates and shall consist of at least the following:
   a. Manufacturer's name.
   b. Model number.
   c. Serial number.
   d. Date of manufacture.

E. Delivery And Storage
1. Components placed in storage shall be protected from the weather, humidity, and temperature variation, dirt and dust, or other contaminants. Structural materials shall be stored on sleepers or pallets and shall be protected from rust and objectionable materials such as dirt, grease, or oil.

F. Spare Parts
1. A manufacturer's standard recommended spare parts package, with current unit prices and source of supply complete with detailed manuals on parts replacement, shall be provided with each barrier to facilitate 1 year of normal operation. Particular consideration shall be given to system components which are not readily available from local or commercial sources and which are critical to the operation of the system.

G. Manufacturer's Services
1. Services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment supplied shall be available. The representative shall supervise the installation, adjustment, and testing of the equipment.

1.2 PRODUCT

A. Retractable Barriers: When in the raised position, the total retractable barrier heights shall be no less than 28 inches (711 mm) above the roadway surface and shall be 144 inches (3.66 m) wide. When in the lowered position, the retractable barrier shall extend no more than 5/8 inch (16 mm) above the roadway surface. Retractable barriers in the lowered position shall be capable of supporting a 32,000 pound (142 kN) axle load or a 16,000 (71 kN) wheel load. Design for this load shall be in accordance with AASHTO HB-17.
1. Powered Retractable Barrier: The retractable barrier shall be capable of 300 complete up/down cycles per hour. The retractable barrier motion shall be instantly reversible and shall be capable

of raising the barrier from the lowered position to the raised position within 8 seconds during normal use, and within 2 seconds during an emergency. Also, the barrier shall be capable of being lowered from the raised position to the lowered position in not more than 3 seconds. Retractable barrier shall withstand a K4 **OR** K8 **OR** K12, **as directed**, impact condition with Performance Level of L1.0 **OR** L2.0 **OR** L3.0, **as directed**.

a. Failure Modes of Operation: The system shall be designed to remain in the last commanded position in the event of hydraulic, electrical, or mechanical failure. A manual pump, or other system, shall be included for operation of hydraulic barriers without power.

b. Electric Motors: Unless otherwise indicated, electric motors shall have drip-proof **OR** totally enclosed **OR** totally enclosed fan cooled, **as directed**, enclosures. All couplings, motor shafts, gears, and other moving parts shall be fully guarded in accordance with 29 CFR 1910 Subpart O. Guards shall be removable without disassembling the guarded unit. For multiple barriers operated from a single hydraulic unit it is highly recommended that the electric motor be 3-phase.

c. System: The system shall be designed to maintain the barriers in the raised position, without inspection, for periods of time of up to 1 week. If a hydraulic system is used, it shall be equipped with pressure relief valves to prevent overpressure. The system shall not require continuous running of the motor to stay in the raised position, excluding the use of manual pinning to do so.

d. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Buried hydraulic lines for the connection of the hydraulic power unit to the barrier shall be flexible or carbon steel pipe, or a combination of flexible and carbon steel pipe. Flexible and rigid hydraulic line working pressures shall exceed the maximum system relief pressure. PVC pipe and fittings for burial of hydraulic lines shall be in accordance with ASTM D 3034 Type PS 46 with minimum pipe stiffness of 46.
   1) Flexible hydraulic lines shall be in accordance with SAE J517.
   2) Rigid hydraulic lines shall be seamless carbon steel pipe in accordance with ASTM A 106.

e. Hydraulic Power Unit Enclosure: A NEMA Type 3R enclosure as specified in NEMA 250 shall be provided to enclose the hydraulic power unit. The enclosure shall be designed for easy removal of the hydraulic power unit and other accessories without complete removal of the enclosure. An access door with hinges and an inside and outside operable/lockable (exterior) door latch shall be provided. Equipment within the enclosure shall be placed and configured so that all periodic maintenance can be performed through the access door without removal of the equipment. The enclosure shall be equipped with weatherproof louver vents appropriately sized and located to dissipate internal heat generation.

2. Manual Retractable Barriers: The manual barrier shall be capable of being raised and lowered by manual means such as levers or hydraulics requiring a maximum 60 pounds (267 N) of force. The manual mechanism shall contain a locking pin which accepts a padlock for securing the barrier when it is in the "UP" position. Retractable barrier shall withstand a K4 **OR** K8 **OR** K12, **as directed**, impact condition with Performance Level of L1.0 **OR** L2.0 **OR** L3.0, **as directed**. Barrier should be capable of being locked in the down position.

B. Retractable Bollards: The total bollard height when in the raised position shall be no less than 30 inches (750 mm) above the roadway surface and shall have an outside diameter of no less than 8 inches (200 mm). A bollard system shall consist of a minimum of 3 bollards spaced no more than 36 inches (915 mm) from centerline to centerline of bollards across a 10 foot (3.0 m) roadway. Bollards in the lowered position shall be capable of supporting a 16,000 pound (71 kN) wheel load each. Design for this load shall be in accordance with AASHTO HB-17. Retractable bollards shall withstand a K4 **OR** K8 **OR** K12, **as directed**, Impact Condition with Performance Level of L1.0 **OR** L2.0 **OR** L3.0, **as directed**.

1. Powered Retractable Bollards: The retractable bollard shall be capable of 300 complete up/down cycles per hour. Bollards shall be capable of being raised or lowered within a 3 to 15-second range during normal use and within 2.5 seconds for emergency operations.
   a. Failure Modes of Operation: The system shall be designed to prevent lowering of the barrier in the event of hydraulic, electrical, or mechanical failure. A manual pump, or other system, shall be included for operation of hydraulic and/or mechanical barriers without power.
   b. Electric Motors: Unless otherwise indicated, electric motors shall have drip-proof **OR** totally enclosed, **as directed**, enclosures. For multiple barriers being operated from a hydraulic power unit it is highly recommended that the electric motor be 3-phase.
   c. System: The system shall be designed to maintain the barriers in the raised position, without inspection, for period of time of up to 1 week. If a hydraulic system is used, it shall be equipped with pressure relief valves to prevent overpressure.
   d. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range, if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Buried hydraulic lines for the connection of the hydraulic power unit to the barrier shall be flexible or carbon steel pipe, or a combination of flexible and carbon steel pipe. Flexible and rigid hydraulic line working pressures shall exceed the maximum system relief pressure. PVC pipe and fittings for burial of hydraulic lines shall be in accordance with ASTM D 3034 Type PS 46 with minimum pipe stiffness of 46.
      1) Flexible hydraulic lines shall be in accordance with SAE J517.
      2) Rigid hydraulic lines shall be seamless carbon steel pipe in accordance with ASTM A 106.
   e. Hydraulic Power Unit Enclosure: A NEMA Type 3R enclosure as specified in NEMA 250 shall be provided to enclose the hydraulic power unit. The enclosure shall be designed for easy removal of the hydraulic power unit and other accessories without complete removal of the enclosure. An access door with hinges and an inside and outside operable/lockable (exterior) door latch shall be provided. Equipment within the enclosure shall be placed and configured so that all periodic maintenance can be performed through the access door without removal of the equipment. The enclosure shall be equipped with weatherproof louver vents appropriately sized and located to dissipate internal heat generation.
2. Manual Retractable Bollards: Manual bollards shall be capable of being raised and lowered utilizing a recessed handle on the top surface of the bollard or a manual hydraulic pump, either requiring a maximum 60 pounds (267 N) of force. A mechanism, that is lockable, shall be provided to secure the bollard in either the full "UP" or full "DOWN" position.

C. Crash Gate: The crash gate shall consist of steel buttresses anchored into the ground and an above grade assembly consisting of a heavy steel structure or a combination of heavy steel and structural aluminum capable of being opened and closed. The height of the gate shall be a minimum of 84 inches (2.1 m) from the road surface to the top of the gate frame. The length shall close and protect a minimum 120 inch (3.0 m) clear opening. The maximum clear opening between the gate frame and end posts, between the bottom of the gate and finished grade, and between any grill work shall be 3 inches (75 mm).
   1. Powered Crash Gate: The gate movement shall be controlled by an electro-mechanical gate operator **OR** a hydraulic gate operator, **as directed**, consisting of an operator unit with required control circuits and operator station. The control and operating voltage shall be 24 vac (nominal) or, as an option 24 vdc. A remote control master station shall be capable of driving the gate at minimum 48 fpm (14.6 m per minute) for a slide gate or 6 degrees per second for a swing gate. Unless otherwise indicated, motors shall have drip-proof **OR** totally enclosed, **as directed**, enclosures. Crash gate shall withstand a 15,000 pound (6804 kg) vehicle at impact speed of 30 **OR** 40 **OR** 50, **as directed**, mph (48 **OR** 64 **OR** 80, **as directed**, km/hour), with maximum barrier deflection or vehicle penetration of 3 feet (1 m).

a. Failure Mode of Operation: The system shall be designed to prevent opening of the crash gate in the event of electrical or mechanical failure. A disconnect system for the gate drive shall be provided to allow manual operation of the barrier in the event of a power outage.

b. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity within its operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Buried hydraulic lines for the connection of the hydraulic power unit to the barrier shall be flexible or carbon steel pipe, or a combination of flexible and carbon steel. Flexible and rigid hydraulic line working pressures shall exceed the maximum system relief pressure. PVC pipe and fittings for burial of hydraulic lines shall be in accordance with ASTM D 3034 Type PS 46 with minimum pipe stiffness of 46.
   1) Flexible hydraulic lines shall be in accordance with SAE J517.
   2) Rigid hydraulic lines shall be seamless carbon steel pipe in accordance with ASTM A 106.

c. Hydraulic Power Unit Enclosure: A NEMA Type 3R enclosure as specified in NEMA 250 shall be provided to enclose the hydraulic power unit. The enclosure shall be designed for easy removal of the hydraulic power unit and other accessories without complete removal of the enclosure. An access door with hinges and an inside and outside operable/lockable (exterior) door latch shall be provided. Equipment within the enclosure shall be placed and configured so that all periodic maintenance can be performed through the access door without removal of the equipment. The enclosure shall be equipped with weatherproof louver vents appropriately sized and located to dissipate internal heat generation.

2. Manual Crash Gate: The manual crash gate shall be capable of being hinged from either side. Hinge points of both buttresses shall each contain a locking pin with padlock acceptance for securing the crash gate in the closed position. The crash gate shall withstand a 10,000 pound (4535 kg) vehicle at impact speed of 50 mph (80 km/hour), with maximum gate deflection or vehicle penetration of 10 feet (3 m) 15,000 pound (6804 kg) vehicle traveling at impact speed of 30 **OR** 40 **OR** 50, **as directed**, mph (48 **OR** 64 **OR** 80, **as directed**, km/hour), with a maximum gate deflection or vehicle penetration of up to 3 feet (1 m).

D. Crash Beam: The crash beam shall be an above-grade assembly that, in the "DOWN" position, shall present a visible obstacle to approaching vehicles. The height of the barrier shall be a minimum of 30 inches (750 mm) as measured from the roadway surface to the centerline of the crash beam. The crash beam shall be capable of blocking a minimum road width of 120 inches (3.0 m). The crash beam end shall contain a locking pin with padlock acceptance for securing the crash beam when it is in the "DOWN" position. Crash beam shall withstand a 15,000 pound (6804 kg) vehicle traveling at 30 **OR** 40 **OR** 50, **as directed**, mph (48 **OR** 64 **OR** 80, **as directed**, km/hour), with maximum vehicle penetration of 20 feet (6 m) 10,000 pound (4535 kg) vehicle at impact speed of 15 mph (24 km/hour), with a maximum vehicle penetration of 10 feet (3 m).

1. Powered Crash Beam: The crash beam shall be operated by means of a hydraulic power system. The crash beam shall be capable of being raised or lowered within an 8 to 15 second time range.

a. Failure Mode of Operation: A disconnect system for the crash beam shall be provided to allow manual operation of the barrier in the event of an electrical or mechanical failure.

b. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Buried hydraulic lines for the connection of the hydraulic power unit to the barrier shall be flexible or carbon steel pipe or a combination of flexible and carbon steel pipe. Flexible and rigid hydraulic line working pressures shall exceed the maximum system relief pressure. PVC pipe and fittings for burial of hydraulic lines shall be in accordance with ASTM D 3034 Type PS 46 with minimum pipe stiffness of 46.

1) Flexible hydraulic lines shall be in accordance with SAE J517.
2) Rigid hydraulic lines shall be seamless carbon steel pipe in accordance with ASTM A 106.

c. Hydraulic Power Unit Enclosure: A NEMA Type 3R enclosure as specified in NEMA 250 shall be provided to enclose the hydraulic power unit. The enclosure shall be designed for easy removal of the hydraulic power unit components and other accessories without complete removal of the enclosure. An access door with hinges and an inside and outside operable/lockable exterior door latch shall be provided. Equipment within the enclosure shall be placed and configured so that all periodic maintenance can be performed through the access door without removal of the equipment. The enclosure shall be equipped with weatherproof louver vents appropriately sized and located to dissipate internal heat generation.

2. Manual Crash Beam: The crash beam shall be manually raised and lowered with the aid of a counterbalanced end requiring approximately 60 pounds (267 N) of force.

E. Portable Retractable Barrier: The portable retractable barrier shall be transportable and capable of manual and/or electro-mechanical operation. When in the raised position, the total barrier heights shall be no less than 28 inches (711 mm) above the roadway surface and shall be up to 144 inches (3.66 m wide). The barrier shall be equipped with entrance/exit ramps when the barrier extends more than 5/8 inch (16 mm) above the roadway surface. Retractable barriers in the lowered position shall be capable of supporting a 32,000 pound (142 kN) axle load or a 16,000 (71 kN) pound wheel load. Design for this load shall be accordance with AASHTO HB-17.

1. Powered Portable Retractable Barrier: The portable retractable barrier shall be capable of 300 complete up/down cycles per hour. The retractable barrier motion shall be instantly reversible and shall be capable of raising the barrier from the lowered position to the raised position within 8 seconds during normal use, and within 2 seconds during an emergency. Also, the barrier shall be capable of being closed from the raised position to the lowered position in not more than 3 seconds. Retractable barrier shall withstand a K4 **OR** K8 **OR** K12, **as directed**, impact condition with Performance Level of L1.0 **OR** L2.0 **OR** L3.0, **as directed**. Portable retractable barrier, when impacted by a 15,000 pound (6,800 kg) vehicle at impact speed of 50 mph (80 km/hour) shall disable the vehicle and allow it to travel no more than 50 feet (15.2 m) after impact. Portable power assisted retractable barriers shall be equipped with on and off ramps for smooth transition between surfaces when the barrier extends more than 5/8 inch (16 mm) above the roadway surface.
   a. Failure Modes of Operation: The system shall be designed to prevent lowering of the barrier in the event of hydraulic, electric, or mechanical failure. A manual pump shall be included for operation of hydraulic and/or mechanical barriers without power.
   b. Electric Motors: Unless otherwise indicated, electric motors shall have drip-proof **OR** totally enclosed, **as directed**, enclosures.
   c. System: The system shall be designed to maintain the barriers in the raised position, without inspection, for periods of time of up to 1 week. If a hydraulic system is used, it shall be equipped with pressure relief valves to prevent overpressure.
   d. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Flexible hydraulic lines shall be used for the connection of the hydraulic power unit to the barrier. Flexible hydraulic line working pressures shall exceed the maximum system relief pressure; flexible hydraulic lines shall be in accordance with SAE J517.
2. Manual Retractable Portable Barriers: The manual barrier shall be capable of being raised and lowered by manual means such as levers or hydraulics requiring a maximum 60 pounds (267 N) of force. The manual mechanism shall contain a locking pin which accepts a padlock for securing the barrier when it is in the "UP" position and shall also be capable of being locked in the

"DOWN" position. Retractable barrier shall withstand a K4 **OR** K8 **OR** K12, **as directed**, impact condition with Performance Level of L1.0 **OR** L2.0 **OR** L3.0, **as directed**

F. Portable Crash Beam: The portable crash beam shall be an above-grade assembly that, in the "DOWN" position, shall present a visible obstacle to approaching vehicles. The height of the barrier shall be a minimum of 30 inches (750 mm) as measured from the roadway surface to the centerline of the crash beam. The crash beam shall be capable of blocking a minimum road width of 120 inches (3.0 m). The crash beam end shall contain a locking pin with padlock acceptance for securing the crash beam when it is in the "DOWN" position. Crash beam shall withstand a 15,000 pound (6804 kg) vehicle traveling at 30 mph (48 km/hour), with maximum vehicle penetration and/or barrier deflection of 20 feet (6 m).

1. Powered Portable Crash Beam: The portable crash beam shall be operated by means of a hydraulic power system. The crash beam shall be capable of being raised or lowered within an 8 to 15 second time range.
   a. Failure Mode of Operation: A disconnect system for the portable crash beam shall be provided to allow manual operation of the barrier in the event of an electrical or mechanical failure.
   b. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Flexible hydraulic lines shall be used for the connection of the hydraulic power unit to the barrier. Flexible hydraulic line working pressures shall exceed the maximum system relief pressure; flexible hydraulic lines shall be in accordance with SAE J517.
   c. Hydraulic Power Unit Enclosure: A weather resistant enclosure shall be provided to enclose the hydraulic power unit. The enclosure shall be designed for easy removal of the hydraulic power unit components and other accessories without complete removal of the enclosure. An access door with hinges and an inside and outside operable lockable (exterior) door latch shall be provided. Equipment within the enclosure shall be placed and configured so that all periodic maintenance can be performed through the access door without removal of the equipment. The enclosure shall be equipped with weatherproof louver vents appropriately sized and located to dissipate internal heat generation.
2. Manual Portable Crash Beam: The crash beam shall be manually operated by means of a counter balanced system requiring approximately 60 pounds (267 N) of force.

G. Electrical Work: Motors, manual or automatic motor control equipment except where installed in motor control centers and protective or signal devices required for the operation specified herein shall be provided in accordance with Division 15. All field wiring for loop detectors, communication lines, and power circuits shall have surge protection. Any wiring required for the operation specified herein, but not shown on the electrical plans, shall be provided under this section in accordance with Division 15.

H. Control Panel: A control panel and control circuit shall be provided to interface between all barrier control stations and the power unit. A control panel shall be provided for the inbound lanes and a separate one for the outbound lanes where the barriers are located. The control station is defined as the main control panel and the remote control panel as shown. The control circuit shall contain all relays, timers, and other devices or an industrial programmable controller programmed as necessary for the barrier operation. The control panel shall allow direct interface with auxiliary equipment such as card readers, remote switches, loop detectors, infrared sensors, and sliding **OR** swinging, **as directed**, gate limit switches. Loop controllers shall not cause an automatic barrier raise following power loss or restoration. The enclosure shall be as indicated on the drawings. All device interconnect lines shall be run to terminal strips.

1. Voltage: The control circuit shall operate from a 120 volt 60 **OR** 50, **as directed**, Hz supply. The control circuit voltage shall be 12 **OR** 24, **as directed**, ac **OR** dc, **as directed**, for all external control panels.

2. Main Control Panel: A main control panel shall be supplied to control barrier function. This panel shall have a key-lockable main switch with main power "ON" and panel "ON" lights. Buttons to raise and lower each barrier **OR** set of barriers, **as directed**, shall be provided. Barrier "UP" and "DOWN" indicator lights shall be included for each barrier **OR** set of barriers, **as directed**. An emergency fast operate circuit (EFO) shall be operated from a push button larger than the normal controls and have a flip safety cover installed over the push button or toggle switch. The EFO shall also be furnished with an EFO-active light and reset button. The main control panel shall have a key lockable switch to arm or disable the remote control panel. An indicator light shall show if the remote control panel is enabled.
3. Remote Control Panel: A remote control panel, one panel for the inbound lane(s) and a separate panel for the outbound lane(s), shall have a panel "ON" light that is lit when enabled by a key lockable switch on the main control panel. Buttons to raise and lower each barrier shall be provided. Barrier "UP" and "DOWN" indicator lights shall be included for each barrier. The EFO shall be operated from a push button larger than the normal controls and have a flip safety cover installed over the push button or toggle switch. Activation of either EFO will operate all barriers. The EFO shall be interconnected with an EFO-active light. When the remote control panel EFO is pushed, operation of the barrier will not be possible from this panel until reset at the main control panel.

I. Miscellaneous Equipment
1. Safety Equipment
   a. Barrier Systems Sensors: The sensors shall be compatible with the barrier controller and shall function as part of a complete barrier control system. The barrier system sensors shall consist of the following:
      1) Suppression Loops - Two inductive loops whose outputs shall be used to prevent barriers raising when a vehicle is within a prescribed distance of the barrier. The output of the loops shall override all barrier rise signals until one second after a vehicle clears the suppression loop.
      2) Speed Loops - Two inductive loops whose output shall be used to signal the barrier controller of a vehicle approaching at a speed greater than the posted speed (25 mph (11.2 m/sec) or less (recommended)). The speed loops shall cause the barrier control panel to annunciate a warning sound alerting the guard to make a decision as to whether the barrier should be raised or not.
      3) Wrong Way Loops - Two inductive loops whose output shall be used to signal the barrier control panel to ennunciate a warning sound if a vehicle is attempting to enter the facility through the exit lane. The warning sound will alert the guard to make a decision as to whether the barrier should be raised or not.
   b. Traffic Lights: Red/yellow 8 inch (200 mm) traffic lights shall be supplied for each entrance and exit to alert motorists of the barrier position. Traffic lights are not required for manual barriers. The yellow flashing light shall indicate that the barrier is fully open. All other positions shall cause the light to show red. Brackets shall be supplied to allow the light to be mounted a minimum 4.5 feet (1.4 m) above the roadway pavement on a 3.5 inch (90 mm) outside diameter metal post or mounted directly on the crash gate.
2. Warning Annunciator: Provide a warning annunciator built into the barrier control panel that produces a pulsing audible sound when the speed loop detects a vehicle entering the facility with excess speed. Provide a warning annunciator built into the barrier control panel that produces a continuous sound whenever a wrong way loop detects a vehicle entering from the exit. The warning annunciator shall sound until a warning annunciator silence reset button is pressed.
3. Heater: A waterproof barrier heater with a thermostat control and NEMA 4 junction box connection point shall be provided for de-icing and snow melting. The heater shall provide barrier operation to an ambient temperature of minus 40 degrees F (minus 40 degrees C). For retractable bollards, a 250-watt heater shall be provided for each bollard.
4. Signage: Signage shall read "Axle Weight Limit 9 Tons" and shall conform to FHWA SA-89-006 sign (R12.2).

5. Vertical Arm Gates (Traffic Arms): Vertical arm gates shall have an opening and closing time of less than or equal to 5 seconds. The gates shall be capable of 500 duty cycles per hour as a minimum. Gate shall operate the arm through 90 degrees. Gate operators shall be supplied with single phase 120 volt motors. Each entry lane shall be provided with a vertical arm gate. Each gate shall be capable of being operated from a remote open-close push button station in each guard booth and the gatehouse for the respective entry lane. Gates shall have a hand-crank, or other means, which will allow manual operation during power failures. Gate arms shall be constructed out of wood, steel, fiberglass, or aluminum, as specified by the manufacturer for the given lengths as shown on the drawings. Gate arms shall be covered with 16 inch (406 mm) wide reflectorized red and white sheeting. Each gate shall be furnished with a spare gate arm. Gate operator cabinets shall be constructed of galvanized steel, or aluminum and shall be painted manufacturers standard color as approved. Each gate operator shall be provided with an obstruction detector that will automatically reverse the gate motor when an obstruction is detected. The obstruction detector shall be any of the following 3 types: An electronic loop vehicle detector buried in the road, a photocell electric eye mounted on the gate operator, or a safety strip mounted on the lower edge of the arm. The detector system shall be automatically deactivated when the arm reaches the fully lowered position. Slab size and anchorage for gate operator shall be per manufacturer requirements.

6. Vehicle Barrier Vertical Arm Gate (Traffic Arm): A traffic arm, as a separate piece of equipment, will be included with each non-portable active vehicle barrier as part of the barrier safety operating system. This traffic arm shall automatically deploy (close) when the emergency up button is activated and open when the vehicle barrier is reset. This traffic arm will not be equipped with an automatic obstruction detector.

J. Finish: Surfaces shall be painted in accordance with requirements of Division 09 Section(s) "Exterior Painting" OR "Interior Painting", as applicable. The roadway plate shall have a nonskid surface painted white with reflective red 4 **OR** 6, **as directed**, inch (100 **OR** 150, **as directed**, mm) wide red reflective stripes 4 inches (100 mm) apart. The barrier front shall be painted white and have 4 **OR** 6, **as directed**, inch (100 **OR** 150, **as directed**, mm) wide reflective red stripes 4 inches (100 mm) apart. The diagonal striping should point down and outward from the center of the device. Bollards shall be painted white with 2 **OR** 3, **as directed**, inch (50 **OR** 75, **as directed**, mm) wide reflective red diagonal stripes. The barrier crash gate shall be painted as specified by purchaser and the crash beam shall be painted white with 3 inch (75 mm) wide reflective red diagonal stripes.

K. Concrete: The concrete shall conform to Division 03 Section "Cast-in-place Concrete".

L. Welding: Welding shall be in accordance with AWS D1.1/D1.1M.

M. Pavement: After placement of the vehicle barrier, the pavement sections shall be replaced to match the section and depth of the surrounding pavement. Pavement shall be warped to match the elevations of existing pavement. Positive surface drainage, away from the vehicle barrier, shall be provided by pavement slope.

1.3 EXECUTION

A. Installation: Installation shall be in accordance with manufacturer's instructions and in the presence of a representative of the manufacturer. Manufacturer's representative shall be experienced in the installation, adjustment, and operation of the equipment provided. The representative shall also be present during adjustment and testing of the equipment.

B. Hydraulic Lines: Buried hydraulic lines shall be placed in polyvinyl chloride (PVC) sleeves. Positive drainage shall be provided from the hydraulic power unit to the barrier for drainage of condensation within the PVC sleeve.

C. Pit Drainage: A drain connection and oil/water separator, **as directed**, shall be provided in each barrier that requires pit/vault type construction. Hookups between the storm drains shall be made. The self-priming sump pump shall have the capacity to remove minimum 150 gallons per minute (34 cubic meters per hour).

D. Electrical: All control power wiring requiring compression terminals shall use ring-style terminals. Terminals and compression tools shall conform to UL 486A. Roundhead screws and lockwashers shall be used to provide vibration-resistant connections. Connections between any printed circuit cards and the chassis shall be made with screw connections or other locking means to prevent shock or vibration separation of the card from its chassis. The electrical power supply breaker for the hydraulic power unit shall be capable of being locked in the power on and power off positions.

E. Field Testing: Upon completion of construction, a field test shall be performed for each vehicle barrier. The test shall include raising and lowering the barrier, both electrically and manually, through its complete range of operation. Each vehicle barrier shall then be continuously cycled for not less than 30 minutes to test for heat build-up in the hydraulic system. the Owner shall be notified at least 7 days prior to the beginning of the field test. The Contractor shall furnish all equipment and make all necessary corrections and adjustments prior to tests witnessed by the Owner. Any conditions that interfere with the proper operation of the barrier disclosed by the test shall be corrected at no additional cost to the Owner. Adjustments and repairs shall be done by the Contractor under the direction of the Owner. After adjustments are made to assure correct functioning of components, applicable tests shall be completed.

F. Field Training: A field training course shall be provided for designated operating staff members. Training shall be provided for a total period of not less than 8 hours (for electrical/hydraulic operated units) or 1 hour (for manually operated units) of normal working time and shall start after the system is functionally complete but prior to final acceptance tests. Field training shall cover all of the items contained in the operating and maintenance instructions.

END OF SECTION 02726

SECTION 02730 - COLORED ATHLETIC WEARING SURFACE

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of colored athletic wearing surface on asphaltic concrete base. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals: Submit product data and manufacturer's application instruction.

1.2 PRODUCTS

A. Manufacturer: Athletic wearing surface shall be the "Plexipave" system by California Products Corporation, 169 Waverly Street, Cambridge Ma. 02139 or approved equal.

B. Plexipave Court Patch Binder prepared as per manufacturers recommendations.

C. California Acrylic Resurfacer prepared as per manufacturers recommendations.

D. Fortified Plexipave Job Mix prepared as per manufacturers recommendations.

E. Plexipave Color Base as required to meet project requirements.

F. Plexichrome Color as required to meet project requirements.

1.3 EXECUTION:

A. Personnel used to install athletic wearing surface must have a minimum of three years experience and at least three jobs with similar square footage of placement.

B. When required, asphaltic concrete base shall be placed to conform to manufacturer’s planarity requirements.

C. Protect adjacent surfaces not to receive coating during application.

D. All finished surfaces must have a uniform appearance and be free of ridges and tool marks and shall not vary more than 1/8" in 10 feet measured in any direction.

END OF SECTION 02730

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SECTION 02730a - SYNTHETIC TURF

1.1 GENERAL

A. Description Of Work
1. This section covers the furnishing and/or installation of: synthetic turf with covers for cut-outs; paint lines and markings for football, soccer and baseball fields; the painting of a logo at midfield; line painter equipment, portable blower for ground clean-up, turf vacuum cleaner, and pylon markers. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals:
1. Turf covers for baseball infield cutouts.
2. Painting template for a logo.
3. Layouts for lines and markings of game fields.
4. Maintenance Manual: 2 copies, providing a full description of materials to be used for maintaining Synthetic Turf System.
5. Manufacturer's literature for line painter equipment, turf vacuum cleaner, and portable blowers.
6. Warranties: For synthetic turf, for line painter equipment, for turf vacuum cleaner, and for portable blowers.
7. Synthetic turf: Sample, technical data and manufacturer's directions for installation and maintenance.
8. Line Paint: Manufacturer's literature and application directions.

C. Warranties: The warranty submitted shall have the following characteristics:
1. Shall provide full coverage for eight (8) years, from date of first use.
2. Shall warrant materials and workmanship.
3. Shall warrant that the materials installed meet or exceed the product specifications.
4. Shall have a provision to either: (a) make repairs or (b) replace such portions of the installed materials that are no longer serviceable, to maintain a serviceable and playable surface, and make good without cost or expense to the Owner.
5. Shall state all limitations and exclusions.
6. Shall be a warranty from a single source covering workmanship and all self-manufactured or procured materials.
7. Warranty shall be for full value, not prorated.

1.2 PRODUCTS

A. Synthetic Turf
1. Synthetic turf shall be Astro Turf-8, by Astro Turf Industries, Inc., 809 Kenner Street, Dalton, Georgia 30720, or approved equivalent.
2. Turf fabric: Knitted of nylon 6.6 ribbon with a polyester filament backing yarns and weighing approximately 63 ounces per square yard.
3. Pile material: 500 denier, textured nylon, 6.6 ribbon with a 1/2-inch pile height to give the appearance of mown grass; weight 50 ounces per square yard; pigmented green and stabilized for outdoor exposure.
4. Backing Yarns: High strength polyester fiber yarns, heat set for maximum dimensional stability.

B. Underpad
1. Underpad: 5/8-inch thick, energy-absorbing, made of closed cell foam, reinforced with carbon black, and perforated for drainage.
2. Pad density: 7.5 pounds per cubic foot.
3. Compression module: 25%, 8 pounds per square inch.

4. Perforations: 3/8-inch holes, 3 on center in a staggered pattern, factory perforated.

C. Adhesives for bonding the synthetic turf to the pad shall be weather-resistant to withstand the climate of the site and shall be compatible with the materials of the turf and pad.

D. All butt seams of the turf surface shall be sewn and glued.

E. Paint shall be Sherwin-Williams "Watch-Guard System Metalex" semi-gloss enamel, or approved equivalent.

F. Line painter shall be Model 98-331, as manufactured by Binks Co., or approved equivalent, with 5 gallon pressure-tested tank, adjustable line marker, quick disconnect for ease of cleaning, 12" front pneumatic wheels, 5HP 4-cycle air-cooled gasoline engine, air-actuated spray gun, dual cylinder compressor.

G. Turf vacuum cleaner shall be Model BT-80-VIC, manufactured by the Billy Goat Industries, Inc., Lees Summit, MO, or approved equivalent. Vacuum shall be 8 HP Push-gasoline Big Wheel model complete with 5" intake hose kit (Part No. 800521) exhaust hose kit (Part No. 800077), and caster assembly (Part No. 800065).

H. Portable Blower for Ground Cleanup
1. Windmill "Fast-Blo", Model No. 22B hand-held gas power blower as supplied by A.M. Leonard Inc., Piqua, Ohio, or approved equivalent.
2. Variable speed control, 2-cycle gas engine type, weighing 10 pounds.

I. Football Pylons: Model No. "WP-12"
1. "Ethafoam", water and mildew resistant, size 4" x 4" x18", of standard bright color.
2. Weighted: Springs back upon impact.
3. Provide two (2) sets of twelve (12) pylons for a total of 24, for football field.

J. Soccer Flags
1. Soccer Flags: Model "WSF" as manufactured by Marty Gilman, Inc., Gilman, CT. 06336, or approved equivalent.
2. Provide two (2) sets of four (4) flags for a total of eight, for soccer field.

K. Baseball Infield Conversion System
1. Submit Shop Drawings indicating method of detailing conversion panels for approval.
2. Panels shall be removable in conversion area.
3. Cut panels from same synthetic turf material as football field, to match.
4. Provide spacers and pad wedges.

1.3 EXECUTION

A. Before any synthetic turf is installed, the Contractor shall inspect the asphaltic concrete base and, when satisfied with its condition, shall notify the Owner in writing of acceptance of the base.

B. A manufacturer's representative shall be present at the job site when the synthetic turf is installed. Turf shall be laid in strict accordance with the manufacturer's instructions by workmen who are skilled in this type of work.

C. Turf material shall be protected before, during and after installation.

D. Installed work and materials of other trades shall be protected.

E. Assurance
1. Qualified bidders must have successfully installed at least five (5) other outdoor installations of synthetic stadium surface within the last three (3) years of a type described herein.
2. The field installation shall be made under the direct, active, personal supervision of technical representatives of the synthetic turf manufacturer. All key positions shall be manned by experienced employees of the installer.
3. The synthetic turf contractor shall keep a full-time superintendent on the project during the installation of the synthetic turf.
4. The synthetic turf system supplied shall be of previous acceptance at all levels of competition, including University and Professional.

F. Underpad Installation
1. At "float drain" system: strip glue underpad at all joints.
2. At "vertical drain" system: provide intermittent gluing at a spread rate of 150-160 sq. ft./gal.
3. Sew Pad joints, using thread and stitching recommended by the synthetic turf manufacturer.
4. Lay out work so that seams of the underpad are offset from the seams of turf, but not less than 12".

G. Turf Installation
1. The synthetic turf shall be bonded to the pad with no wrinkles, ripples or bubbles. Slits in the fabric to relieve such defects are not permitted. Joints in the turf shall be offset from joints of the pad by not less than 12".
2. Side seams in the fabric shall be at 15'-0" intervals, at 5-yard lines for the football field. There shall be no cross or head seams.
3. Sew seams with high strength polyester fiber cord and lay with a bed of adhesive. Seams shall be flat, tight and permanent, with no separation or fraying.
4. Covers for the baseball infield cut-outs shall be flush and tight. Install covers and check for proper fittings.
5. Insert edges of turf in trench drain receptor at perimeter of field for "float drain" systems; terminated edges at concrete curb and wood nailer at "vertical drain" systems.
6. Provide covering caps for football and soccer goal posts and markers within the playing fields.
7. At completion, remove all excess materials and all debris resulting from operations of Work in this Section. Leave entire Work in neat, clean condition.

H. Painting
1. Lines and markings for game fields shall be painted in accordance with the approved Shop Drawings.
2. Any logo shall be painted at midfield in accordance with the approved Shop Drawings.

I. Maintenance
1. Manual shall describe the materials, devices and procedures to be followed for use and maintenance or the synthetic turf system, including the cleaning, paint application and removal, and conversion techniques. Include any precautions required by the warranty.
2. Training: Give demonstrations and training sessions, devoting a sufficient amount of time to thoroughly instruct the Owner's personnel in operation and maintenance (for cleaning, conversion of baseball-to-football, and line striping) of the synthetic turf system and equipment.

J. Acceptance
1. Before the acceptance of the work, should any imperfect areas or spots develop in the surface, such areas shall be removed and replaced with new materials.
2. All such repair work shall be done at no additional cost to the Owner.

K. At the completion of the Work, remove all material scraps, debris, and equipment from the site and leave the synthetic turf area ready for use.

END OF SECTION 02730a

SECTION 02730b - TRACK, COURT, AND PLAYGROUND MARKINGS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing of materials and the installation of track, court, and playground markings. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Submit product data and manufacturer's recommendations for each marking to be furnished.
2. Submit sample of each marking to be furnished.
3. Submit "Line Layout Drawing" prior to installation of marking and upon completion of markings, submit three (3) certified line layout drawings indicating all lines and colors.

C. Quality Assurance: Personnel shall have a minimum of three years marking experience.

D. Delivery, Storage and Handling: Deliver paint to site in original sealed containers or drums, with labels legible, intact and unbroken. Comply with all health and fire regulations.

E. Environmental Requirements: Do not install markings on wet or frozen surfaces. Comply with manufacturer's instructions for temperature requirements.

1.2 PRODUCTS

A. Manufacturers
1. Line Paint for Resilient Surface: Aliphatic polyurethane paint, such as Hi-Build Aliphatic Polyurethane paint by Sherwin-Williams, or approved equivalent.
2. Line Paint for Asphaltic Concrete Pavement: Latex traffic marking paint, such as Setfast Latex Traffic Marking paint by Sherwin-Williams, or approved equivalent.
3. Line Paint for Athletic Wearing Surface (Plexipave): 100% acrylic latex paint, such as Plexicolor by California Products, or approved equivalent.

1.3 EXECUTION

A. Application
1. Line Painting
   a. Accurately measure and layout line markings.
   b. Apply paint with mechanical equipment.
   c. Paint lines as specified below under "Track Marking".
   d. Provide uniform straight edges.
   e. Apply not less than two coats in accordance with manufacturer's recommended rates.
   f. Lines shall be 2 in. (50 mm) wide unless otherwise specified.
2. Track Marking
   a. Employ a licensed land surveyor to accurately measure and lay out line markings in accordance with National Federation of State High School Athletic Association Regulations or other Standards set forth by the Owner.
   b. Events:
      1) 100 meter dash
      2) 200 meter dash
      3) 400 meter dash

4) 800 meter run
5) 1600 meter run
6) 3200 meter run
7) One mile run
8) 4 x 100 meter relay
9) 4 x 200 meter relay
10) 4 x 400 meter relay
11) 4 x 800 meter relay
12) 110 meter high hurdles
13) 300 meter intermediate hurdles
14) Girls 100 meter hurdles
15) Girls 300 meter hurdles

c. Hurdle location markers: yellow hash marks.
d. Lane lines: white (min. 42 in. (105 cm) apart).
e. Exchange zones:
1) 4 x100 m green
2) 4 x 200 m blue
3) 4 x 400 m yellow
4) 12 in. (305 mm) across entire lane width.
f. Lane numbers: Stenciled in three locations from inside to outside. Numbers shall be 24 in. (60 cm) high and white in color.
g. Finish line to be located near bleachers.
h. All starts and finishes to be white.

B. Cleaning: Upon completion of work, remove containers and debris and leave site in clean orderly condition acceptable to the Owner.

C. Protection
1. Erect temporary barriers to protect paint during drying period.
2. Protect markings from damage until completion of project.

END OF SECTION 02730b

SECTION 02730c - PLAYING FIELDS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for repair and maintenance of playing fields. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product/material indicated.
2. Shop drawings shall be submitted for approval.

1.2 PRODUCTS

A. Fills required to bring the subgrade of playing surfaces up to required elevation shall be placed in horizontal layers of not more than 8 in. (200 mm) in loose thickness. The top layer of all fills and excavated areas under the playing surfaces shall be compacted to 95 percent maximum density in accordance with ASTM D 698.

B. Sand-Clay Playing Surfaces shall consist of a stone foundation course, a clay foundation course, a wearing course and, where equipped, a drainage filter course, constructed on the prepared subgrade.
1. Stone Foundation Course: A layer at least 3 in. (75 mm) thick of 3/4- to 1-1/2 in. (19 to 38 mm) crushed stone shall be spread over the subgrade or over the drainage filter course constructed thereon and shall be given preliminary compaction by rolling, followed by a filler consisting of 1/4- to 1/2-in. (6 to 13 mm) crushed stone to fill voids in the underlying stone. The stone foundation course shall be compacted to a minimum of 95 percent maximum density in accordance with ASTM D 698.
2. Clay Foundation Course: Selected inorganic fat clay (CH) shall be evenly spread on the stone foundation course to produce a compacted layer not less than 3 in. (75 mm) thick. The clay layer shall be compacted to a minimum of 90 percent of CE 55 maximum density in accordance with ASTM D 698.
3. Wearing Course: The approved inorganic clay-silt mixture of approximately 50 percent each of clay and silt shall be screened through a 1/4-in. (6 mm) mesh screen. The wearing course shall be mixed in proportions of 1 part sand to 2 parts clay-silt by volume. The wearing course shall be compacted to at least 95 percent maximum density in accordance with ASTM D 698 and shall range from 1 to 1-1/2 in. (25 to 38 mm) in thickness.
4. Drainage Filter Course: The drainage filter course shall consist of a well-graded aggregate course encased in a geotextile material and laid in such a manner to allow water to freely drain from the playing surfaces. The geotextile material shall be a woven or non-woven filter material with a minimum permeability of 0.008 in./sec (0.02 cm/sec). The material shall be resistant to mildew, ratting, insects, rodents, and chemicals normally encountered in a subsurface drainage system.

C. Bituminous Concrete Playing Surfaces shall consist of a base course, prime coat, bituminous leveling course, tack coat, surface course, color coating and, where required, a drainage filter course, all constructed on a prepared subgrade. The stabilized-aggregate base course shall be compacted at optimum moisture to at least 95 percent maximum density in accordance with ASTM D 698. Marshall stability shall not be less than 500 pounds (190 kg) and the flow shall not be greater than 20/100 in. (12.7 mm). The bituminous mixture shall be compacted until the voids in the total mix are reduced to less than 4.0 percent by volume.

1. Thickness of Courses: Base course shall be 4 in. (400 mm) thick after compaction. Leveling course shall be 1-1/2 in. (38 mm) thick after compaction unless directed otherwise. Surface course shall be 1 in. (100 mm) thick after Compaction.
2. Color Coating and Marking Paint: After curing of the bituminous surface course, the entire playing surface shall be covered with a color coat as required.

D. Portland Cement Concrete Playing Surfaces:
1. Aggregate: The nominal aggregate size shall be 1-1/2 in. (38 mm) to No. 4 sieve size and shall conform to ASTM C 33.
2. Portland Cement: The cement shall conform to ASTM C 150, Type IA or IIA; or ASTM C 595, Type IP-A.
3. Thickness: Horizontal Portland cement concrete playing surfaces shall consist of concrete slabs 4 inches thick.

E. Maintenance of Sand-Clay Surfaces: Prior to final acceptance, the Contractor shall make one application of 3/4 lb/sq yd (0.4 kg/sq m) of calcium chloride to the sand-clay surface of the entire playing area.

F. Portable Outdoor Bleachers:
1. Bleachers shall be designed to support a uniformly distributed live load of 100 lb/sq ft (490 kg/sq m) of gross horizontal projection and a horizontal wind load of 30 lbs/sq ft (150 kg/sq ft) of gross vertical projection. All seat and foot plank members shall be designed to support not less than 120 lb/lin ft (150 kg/m).
2. Wood Seating and Walk Boards shall be preservative-treated and painted.

G. Steel Basketball Poles: Minimum diameter 3-1/2 in. (88 mm); galvanized pipe.

H. Running Track: Gravel and cinders over stone base; compaction to 95 percent of maximum density in accordance with ASTM D 698. One hundred percent by weight of the gravel and cinders shall pass the 3/4-in. (19 mm) screen, and 90 percent of the gravel and cinders shall be retained on the No. 4 screen.

1.3 EXECUTION (Not Used)

END OF SECTION 02730c

SECTION 02730d - FIXED WOOD BLEACHERS (EXTERIOR)

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of fixed wood bleachers (exterior). Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Hardware, Brackets, Fasteners, and Connectors
1. Zinc-coated or hot-dipped galvanized steel or aluminum. Nails, brads, staples, and spikes shall comply with ASTM F 547.

B. Lumber and Timber Members
1. Repair or replacement bleacher components shall be of the species and grades complying with National Design Specification for Wood Construction and its Fastenings (National Forest Products Association). Sizes shall comply with American Lumber Standards Committee PS20. Lumber materials shall bear a mark of recognized inspection agency identifying the species, grade, and compliance with the applicable standard. Wood preservatives shall be pressure-applied and shall comply with ASTM D 1760. Creosote or arsenate treatments shall not be used.
a. Seatboard Lumber shall be kiln-dried Dense No. 1 Douglas fir or Dense No. 1 Southern yellow pine boards.
b. Footboard Lumber shall be kiln-dried Dense No. 1 Douglas fir or Dense No. 1 Southern yellow pine boards.
c. Support Member and Timber shall be Dense No. 1 Douglas fir or Dense No. 1 Southern yellow pine timbers or boards.

C. Ready-Mixed Concrete
1. Comply with ASTM C 94 with compressive strength of 3,000 pounds per square inch (210.9 kgs per square cm) at 28 days and shall be protected from freezing for seven days after placement.

D. Reinforcement for Concrete
1. Comply with ASTM A 184, A 185, or A 615 as indicated.

1.3 EXECUTION

A. Repair or replace bleacher components using methods complying with the approved practices as referenced in American Institute of Timber Construction Timber Construction Manual.

END OF SECTION 02730d

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SECTION 02730e - DEMOUNTABLE BLEACHERS (EXTERIOR)

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of demountable bleachers (exterior). Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Hardware and Accessories
1. Zinc-coated or hot-dipped galvanized steel or aluminum.

B. Lumber
1. Seat-board and foot-board repair or replacement lumber shall be species and grades complying with National Forest Products Association National Design Specification for Wood Construction and Its Fastenings. Sizes shall comply with American Lumber Standards Committee PS20. Lumber materials shall bear the mark of a recognized inspection agency identifying the species, grade, and compliance with the applicable standard. Wood preservatives shall be pressure-applied and shall comply with ASTM D 1760. Creosote or arsenate treatments shall not be used.
a. Seat-board Lumber shall be kiln-dried Dense No. 1 Douglas fir or Dense No. 1 Southern yellow pine boards.
b. Foot-board Lumber shall be kiln-dried Dense No. 1 Douglas fir or Dense No. 1 Southern yellow pine boards.

C. Steel Structural Members
1. Comply with ASTM A36.

D. Aluminum Structural Members
1. Comply with ASTM B308.

1.3 EXECUTION

A. Repair or replace bleacher components using methods complying with the approved practices as referenced in American Institute of Timber Construction Timber Construction Manual.

END OF SECTION 02730e

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SECTION 02730f - PORTABLE BLEACHERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of portable bleachers. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

C. Warranty
1. Contractor shall warranty any and all materials or workmanship covered by these specifications for a period of one (1) year. Defects shall be corrected by the Contractor at once without charge to the Owner.

1.2 PRODUCTS

A. Design:
1. The design shall be in accordance with the generally accepted standards as published by The American Institute of Steel Construction and The Aluminum Association.
2. Design Loads:
   a. A uniformly distributed live load of not less than 100 psf of gross horizontal projection of the bleachers.
   b. Bleachers shall be designed to withstand, with or without live loads, the horizontal and uplift pressures due to the wind. Wind pressures shall be derived from ANSI/ASCE 7-93, Minimum Design Loads in Buildings and Other Structures.
   c. A horizontal swaying force applied to the seats, in a direction parallel to the length of the seats, of 24 lbs./ft.
   d. A horizontal swaying force applied to the seats, in a direction perpendicular to the length of the seats, of 10 lb./ft.
   e. All seat and footboard members shall be designed for live loads of not less than 120 lb. per lineal foot.
   f. Guardrails shall be capable of sustaining a vertical load of 100 plf and a horizontal thrust of 50 plf. Acting outwardly at the top of the rail.
   g. Under these loads, stresses shall now exceed those allowed in the "Specifications for Structural Steel Buildings, June 1, 1989" as adopted by the American Institute of Steel Construction.
3. Shop Connections: Welded and capable of carrying stress put upon them as per AWS standards.
4. Supporting Members (Framework):
   a. Main supporting members are to be of a welded angle frame design.
   b. Spaced at 6'-0" centers (maximum).
   c. Constructed of a minimum 2 x 2 x 3/16" angle.
   d. Every frame shall be laterally supported with cross-bracing to the adjacent frame.
5. Dimensions:
   a. Length of Unit: 15” **OR** 21” **OR**.27,” **as directed**.
   b. Number of rows: 2 **OR** 3 **OR** 4 **OR** 5 **OR** 10, **as directed**.
   c. Seat Height: 17 inches.
   d. Typical Stands: 8" Rise with a 24" row depth.
6. Deck Arrangements:

a. Seats: Nominal 2 x 10, anodized aluminum.
b. Footboards: Nominal 2 x 10 mill finish aluminum. (Optional 2 @ 2 x 10 mill finish aluminum on 2, 3, 4, 5 row units; Standard on 10 row units).
c. Riser: Optional on 2,3,4 & 5 row units, Standard on 10 row units
d. Vertical aisles with handrails as required by code.

7. Guardrails:
   a. Furnished on sides of any bleacher that is 5 rows high or higher per code. (Optional on 2, 3, & 4 row units).
   b. All pipes shall be 1 5/8" O.D. anodized aluminum pipe with end plugs and elbows at corners. Secured to angle rail posts with galvanized fasteners.
   c. Rails not less than 42" vertically above the center of the seatboard surface shall be provided at the back and sides of the bleacher.
   d. Included on all sides of the bleacher shall be 2" x 9 gauge galvanized chain link fencing fastened in place with aluminum ties and galvanized tension bars and aluminum rail clamps.
8. Mudsills: 2 x 4 pressure treated wood shall be provided on all frames.
9. Transporting Options:
   a. Galvanized steel angle tow bar
   b. Pneumatic wheels with axles
10. Tip-N-Roll Package: Optional on 2, 3, & 4 row units up to 21'-0" long.
    a. Non-marking rubber grommets shall be provided on all frames.
    b. Caster wheels shall be 4" diameter, swivel mounted, non-marking soft rubber.

B. Materials
1. Steel: ASTM A572 (Hot-Dipped Galvanized), ASTM A586 (Weathering Steel).
2. Aluminum: Extruded alloy 6063-T6.
3. Accessories:
   a. High Strength Bolts and Nuts - ASTM A325 steel.
   b. Ordinary Bolts and Nuts - ASTM A307.
   c. Hold-Down Clip Assemblies - Aluminum alloy 6063-T6.
   d. End Caps - Channel aluminum alloy 6063-T6.

C. Finishes
1. Steel: Galvanized Steel and Weathering Steel.
2. Aluminum:
   a. Anodized: Seat planks, backrest, stanchions and also risers if requested clear anodized 204R1, AA-M10C22A31, Class II.
   b. Mill Finish: Footboards and riser boards (6063-T6).
   c. Paint: Electrostatically applied, baked-on siliconized acrylic or siliconized polyester enamel.

1.3 EXECUTION

A. Installation
1. Install bleacher unit in accordance with manufacturer's installation procedures.

END OF SECTION 02730f

SECTION 02730g - GRANDSTANDS AND BLEACHERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of grandstands and bleachers. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Shop Drawings submitted shall be Designed and Detailed under the direct supervision of a licensed, in house, Professional Engineer. The Professional Engineer shall be present during the time the design and detailing is completed unless all details are included on the approval drawings bearing his/her seal.

C. Warranty
1. Contractor shall warranty any and all materials or workmanship covered by these specifications for a period of one (1) year. Defects shall be corrected by the Contractor at once without charge to the Owner.

1.2 PRODUCTS

A. Design:
1. The design shall be in accordance with the generally accepted standards as published by The American Institute of Steel Construction and The Aluminum Association.
2. Design Loads:
   a. A uniformly distributed live load of not less than 100 psf of gross horizontal projection of the grandstand.
   b. Grandstands and bleachers shall be designed to withstand, with or without live loads, the horizontal and uplift pressures due to the wind. Wind pressures shall be derived from ANSI/ASCE 7-93, Minimum Design Loads in Buildings and Other Structures.
   c. A horizontal swaying force applied to the seats, in a direction parallel to the length of the seats, of 24 lbs./ft.
   d. A horizontal swaying force applied to the seats, in a direction perpendicular to the length of the seats, of 10 lb./ft.
   e. All seat and footboard members shall be designed for live loads of not less than 120 lb. per lineal foot.
   f. Guardrails shall be capable of sustaining a vertical load of 100 plf and a horizontal thrust of 50 plf. Acting outwardly at the top of the rail.
   g. Under these loads, stresses shall now exceed those allowed in the "Specifications for Structural Steel Buildings, June 1, 1989" as adopted by the American Institute of Steel Construction.
3. Shop Connections: Welded and capable of carrying stress put upon them as per AWS standards.
4. Steel Members for Grandstands:
   a. Stringers: Wide flange beams spaced at 6'-0" on center.
   b. Columns: Wide flange beams spaced at 18'-0" on center longitudinally and transversely they will be spaced according to the size of the stand with a maximum of 24'-0" on center.
   c. Cross Beams: Horizontal cross beams shall be wide flange beams and run "continuously" for the length of the stand.

d. Cross-Bracing: Front to back bracing shall be structural steel angle, bolted at ends and centers. Rod bracing shall be used for side to side bracing. On columns requiring 2 or more sets of cross-bracing, the connecting strut shall run continuously for the entire length of the stand.

5. Supporting Members (Framework) for Bleachers:
   a. Main supporting members are to be of a welded angle frame design.
   b. Spaced at 6'-0" centers (maximum).
   c. Constructed of a minimum 2 x 2 x 3/16" angle.
   d. Every frame shall be laterally supported with cross-bracing to the adjacent frame.
6. Dimensions:
   a. Length of Unit: As required to meet Project requirements.
   b. Number of rows: As required to meet Project requirements.
   c. Net seating capacity: As required to meet Project requirements.
   d. Bleacher seats: As required to meet Project requirements.
   e. Wheelchair spaces: As required to meet Project requirements, A.D.A. or Local Codes
   f. Front Walkways: 66 inches clear width
   g. Seat Height:
      1) Grandstands: 17 to 18 inches.
      2) Bleachers: 17 inches.
   h. Walkway Elevation:
      1) Grandstands: 42 to 49 inches.
      2) Bleachers: 30 to 42 inches.
   i. Aisle Width: 48" minimum clear width, unless directed otherwise.
7. Typical Stands:
   a. Grandstands:
      1) 8" Rise or 10" Rise with a 24" **OR** 28", **as directed**, row spacing.
      2) 12" Rise with 30" row spacing (Min. required for backrest).
   b. Bleachers: Standard 8: Rise with a 24" row depth
8. Deck Arrangements:
   a. Walkways: Six 2 x 12 planks.
   b. Seats: Standard 2 x 10, unless directed otherwise.
   c. Aisle Steps: Standard 2 x 12 plank **OR** 2 x 12 plank with 1" contrasting nosing to delineate the leading edge, **as directed**.
   d. Footboard and Riser plank arrangement: Semi-closed (SC), Fully Closed Deck Plank Arrangement (CD), and Interlocked Deck (IL).
9. Guardrails:
   a. Furnished on sides of the bleacher including stairs, ramps, portals and landings.
   b. All pipes shall be 1 5/8" O.D. anodized aluminum pipe with end plugs and elbows at corners. Secured to angle rail posts with galvanized fasteners.
   c. Rails not less than 42" vertically above the center of the seatboard surface shall be provided at the back and sides of the bleacher.
   d. Rails are not to be less than 42" above the elevated front footrests.
   e. Included on all sides of the bleacher shall be 2" x 9 gauge galvanized chain link fencing fastened in place with aluminum ties and galvanized tension bars and aluminum rail clamps.
10. Stairs: Per applicable codes and/or drawings.
    a. 2 x 12 aluminum plank with a maximum rise of 7".
    b. Stairs shall have a multi-pipe rail system that conforms to the 4" ball rule. Top rail shall be 42" above the leading edge of the treads.
11. Mudsills: 2 x 4 pressure treated wood shall be provided on all frames.
12. Handicap Provisions:
    a. Wheelchair pockets inset into the front rows of seating shall be provided to comply with local codes and ADA for wheelchair accessibility.
    b. Handicapped seating will be enclosed on all three sides with no exposed vertical rise allowed.

c. Front platform shall be accessible from a ramp with a maximum gradient of 1:12.
d. Ramp width shall be minimum 5'-0" for two-way traffic.
e. Ramp shall have a 3-pipe rail system consisting of 1 5/8" O.D. anodized aluminum pipe with 2 x 9 gauge galvanized fence. Top rail will be 42" above the ramp surface.
f. A handrail 36" above the ramp surface shall be provided.

13. Pressbox
a. Grandstands: Pressbox Support Structure will be independently supported but connected to the rear of the grandstand.
b. Bleachers: Pressbox Support Structure will be independently supported on its own poured concrete piers and connected to bleacher by means of stairs off bleacher aisle.
c. Support Structure to be 8'-0" wide and in increments of 6'-0" in length.
d. Pressbox specifications as required to meet Project requirements.

B. Materials
1. Steel: ASTM A572 (Hot-Dipped Galvanized), ASTM A586 (Weathering Steel).
2. Aluminum: Extruded alloy 6063-T6.
3. Ready-Mixed Concrete shall comply with ASTM C94 with compressive strength of 3,000 pounds per square inch (210.9 kgs per square cm) at 28 days and shall be protected from freezing for seven days after placement.
4. Reinforcement for Concrete shall comply with ASTM A184, A185, or A615 as indicated.
5. Accessories:
a. High Strength Bolts and Nuts - ASTM A325 steel.
b. Ordinary Bolts and Nuts - ASTM A307.
c. Hold-Down Clip Assemblies - Aluminum alloy 6063-T6.
d. End Caps - Channel aluminum alloy 6063-T6.

C. Finishes
1. Steel: Galvanized Steel and Weathering Steel.
2. Aluminum:
a. Anodized: Seat planks, backrest, stanchions and also risers if requested clear anodized 204R1, AA-M10C22A31, Class II.
b. Mill Finish: Footboards and riser boards (6063-T6).
c. Paint: Electrostatically applied, baked-on siliconized acrylic or siliconized polyester enamel.

1.3 EXECUTION

A. Installation
1. All work will be performed by factory-trained technicians experienced in bleacher seating installation.
2. Complete installation as per approved shop drawings and manufacturers instructions.
3. Bleachers shall be sufficiently anchored to the ground to withstand the wind loads for their particular areas.
4. After installation, unit shall be inspected for proper alignment and function.

B. Foundations/Piers
1. Piers for the pressbox shall be designed to provide sufficient bearing area to support the total live and dead loads of the pressbox without exceeding the allowable soil bearing pressure.
2. Footings for the grandstand shall be designed to provide sufficient bearing area to support the total live and dead loads of the grandstand without exceeding the allowable soil bearing pressure.
3. Design and depth of footings shall be determined from the Owner supplied geotechnical report indicating local soil conditions.
4. Hot-Dipped galvanized anchor bolts shall be used, secured in the concrete footings.
5. Concrete shall attain a working strength of 3,000 psi.

END OF SECTION 02730g

Task	Specification	Specification Description
02730	01352	No Specification Required

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SECTION 02731 - SYNTHETIC RUNNING TRACK SURFACE

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of synthetic running track surface. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals: Submit the following:
1. Sample of the actual sport surface in the standard color(s) selected.
2. Technical data sheets of the product.
3. Adhesive product data sheets and manufacturer's certificate indicating approval for the proposed application.
4. Line paint data sheets and the manufacturer's certificate indicating approval for the proposed application.
5. Submit 3 copies of the maintenance instruction.

C. Delivery and Storage: Deliver and store the material in the original packaging with the labels intact in a controlled environment of a minimum temperature of 55°F (13°C) and under 50% relative humidity. Protect work until accepted by owner.

D. Warranty: Provide manufacturer's standard warranty.

1.2 PRODUCTS

A. Acrylic Color Coating System
1. Manufacturer: Copeland Coating Company or approved equivalent.
2. System shall consist of stone base, asphalt binder/top, cushion made of granulated rubber particles suspended in acrylic emulsions **(as directed)**, acrylic filler coat(s), acrylic finish coat, and acrylic line paint.
3. Design and construction shall be by materials manufacturer.

B. Polyurethane
1. Manufacturer: Conica Sports Surfaces or approved equivalent.
2. Impermeable, full polyurethane, 3 layer athletic track system. In-situ applied with a granular colored EPDM finish. IAAF certified as required.

C. Rubber Granule Surface
1. Manufacturer: Atlas Track & Tennis or approved equivalent.
2. Rubber granules applied “dry” to the surface and adhered by spray application of a resin binder. This process is repeated until the specified thickness is achieved, allowing sufficient curing time between each application. The process is then finished with a structural spray coating of highly pigmented polyurethane coating.

D. Prefabricated Rubber Surface
1. Manufacturer: Mondo USA, or approved equivalent.
2. Prefabricated rubber sport surface to be 6 mm (1/4”) **OR** 8mm (5/16") **OR** 10mm (3/8") **OR** 12mm (1/2") **OR** 14mm (9/16"), **as directed**, thickness, with a non-slip, non-reflecting, highly spike resistant top surface. Provided in manufacturer’s standard colors.
3. Prefabricated rubber surface to be sheet goods, double durometer or homogenous vulcanized and calandered, with a particular closed cell structure, based on special isoprenic rubbers, mineral fillers, vulcanizing and stabilizing agents and color pigments, highly resistant to UV rays

and atmospherical agents, with system of differentiated elasticity between top surface and base, supplied in rolls of suitable size and thickness. Surface shall have a special texture including adhesive and striping

4. Prefabricated rubber sport surface to be manufactured in two layers, which are vulcanized together. The shore hardness of the lower layer to be less than the upper layer, shore hardness of the respected layers to be recommended by the manufacturer and within the limits hereinafter specified. Field laminated triple durometer are unacceptable.
5. Adhesive: Rubber sport surface adhesive to be two part polyurethane adhesive suitable for adherence of a sheet good to asphalt, concrete or urethane substrate. Adhesive to be supplied or approved/recommended by sport surface manufacturer.

E. Patching Compound: Patching compound to be supplied or approved/recommended by sport surface manufacturer.

F. Line marking: Line marking paint to be supplied by sport surface manufacturer.

1.3 EXECUTION

A. Installation
1. Install sport flooring in accordance with manufacturer's printed instructions.
2. Prefabricated sport flooring shall be unrolled and allowed to relax.
3. Cut and adjust prefabricated sport flooring prior to adhesion.
4. Mix adhesive in accordance with manufacturer's instructions.
5. Hold all seams in place with suitable weights for a minimum of 12 hours.
6. Lines to be painted as per manufacturer's recommendations.
7. Surface to be protected before, during and after installation until project's acceptance by the Owner or his agent.

END OF SECTION 02731

SECTION 02731a - RECREATIONAL FACILITIES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of recreational facilities. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Shop Drawings and/or Catalogue Cuts shall be submitted for approval prior to any installation.

1.2 PRODUCTS

A. Materials shall be resistant to corrosion and degradation by ultraviolet rays. Hardware and fittings shall be at least as corrosion-resistant as the materials fastened.
1. Steel Plates, Pipe, Tubing, Sheets, Wire Ropes, Chains, and Miscellaneous Shapes shall be stainless steel or galvanized steel, even if painted or coated with vinyl or other protective finish. All open pipe and tube ends shall have rain caps.
2. Wood shall be all-heart cedar, cypress, or redwood or shall be treated with a non-toxic preservative. Wood shall not be used where it will be in direct contact with the ground, unless approved by the Owner.
3. Fiberglass shall be smooth fiberglass-reinforced polyester with gelcoat coating and shall meet the following minimum physical properties: 22,000 psi (1,550 kg/sq cm) flexural strength, 15,000 psi (1,055 kg/sq cm) tensile strength, and 20,000 psi (1,410 kg sq cm) compressive strength.
4. Aluminum shall be anodized.
5. Foundations shall be 3,200 psi (225 kg/sq cm) compressive strength concrete, enforced as required. Provide embedded anchorage items as required,

B. Playground Equipment, including see-saws, slides, swings, whirlers, and monkey bars, shall be prefabricated and designed to withstand the anticipated structural loads.
1. Exposed Surfaces shall be smooth (except where required to be nonslip) seamless, and nonsplintering.
2. Steps, Platforms, and Other Flat Surfaces Subject to Foot Traffic shall be non-slip, but not abrasive and shall be formed to exclude or drain away water.
3. Fastening shall be flush, concealed, or otherwise formed or located to prevent injury to children playing on the equipment.
4. Slides shall have stainless steel sliding surfaces.

C. Bike Racks shall be mounted, and sections (if rack is sectional) shall be attached with tamper-proof fasteners.

D. Fiberglass Shelters shall be reinforced with steel, aluminum, or wood framework as required. Shelter roof shall be sloped to drain. Fiberglass edges shall be returned so that they are not exposed, Shelters shall be prefabricated and designed to withstand the anticipated live, dead, and wind loads.

1.3 EXECUTION

A. Recreational facilities shall be installed plumb, aligned, and securely anchored to the ground. Adjust equipment with moving parts until operation is smooth and easy.

END OF SECTION 02731a

Task	Specification	Specification Description
02731	02730b	Track, Court, And Playground Markings
02735	01352	No Specification Required
02735	02720	Miscellaneous Site and Street Furnishings
02764	02720	Miscellaneous Site and Street Furnishings
02765	01352	No Specification Required
02765	02720	Miscellaneous Site and Street Furnishings

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SECTION 02805 - TREE RELOCATION

1.1 GENERAL

A. Description Of Work
1. This specification covers labor, materials, necessary equipment and services to complete the tree relocation work. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.
2. Before tree excavation, pruning, removal, or relocation of existing trees, contractor shall notify:
   a. the Owner of schedule of operation.
   b. Appropriate utility companies and the Owner for flagging and coordination of service disconnection as necessary to complete work.
   c. Coordinate work with other trades.

B. Definitions
1. Toxic Substances: Do not deliver any toxic substance or item as defined by the state, to the site without furnishing to the Owner a Material Safety Data Sheet (MSDS). Provide current MSDS information with each initial shipment.
   a. The MSDS shall contain the following information:
      1) The chemical name and the common name of the toxic substance.
      2) The hazards or other risks in the use of the toxic substance, including:
         a) The potential for fire, explosion, corrosivity and reactivity.
         b) The known acute and chronic health effects of risks from exposure, including the medical conditions which are generally recognized as being aggravated by exposure to the toxic substance.
         c) The primary routes of entry and symptoms of overexposure.
      3) The proper precautions, handling practices, necessary personal protective equipment, any other safety precautions in the use of or exposure to the toxic substance including appropriate emergency treatment in case of overexposure.
      4) The emergency procedure for spills, fire disposal, and first aid.
      5) A description in lay terms of the known specific potential health risks posed by the toxic substance intended to alert any person reading this information.
      6) The year and month, if available, that the information was compiled and the name, address, and emergency telephone number of the manufacturer responsible for preparing the information.

C. Description
1. Protect existing trees to remain during construction phases. Provide tree protection barriers for those existing trees adjacent to tree transplantation operations. Any trees scarred or destroyed, designated to remain, will be replaced at the Contractor's expense, with similar species, size, and quality.
2. Remove other vegetation as necessary and as required to meet project requirements to accommodate new plantings. Prepare areas to be planted according to Division 02 Section "Exterior Plants".
3. Resulting tree pits of relocated material shall be backfilled with clean fill and brought back flush with surrounding grade, unless the pits are to be immediately replanted. Stabilize grade if required. Correct problems caused by erosion, wind, etc., in the reclaimed area. Pits to be quickly replanted shall be surrounded by safety barricades to prevent accidental falls into pits.
   a. In areas where new plant material will replace relocated plant material, appropriate planting soil mix shall be used as backfill.

D. Submittals

1. Submit a list of equipment, procedure, and labor force anticipated for use for tree relocation for approval by the Owner.
2. Submit a schedule by day indicating units to be dug and relocated. Note materials requiring root pruning, and that the relocation schedule is to begin at the end of the specified root pruning period.
3. Obtain permits required by authority having jurisdiction.
4. Submit written certification that trees indicated to remain have been protected during the course of construction according to recognized standards of the industry. Certify that where damage did occur:
   a. Trees were promptly and properly treated.
   b. Indicate which damaged trees (if any) are incapable of retaining full growth potential and are recommended to be replaced.
5. Submit for approval, proposed methods, and schedule for effecting tree and plant protection.

E. Quality Assurance
1. Unless otherwise specified, tree transplanting shall comply with NAA Ref.1.
2. Comply with NAA standards for pruning and remove branches from trees to remain to clear new construction.
3. Recommend procedures to compensate for loss of roots (if any) and perform initial pruning of branches and stimulation of root growth where removed to accommodate new construction.
4. Perform tree repair work for damage incurred by new construction.
5. Provide routine progress evaluation reports on relocated trees until the end of the maintenance period.
6. Evaluate existing trees and verify trees are free of disease and ready to survive relocation from the site to their new location on-site or off-site.

F. Delivery, Storage, and Handling
1. Properly handle trees and palms during moving so trunks will not be scarred or damaged and to avoid broken limbs. Broken limbs not causing the tree to be rejected shall be repaired as follows:
   a. Properly prune dead, dying, or damaged branches with clean, sharp equipment.
   b. Remove injured bark and wood of a tree would with a clean, sharp knife to a point where healthy bark and wood make contact at their margins.
   c. Inspect and treat wound for insect and disease.
   d. Seal wounds with bituminous base wound paint for all oak limbs greater than 3 inch diameter.
2. Transport trees on vehicles of adequate size to prevent overcrowding, broken limbs, foliage damage, or root ball damage.
3. Keep root balls moist during relocation.
4. Protect tree crowns with shade cloth to prevent desiccation and wind burn. Crowns shall be periodically sprayed with water to help ensure against desiccation.
5. Handle plant material only in ways and means accepted by the landscaping industry and accepted by the Owner.
6. Plant material shall be planted the same day it is dug. Coordinate preparation of planting pits or beds to ensure this schedule.

G. Warranty
1. Relocated plant material does not fall under the standard 12 month guarantee.
2. For relocated trees or palms that die, replace their canopy area with new trees as specified.
   a. Canopy spread for all palms and trees shall be listed on proposal when submitted for relocation work.
   b. Replacements (mitigation plantings) shall be provided at no additional cost to the Owner.
   c. Submit the attached form to the Owner for review and approval.
   d. Proposed replacement canopy tree species shall be the Owner accepted trees and palms.
3. Repair damage to other plants and lawn or construction work within the relocation area during tree transplantation at no cost to the Owner. This includes, but is not limited to, damage to curbs,

walks, roads, fences, site furnishings, etc. Replacing and replanting of damaged trees or shrubs shall be according to Division 02 Section "Exterior Plants" Replacing and replanting of damaged turf shall be according to Division 02 Section "Lawns And Grasses".

H. Maintenance
1. Maintain relocated plant materials immediately after each item is planted and continued until the 90 day watering period is completed, upon which time the Owner will take over maintenance of materials following procedures and recommendations of contractor and specifications.
2. During the maintenance period, maintain relocated plant materials.

1.2 PRODUCT

A. Materials
1. Bone meal shall be readily available steamed bone meal, useable as a natural organic nitrogen fertilizer.
2. Peat moss, topsoil, planting soil, mulch, staking, and guying shall be as specified in Division 02 Section "Exterior Plants".

1.3 EXECUTION

A. Transplantation
1. Transplanting shall consist of on-site or off-site transplanting of existing trees or palms from proposed construction areas to permanent positions.
2. Digging, Wrapping, and Handling: Plants shall be dug and prepared for moving in a manner that will not cause damage to branches, shape, root system, and development.
3. Balled and Burlapped Plants:
   a. Balls shall be firmly wrapped with burlap or accepted cloth substitute.
   b. No balled plant will be acceptable if the ball is cracked and broken or if the stem or trunk is loose in the ball, either before or during transplanting.
   c. Balled plants shall be lifted and handled from the bottom of the ball.
   d. Protect ball and deliver to the site, plant immediately, and water thoroughly.
   e. Ball sizes shall be as recommended in ANSI Z 60.1.

B. Planting
1. Relocated Material
   a. Relocated trees/palms shall be planted according to procedures described for new material, Division 02 Section "Exterior Plants". Verify final grades have been established before planting operations. Ensure proposed planting pits drain by test-filling with water before transplantation.
   b. Continue watering and caring for relocated material as specified.
   c. Mulch tree pit areas to reduce weeds, discourage foot traffic, conserve moisture, and minimize temperature fluctuations.
   d. Brace trunk and leave in place for approximately one year until trees are wind firm.
   e. Wrap trunks and structural branches of thin-barked trees to protect against sun scald and dehydration. Retain through at least one growing season, and through cold season.
   f. Feed with a diluted solution of N-P-K in solution form with a soil needle, providing water, air, and nutrients.
   g. Where foliage is retarded, spray with one of the soluble types of foliage feeders.
   h. At time of planting, fill air pockets and keep roots, especially feeder roots, moist, live, and healthy. Use soil needles for watering new transplants. Direct fine spray at foliage to help harden-off new leaves.

C. Staking And Guying: Stake and guy designated material according to procedures described for new plant materials, Division 02 Section "Exterior Plants".

D. Watering
1. Following transplantation, water trees daily for the first two weeks, every other day for the next three weeks, and every third day for the balance of the three month watering/maintenance period. Such watering shall thoroughly saturate the root ball to its full depth.
2. Following relocation, trees designated for transplanting shall be watered as specified in this section. Such watering shall thoroughly saturate the root ball to its full depth.
3. Provide manual watering of relocated plant materials for 90 days. If used, after watering period, Contractor shall be responsible for the complete removal of all temporary watering systems.

E. Tagging: Trees within the designated areas for relocation shall be clearly marked by means of yellow plastic surveyor's ribbons and coordinated with, inspected, and accepted by the Owner before root pruning and digging.

F. Root Preparation
1. Trees to be relocated shall be root pruned at least 45 days before digging with clean, sharp equipment.
   a. Maintain root pruned materials by watering, weeding, mowing, spraying, fertilizing, and other horticulture practices.
   b. After root pruning, backfill with good rooting medium, fertilize with organic fertilizer to promote root growth.
   c. Mulch to reduce weeds, discourage foot traffic, conserve moisture, and minimize temperature fluctuation.
2. Root Ball Size Chart: Root ball sizes shall be according to minimum standards set forth in Grades and Standards for Nursery Plants Part II, Palms and Trees, local state Department of Agriculture.
   a. Trees-Minimum Ball Sizes:

Caliper	Minimum Ball Diameter
3-1/2" to 4"	28"
4" to 4-1/2"	30"
4-1/2" to 5"	32"
5" to 5-1/2"	34"

Larger sizes increase proportionally.

   b. Minimum Ball Depth:

Ball Diameter	Depth
Less than 20"	Not less than 75 percent of diameter.
20" to 30"	Not less than 65 percent of diameter.
30" to 48"	Not less than 60 percent of diameter.

G. Crown Preparation
1. Shade and Flowering Trees
   a. Shade Trees: Selectively prune and thin crown to remove approximately one third of the branches. Preserve the basic shape and form of the tree, eliminate cross-branching and dead or diseased branches.
   b. Hand strip selected species of all leaves following pruning and before moving.
2. Palms: Follow standard procedure for transplantation of palms.

H. Hand Digging: Burlapping is required. Trees that are burlapped for relocation shall comply and be handled in same manner as new plant material specified in Section “Exterior Plants.”

I. Special Conditions
   1. Multi-Trunk Trees: Relocate multi-trunk tree as one unit. Measure unit by taking the aggregate total of all DBH measurements.
   2. Multi-Trunk Palms: Relocate multi-trunk palms as one unit. Unit shall be measured as follows:
      a. 50 percent of the value in dollars of the largest trunk in the grouping times the number of trunks in the clump.
   3. On-site relocation
      a. On-site relocation shall include root pruning, canopy pruning, on-site transportation, hauling and dumping of debris, and 90-day maintenance.
      b. If the tree or palm should die within the 90-day maintenance period, remove the tree, replace the material, and restore the site at no additional cost to the Owner.

J. Cleaning
   1. Cleaning up the Site
      a. Upon completion of the work, thoroughly clean up the project site.
      b. In addition to removing equipment, unused materials, deleterious material, and surplus excavated material, the Contractor shall fine grade all disturbed areas and the areas adjacent to the transplanted material to provide a neat and uniform site.
      c. All damaged or altered existing structures, as a result of the landscape work, shall be corrected.

END OF SECTION 02805

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SECTION 02810 - SITE CLEARING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for site clearing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Protecting existing vegetation to remain.
b. Removing existing vegetation.
c. Clearing and grubbing.
d. Stripping and stockpiling topsoil.
e. Removing above- and below-grade site improvements.
f. Disconnecting, capping or sealing, and removing site utilities **OR** abandoning site utilities in place, **as directed**.
g. Temporary erosion- and sedimentation-control measures.

C. Definitions
1. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
OR
Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.
2. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow.
OR
Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches (50 mm) in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.
3. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.
OR
Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and indicated on Drawings **OR** defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated, **as directed**.
4. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

D. Material Ownership
1. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

E. Submittals
1. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.
a. Use sufficiently detailed photographs or videotape.

b. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

2. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

F. Quality Assurance
1. Preinstallation Conference: Conduct conference at Project site.

G. Project Conditions
1. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
   a. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
   b. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
2. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.
   a. Do not proceed with work on adjoining property until directed by the Owner.
3. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
4. Utility Locator Service: Notify utility locator service **OR** Miss Utility **OR** Call Before You Dig **OR** Dig Safe System **OR** One Call, **as directed**, for area where Project is located before site clearing.
5. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.
6. The following practices are prohibited within protection zones:
   a. Storage of construction materials, debris, or excavated material.
   b. Parking vehicles or equipment.
   c. Foot traffic.
   d. Erection of sheds or structures.
   e. Impoundment of water.
   f. Excavation or other digging unless otherwise indicated.
   g. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
7. Do not direct vehicle or equipment exhaust towards protection zones.
8. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.
9. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

1.2 PRODUCTS

A. Materials
1. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Division 02 Section "Earthwork".
   a. If soil backfill is required in below-grade areas after site clearing, obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.
2. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with MPI #79, Alkyd Anticorrosive Metal Primer **OR** SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating, **as directed**.
   a. Use coating with a VOC content of 420 g/L (3.5 lb/gal.) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1.3 EXECUTION

A. Preparation

1. Protect and maintain benchmarks and survey control points from disturbance during construction.
2. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated. Flag **OR** Wrap a 1-inch (25-mm) blue vinyl tie tape flag around, **as directed**, each tree trunk at 54 inches (1372 mm) above the ground.
3. Protect existing site improvements to remain from damage during construction.
   a. Restore damaged improvements to their original condition, as acceptable to Owner.

B. Temporary Erosion And Sedimentation Control
1. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.
2. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
3. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
4. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

C. Tree And Plant Protection
1. General: Protect trees and plants remaining on-site according to requirements in Division 02 Section "Tree Protection And Trimming".
2. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by the Owner.

D. Existing Utilities
1. Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.
   OR
   Verify that utilities have been disconnected and capped before proceeding with site clearing.
2. Locate, identify, disconnect, and seal or cap utilities indicated to be removed.
   a. Arrange with utility companies to shut off indicated utilities.
      OR
      Owner will arrange to shut off indicated utilities when requested by Contractor.
3. Locate, identify, and disconnect utilities indicated to be abandoned in place.
4. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
   a. Notify the Owner not less than two days in advance of proposed utility interruptions.
   b. Do not proceed with utility interruptions without the Owner 's written permission.
5. Excavate for and remove underground utilities indicated to be removed.
   OR
   Removal of underground utilities is included in Division 02.

E. Clearing And Grubbing
1. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
   a. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
   b. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches (450 mm) below exposed subgrade.
   c. Use only hand methods for grubbing within protection zones.
   d. Chip removed tree branches and stockpile in areas approved by the Owner **OR** dispose of off-site, **as directed**.
2. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

a. Place fill material in horizontal layers not exceeding a loose depth of 8 inches (200 mm), and compact each layer to a density equal to adjacent original ground.

F. Topsoil Stripping
1. Remove sod and grass before stripping topsoil.
2. Strip topsoil to depth indicated on Drawings **OR** to depth of 6 inches (150 mm), **as directed**, in a manner to prevent intermingling with underlying subsoil or other waste materials.
   a. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects more than 2 inches (50 mm) in diameter; trash, debris, weeds, roots, and other waste materials.
3. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.
   a. Limit height of topsoil stockpiles to 72 inches (1800 mm).
   b. Do not stockpile topsoil within protection zones.
   c. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
   d. Stockpile surplus topsoil to allow for respreading deeper topsoil.

G. Site Improvements
1. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.
2. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
   a. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
   b. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

H. Disposal Of Surplus And Waste Materials
1. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
2. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 02810

SECTION 02810a - CONCRETE REVETMENT

1.1 GENERAL

A. Description Of Work
1. This specification covers installation of a concrete revetment. Work includes but is not limited to furnishing all labor, materials, equipment and supervision necessary to construct concrete revetment as follows or as directed by the Owner.

1.2 PRODUCTS

A. The Concrete Revetment shall be an articulating cellular concrete block system, as manufactured by American Excelsior Company, or approved equal, (800-713-8245), is a block structure installed over a geotextile fabric as described herein. The cellular blocks are made of Portland Cement Concrete cast into “lock” blocks and “key” blocks to provide a three directional interlock to resist lateral movement. The articulating cellular concrete block system is a “flexible” concrete revetment which allows the blocks to traverse changes in terrain without disruption of the placement pattern and interlock feature.
1. The minimum concrete strength shall be 3,000 psi. Nominal block thickness shall be either 4 inches, 6 inches or 8 inches, as required to meet project requirements. Block weights, per pair of “key” and “lock” blocks, shall be approximately 50, 70 and 90 pounds for #4010-4 inch, #4015-6 inch and #4020-8 inch thick blocks, respectively. Each pair of “key” and “lock” blocks shall cover approximately 1.54 square feet, including uncovered openings between the blocks. The system shall provide approximately 80 percent coverage of the area with blocks, leaving approximately 20 percent, but not less than 16 percent, uncovered area at the ground surface.

B. Filter fabric shall be Tri-Lock Fabric #792 as supplied by American Excelsior Company, or approved equal, (800) 713-8245; roll values:

Property	Specification	Test Method
Weight	7.4 oz/sy	ASTM D3776
Thickness	25 mils	ASTM D1777
Permeability	0.5 cm/sec	ASTM D4491
Abrasion Resistance	Warp: 58 percent	ASTM N3884
(% strength retained)	Fill: 81 percent	
Tensile Grab Strength	350 lbs. x 395 lbs	ASTM D4632
Grab Elongation	24% x 24%	ASTM D4632
Burst Strength	780 psi	ASTM D3786
Trapezoid Tear	120 lbs x 110 lbs.	ASTM D4533
Puncture Strength	165 lbs.	ASTM D4833
Apparent Opening Size	40-70	ASTM D-4751
UV Resistance @ 500 hours	90 percent	ASTM D-4355

C. Tri-Lock block size selection shall be determined from documented hydraulic characteristics, derived from test procedures outlined in: “Hydraulic Stability of Articulating Concrete block Revetment Systems During Overtopping Flow.” Report No. FHWA-RD-89-199, and “Minimizing Embankment Damage During Overtopping Flow.” Report No. FHWA-RD-88-181.

D. Backfill: Topsoil and seeding shall be as per Division 02 Section(s) "Earthwork" AND "Lawns And Grasses".

1.3 EXECUTION

A. Excavation shall be made so that the placement of the geotextile and concrete blocks shall be in conformity with the lines and grades shown on the plans or as required to meet project requirements. The area for placement shall be free from obstructions such as tree roots, projecting stones or other foreign matter and graded smooth. Voids or soft areas shall be filled with suitable materials and compacted to non-movement. Place the geotextile on the prepared subgrade. Lock the edges into a key trench as required to meet project requirements. The concrete blocks shall be assembled overlaying a geotextile in a manner that allows maximum flexibility but discourages vertical movement of any single component. Fill open areas of the blocks with concrete at the interface to concrete structure. After placement, the open areas of the block system shall be backfilled with topsoil to the top of the blocks. The backfilling shall be completed within 14 days of placement of the geotextile.

END OF SECTION 02810a

SECTION 02810b - LAWNS AND GRASSES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for lawns and grasses. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Seeding.
   b. Hydroseeding.
   c. Sodding.
   d. Plugging.
   e. Sprigging.
   f. Meadow grasses and wildflowers.
   g. Turf renovation.
   h. Erosion-control material(s).
   i. Grass paving.

C. Definitions
1. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.
2. Finish Grade: Elevation of finished surface of planting soil.
3. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
4. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
5. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
6. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
7. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.
8. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
9. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

D. Submittals
1. Product Data: For each type of product indicated.
2. Certification of Grass Seed.
   a. Certification of each seed mixture for turfgrass sod **OR** plugs, **as directed**.
3. Product Certificates: For soil amendments and fertilizers, from manufacturer.
4. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of turf and meadows during a calendar year. Submit before expiration of required initial maintenance periods.

E. Quality Assurance
1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
   a. Pesticide Applicator: State licensed, commercial.
2. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory.
   a. The soil-testing laboratory shall oversee soil sampling.
   b. Report suitability of tested soil for turf growth.
      1) State recommendations for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
      2) Report presence of problem salts, minerals, or heavy metals; if present, provide additional recommendations for corrective action.

F. Delivery, Storage, And Handling
1. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable.
2. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.
3. Bulk Materials:
   a. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
   b. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
   c. Accompany each delivery of bulk fertilizers, lime, and soil amendments with appropriate certificates.

G. Maintenance Service
1. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 1.3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established but for not less than the following periods:
   a. Seeded Turf: 60 days from date of planting completion **OR** Substantial Completion, **as directed**.
      1) When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.
   b. Sodded Turf: 30 days from date of planting completion **OR** Substantial Completion, **as directed**.
   c. Plugged Turf: 30 days from date of planting completion **OR** Substantial Completion, **as directed**.
   d. Sprigged Turf: 30 days from date of planting completion **OR** Substantial Completion, **as directed**.
2. Initial Meadow Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 1.3. Begin maintenance immediately after each area is planted and continue until acceptable meadow is established, but for not less than 40 days from date of planting completion **OR** Substantial Completion, **as directed**.
3. Continuing Maintenance Proposal: From Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1.2 PRODUCTS

A. Seed
1. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.
2. Seed Species: If grass seed is required to be certified by the State Department of Agriculture, State-certified seed of grass species as follows:
OR
Seed Species: If grass seed is not required to be certified by the State Department of Agriculture, seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:
   a. Warm-season grass
      1) Full Sun: Bermudagrass (Cynodon dactylon).
   b. Cool-season grass
      1) Full Sun: Kentucky bluegrass (Poa pratensis), a minimum of three cultivars.
      2) Sun and Partial Shade: Proportioned by weight as follows:
         a) 50 percent Kentucky bluegrass (Poa pratensis).
         b) 30 percent chewings red fescue (Festuca rubra variety).
         c) 10 percent perennial ryegrass (Lolium perenne).
         d) 10 percent redtop (Agrostis alba).
      3) Shade: Proportioned by weight as follows:
         a) 50 percent chewings red fescue (Festuca rubra variety).
         b) 35 percent rough bluegrass (Poa trivialis).
         c) 15 percent redtop (Agrostis alba).
3. Grass Seed Mix: Proprietary seed mix as directed by the Owner.

B. Turfgrass Sod
1. Turfgrass Sod: Certified **OR** Approved **OR** Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects, **as directed**, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.
2. Turfgrass Species (warm-season grass): Bermudagrass (Cynodon dactylon) **OR** Carpetgrass (Axonopus affinis) **OR** Centipedegrass (Eremochloa ophiuroides) **OR** St. Augustinegrass (Stenotaphrum secundatum) **OR** Zoysiagrass (Zoysia japonica) **OR** Zoysiagrass (Zoysia matrella), **as directed**.
3. Turfgrass Species (cool-season grass): Sod of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:
   a. Full Sun: Kentucky bluegrass (Poa pratensis), a minimum of three cultivars.
   b. Sun and Partial Shade: Proportioned by weight as follows:
      1) 50 percent Kentucky bluegrass (Poa pratensis).
      2) 30 percent chewings red fescue (Festuca rubra variety).
      3) 10 percent perennial ryegrass (Lolium perenne).
      4) 10 percent redtop (Agrostis alba).
   c. Shade: Proportioned by weight as follows:
      1) 50 percent chewings red fescue (Festuca rubra variety).
      2) 35 percent rough bluegrass (Poa trivialis).
      3) 15 percent redtop (Agrostis alba).

C. Plugs
1. Plugs: Turfgrass sod, certified **OR** approved **OR** Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects, **as directed**, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, cut into square or round plugs, strongly rooted,

and capable of vigorous growth and development when planted; of the following turfgrass species and plug size:

a. Turfgrass Species (warm-season grass): Bermudagrass (Cynodon dactylon) **OR** Carpetgrass (Axonopus affinis) **OR** Centipedegrass (Eremochloa ophiuroides) **OR** St. Augustinegrass (Stenotaphrum secundatum) **OR** Zoysiagrass (Zoysia japonica) **OR** Zoysiagrass (Zoysia matrella), **as directed**.

b. Plug Size: 2 inches (50 mm) **OR** 3 inches (75 mm) **OR** 4 inches (100 mm), **as directed**.

D. Sprigs

1. Sod Sprigs: Healthy living stems, rhizomes, or stolons with a minimum of two nodes and attached roots free of soil, of the following turfgrass species:
   a. Turfgrass Species (warm-season grass): Bermudagrass (Cynodon dactylon) **OR** Carpetgrass (Axonopus affinis) **OR** Centipedegrass (Eremochloa ophiuroides) **OR** St. Augustinegrass (Stenotaphrum secundatum) **OR** Zoysiagrass (Zoysia japonica) **OR** Zoysiagrass (Zoysia matrella), **as directed**.
   b. Turfgrass Species (cool-season grass): Creeping bentgrass (Agrostis palustris).

E. Meadow Grasses And Wildflowers

1. Wildflower Seed: Fresh, clean, and dry new seed, of mixed species as directed.
2. Native Grass Seed: Fresh, clean, and dry new seed, of mixed species as directed.
3. Wildflower and Native Grass Seed: Fresh, clean, and dry new seed, of mixed species as directed.
4. Seed Carrier: Inert material, sharp clean sand or perlite, mixed with seed at a ratio of not less than two parts seed carrier to one part seed.

F. Inorganic Soil Amendments

1. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
   a. Class T, with a minimum of 99 percent passing through No. 8 (2.36-mm) sieve and a minimum of 75 percent passing through No. 60 (0.25-mm) sieve.
      OR
      Class O, with a minimum of 95 percent passing through No. 8 (2.36-mm) sieve and a minimum of 55 percent passing through No. 60 (0.25-mm) sieve.
   b. Provide lime in form of ground dolomitic limestone **OR** calcitic limestone **OR** mollusk shells, **as directed**.
2. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, and with a minimum of 99 percent passing through No. 6 (3.35-mm) sieve and a maximum of 10 percent passing through No. 40 (0.425-mm) sieve.
3. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
4. Aluminum Sulfate: Commercial grade, unadulterated.
5. Perlite: Horticultural perlite, soil amendment grade.
6. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 (0.30-mm) sieve.
7. Sand: Clean, washed, natural or manufactured, and free of toxic materials.
8. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.
   OR
   Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

G. Organic Soil Amendments

1. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch (25-mm) **OR** 3/4-inch (19-mm) **OR** 1/2-inch (12.5-mm), **as directed**, sieve; soluble salt content of 5 to 10

decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

a. Organic Matter Content: 50 to 60 percent of dry weight.
b. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

2. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture, with a pH range of 3.4 to 4.8.
3. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.
4. Wood Derivatives: Decomposed, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.
   a. In lieu of decomposed wood derivatives, mix partially decomposed wood derivatives with ammonium nitrate at a minimum rate of 0.15 lb/cu. ft. (2.4 kg/cu. m) of loose sawdust or ground bark, or with ammonium sulfate at a minimum rate of 0.25 lb/cu. ft. (4 kg/cu. m) of loose sawdust or ground bark.
5. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

H. Fertilizers

1. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 1 **OR** 4, **as directed**, percent nitrogen and 10 **OR** 20, **as directed**, percent phosphoric acid.
2. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
3. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
   a. Composition: 1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m) of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
   b. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.
4. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
   a. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
      OR
      Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

I. Planting Soils

1. Planting Soil: ASTM D 5268 topsoil, with pH range of 5.5 to 7, a minimum of 2 percent organic material content **OR** Existing, native surface topsoil formed under natural conditions with the duff layer retained during excavation process **OR** Existing, in-place surface soil **OR** Imported topsoil or manufactured topsoil from off-site sources; do not obtain from agricultural land, bogs or marshes, **as directed**. Verify suitability of soil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clods, clay lumps, pockets of coarse sand, concrete slurry, concrete layers or chunks, cement, plaster, building debris, and other extraneous materials harmful to plant growth. Mix soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:
   a. Ratio of Loose Compost to Topsoil by Volume: 1:4 **OR** 1:3 **OR** 1:2, **as directed**.
   b. Ratio of Loose Sphagnum **OR** Muck, **as directed**, Peat to Topsoil by Volume: as directed by the Owner .
   c. Ratio of Loose Wood Derivatives to Topsoil by Volume: as directed by the Owner.
   d. Weight of Lime per 1000 Sq. Ft. (92.9 Sq. m): as directed by the Owner.

e. Weight of Sulfur **OR** Iron Sulfate **OR** Aluminum Sulfate, **as directed**, per 1000 Sq. Ft. (92.9 Sq. m): as directed by the Owner.
f. Weight of Agricultural Gypsum per 1000 Sq. Ft. (92.9 Sq. m): as directed by the Owner.
g. Volume of Sand Plus 10 Percent Diatomaceous Earth **OR** Zeolites, **as directed**, per 1000 Sq. Ft. (92.9 Sq. m): as directed by the Owner.
h. Weight of Bonemeal per 1000 Sq. Ft. (92.9 Sq. m**):** as directed by the Owner.
i. Weight of Superphosphate per 1000 Sq. Ft. (92.9 Sq. m): as directed by the Owner.
j. Weight of Commercial Fertilizer per 1000 Sq. Ft. (92.9 Sq. m): as directed by the Owner.
k. Weight of Slow-Release Fertilizer per 1000 Sq. Ft. (92.9 Sq. m): as directed by the Owner.

J. Mulches
1. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
2. Sphagnum Peat Mulch: Partially decomposed sphagnum peat moss, finely divided or of granular texture, and with a pH range of 3.4 to 4.8.
3. Muck Peat Mulch: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.
4. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch (25-mm) sieve; soluble salt content of 2 to 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
   a. Organic Matter Content: 50 to 60 percent of dry weight.
   b. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
5. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
6. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.
7. Asphalt Emulsion: ASTM D 977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

K. Pesticides
1. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
2. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
3. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

L. Erosion-Control Materials
1. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches (150 mm) long.
2. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb/sq. yd. (0.5 kg/sq. m), with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches (150 mm) long.
3. Erosion-Control Mats: Cellular, non-biodegradable slope-stabilization mats designed to isolate and contain small areas of soil over steeply sloped surface, of 3-inch (75-mm) **OR** 4-inch (100-mm) **OR** 6-inch (150-mm), **as directed**, nominal mat thickness. Include manufacturer's recommended anchorage system for slope conditions.

M. Grass-Paving Materials
1. Grass Paving: Cellular, non-biodegradable plastic mats, designed to contain small areas of soil and enhance the ability of turf to support vehicular and pedestrian traffic, of 1-inch (25-mm) **OR** 1-3/4-inch (45-mm) **OR** 2-inch (50-mm) **OR** manufacturer's standard, **as directed**, nominal mat thickness. Include manufacturer's recommended anchorage system for slope conditions.
2. Base Course: Sound crushed stone or gravel complying with ASTM D 448 for Size No. 8 **OR** Division 02 Section "Earthwork" for base-course material, **as directed**.
3. Sand: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33 for fine aggregate.
4. Proprietary Growing Mix: As submitted and acceptable to the Owner.
5. Sandy Loam Soil Mix: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33 for fine aggregate blended with planting soil as specified. Use blend consisting of 1/2 sand and 1/2 planting soil **OR** 2/3 sand and 1/3 planting soil, **as directed**.
6. Soil for Paving Fill: Planting soil as specified.

1.3 EXECUTION

A. Preparation
1. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
   a. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
   b. Protect grade stakes set by others until directed to remove them.
2. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

B. Turf Area Preparation
1. Limit turf subgrade preparation to areas to be planted.
2. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 4 inches (100 mm) **OR** 6 inches (150 mm) **OR** 8 inches (200 mm), **as directed**. Remove stones larger than 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
   a. Apply superphosphate fertilizer directly to subgrade before loosening.
   b. Thoroughly blend planting soil off-site before spreading or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil.
      1) Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
      2) Mix lime with dry soil before mixing fertilizer.
   c. Spread planting soil to a depth of 4 inches (100 mm) **OR** 6 inches (150 mm) **OR** 8 inches (200 mm), **as directed**, but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
      1) Spread approximately 1/2 the thickness of planting soil over loosened subgrade. Mix thoroughly into top 2 inches (50 mm) **OR** 4 inches (100 mm), **as directed**, of subgrade. Spread remainder of planting soil.
      2) Reduce elevation of planting soil to allow for soil thickness of sod.
3. Unchanged Subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:
   a. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
   b. Loosen surface soil to a depth of at least 6 inches (150 mm) **OR** 8 inches (200 mm), **as directed**. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, of soil. Till soil to a homogeneous mixture of fine texture.
      1) Apply superphosphate fertilizer directly to surface soil before loosening.
   c. Remove stones larger than 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, in any dimension and sticks, roots, trash, and other extraneous matter.

d. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.

4. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch (13 mm) of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.
5. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
6. Before planting, obtain the Owner's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

C. Preparation For Erosion-Control Materials
1. Prepare area as specified in "Turf Area Preparation" Article.
2. For erosion-control mats, install planting soil in two lifts, with second lift equal to thickness of erosion-control mats. Install erosion-control mat and fasten as recommended by material manufacturer.
3. Fill cells of erosion-control mat with planting soil and compact before planting.
4. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.
5. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

D. Preparation For Grass-Paving Materials
1. Reduce subgrade elevation soil to allow for thickness of grass-paving system. Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade so that installed paving is within plus or minus 1/2 inch (13 mm) of finish elevation. Roll and rake, remove ridges, and fill depressions.
2. Install base course **OR** sand course **OR** base course and sand course, **as directed**, and sandy loam soil mix **OR** proprietary growing mix **OR** soil for paving fill, **as directed**, as recommended by paving-material manufacturer for site conditions; comply with details shown on Drawings. Compact according to paving-material manufacturer's written instructions.
3. Install paving mat and fasten according to paving-material manufacturer's written instructions.
4. Before planting, fill cells of paving mat with planting soil **OR** sandy loam soil mix **OR** proprietary growing mix **OR** sand half full, **as directed**, and compact according to manufacturer's written instructions.
5. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

E. Seeding
1. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph (8 km/h). Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
   a. Do not use wet seed or seed that is moldy or otherwise damaged.
   b. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
2. Sow seed at a total rate of 2 lb/1000 sq. ft. (0.9 kg/92.9 sq. m) **OR** 3 to 4 lb/1000 sq. ft. (1.4 to 1.8 kg/92.9 sq. m) **OR** 5 to 8 lb/1000 sq. ft. (2.3 to 3.6 kg/92.9 sq. m), **as directed**.
3. Rake seed lightly into top 1/8 inch (3 mm) of soil, roll lightly, and water with fine spray.
4. Protect seeded areas with slopes exceeding 1:4 with erosion-control blankets and 1:6 with erosion-control fiber mesh installed and stapled according to manufacturer's written instructions.
5. Protect seeded areas with erosion-control mats where shown on Drawings; install and anchor according to manufacturer's written instructions.
6. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre (42 kg/92.9 sq. m) to form a continuous blanket 1-1/2 inches (38 mm) in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.

a. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
b. Bond straw mulch by spraying with asphalt emulsion at a rate of 10 to 13 gal./1000 sq. ft. (38 to 49 L/92.9 sq. m). Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.

7. Protect seeded areas from hot, dry weather or drying winds by applying compost mulch **OR** peat mulch **OR** planting soil, **as directed**, within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch (4.8 mm), and roll surface smooth.

F. Hydroseeding

1. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
   a. Mix slurry with nonasphaltic **OR** asphalt-emulsion **OR** fiber-mulch manufacturer's recommended, **as directed**, tackifier.
   b. Apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre (15.6-kg/92.9 sq. m) dry weight, and seed component is deposited at not less than the specified seed-sowing rate.

      OR

      Apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than 500-lb/acre (5.2-kg/92.9 sq. m) dry weight, and seed component is deposited at not less than the specified seed-sowing rate. Apply slurry cover coat of fiber mulch (hydromulching) at a rate of 1000 lb/acre (10.4 kg/92.9 sq. m).

G. Sodding

1. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.
2. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
   a. Lay sod across angle of slopes exceeding 1:3.
   b. Anchor sod on slopes exceeding 1:6 with wood pegs or steel staples spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.
3. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches (38 mm) below sod.

H. Plugging

1. Plant plugs in holes or furrows, spaced 12 inches (300 mm) **OR** 18 inches (450 mm), **as directed**, apart in both directions. On slopes, contour furrows to near level.

I. Sprigging

1. Plant freshly shredded sod sprigs in furrows 1 to 1-1/2 inches (25 to 38 mm) **OR** 1-1/2 to 2 inches (38 to 50 mm) **OR** 2-1/2 to 3 inches (64 to 75 mm), **as directed**, deep. Place individual sprigs with roots and portions of stem in moistened soil, 6 inches (150 mm) **OR** 12 inches (300 mm), **as directed**, apart in rows 10 inches (250 mm) **OR** 18 inches (450 mm), **as directed**, apart, and fill furrows without covering growing tips. Lightly roll and firm soil around sprigs after planting.
2. Broadcast sprigs uniformly over prepared surface at a rate of 10 cu. ft./1000 sq. ft. (0.28 cu. m/92.9 sq. m) and mechanically force sprigs into lightly moistened soil.
   a. Spread a 1/4-inch- (6-mm-) thick layer of compost mulch **OR** peat mulch **OR** planting soil, **as directed**, on sprigs.
   b. Lightly roll and firm soil around sprigs after planting.

c. Water sprigs immediately after planting and keep moist by frequent watering until well rooted.

J. Turf Renovation
1. Renovate existing turf.
2. Renovate existing turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.
   a. Reestablish turf where settlement or washouts occur or where minor regrading is required.
   b. Install new planting soil as required.
3. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.
4. Remove topsoil containing foreign materials such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.
5. Mow, dethatch, core aerate, and rake existing turf.
6. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.
7. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.
8. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches (150 mm).
9. Apply soil amendments and initial fertilizers required for establishing new turf and mix thoroughly into top 4 inches (100 mm) of existing soil. Install new planting soil to fill low spots and meet finish grades.
10. Apply seed and protect with straw mulch **OR** sod, **as directed**, as required for new turf.
11. Water newly planted areas and keep moist until new turf is established.

K. Turf Maintenance
1. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
   a. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
   b. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
   c. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
2. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches (100 mm).
   a. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
   b. Water turf with fine spray at a minimum rate of 1 inch (25 mm) per week unless rainfall precipitation is adequate.
3. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
   a. Mow bentgrass to a height of 1/2 inch (13 mm) or less.
   b. Mow bermudagrass to a height of 1/2 to 1 inch (13 to 25 mm).
   c. Mow carpetgrass, centipedegrass, perennial ryegrass, and zoysiagrass to a height of 1 to 2 inches (25 to 50 mm).
   d. Mow Kentucky bluegrass, buffalograss, annual ryegrass, and chewings red fescue to a height of 1-1/2 to 2 inches (38 to 50 mm).

e. Mow bahiagrass, turf-type tall fescue, and St. Augustinegrass to a height of 2 to 3 inches (50 to 75 mm).

4. Turf Postfertilization: Apply fertilizer after initial mowing and when grass is dry.
   a. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m) to turf area.

L. Satisfactory Turf
1. Turf installations shall meet the following criteria as determined by Architect:
   a. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. (0.92 sq. m) and bare spots not exceeding 5 by 5 inches (125 by 125 mm).
   b. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
   c. Satisfactory Plugged Turf: At end of maintenance period, the required number of plugs has been established as well-rooted, viable patches of grass, and areas between plugs are free of weeds and other undesirable vegetation.
   d. Satisfactory Sprigged Turf: At end of maintenance period, the required number of sprigs has been established as well-rooted, viable plants, and areas between sprigs are free of weeds and other undesirable vegetation.
2. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

M. Meadow
1. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph (8 km/h). Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
   a. Do not use wet seed or seed that is moldy or otherwise damaged.
2. Sow seed at a total rate of 4 oz./1000 sq. ft. (113 g/92.9 sq. m) **OR** 5 oz./1000 sq. ft. (142 g/92.9 sq. m) **OR** 6 oz./1000 sq. ft. (170 g/92.9 sq. m), **as directed**.
3. Brush seed into top 1/16 inch (1.6 mm) of soil, roll lightly, and water with fine spray.
4. Protect seeded areas from hot, dry weather or drying winds by applying peat or compost mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch (4.8 mm), and roll surface smooth.
5. Water newly planted areas and keep moist until meadow is established.

N. Meadow Maintenance
1. Maintain and establish meadow by watering, weeding, mowing, trimming, replanting, and performing other operations as required to establish a healthy, viable meadow. Roll, regrade, and replant bare or eroded areas and remulch. Provide materials and installation the same as those used in the original installation.
   a. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and meadow damaged or lost in areas of subsidence.
   b. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
   c. Apply treatments as required to keep meadow and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
2. Watering: Install and maintain temporary piping, hoses, and meadow-watering equipment to convey water from sources and to keep meadow uniformly moist.
   a. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
   b. Water meadow with fine spray at a minimum rate of 1/2 inch (13 mm) per week for four **OR** six **OR** eight, **as directed**, weeks after planting unless rainfall precipitation is adequate.

O. Pesticide Application
   1. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
   2. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

P. Cleanup And Protection
   1. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
   2. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
   3. Remove nondegradable erosion-control measures after grass establishment period.

END OF SECTION 02810b

Task	Specification	Specification Description
02810	02111a	Portland Cement Concrete Removal
02810	02244	Tree Protection And Trimming
02810	02203	Earthwork
02810	02203a	Embankment
02810	02464b	Septic Tank Systems
02810	02805	Tree Relocation
02820	02805	Tree Relocation
02820	02810b	Lawns And Grasses
02831	01352	No Specification Required
02831	02244	Tree Protection And Trimming
02831	02805	Tree Relocation
02831	02630c	Exterior Plants
02832	02810	Site Clearing
02832	02630c	Exterior Plants
02840	02810	Site Clearing
02840	02244	Tree Protection And Trimming
02845	02630c	Exterior Plants
02951	01352	No Specification Required

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SECTION 02953 - SEWER LINE CLEANING

1.1 GENERAL

A. Description Of Work
1. This specification covers sewer line cleaning. Cleaning procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals: Submit product data and manufacturer's instruction.

1.2 PRODUCTS

A. All materials shall be clean, free of defects, corrosion, and damage. All items shall be of proper type, size, design, and characteristics for the use intended. Unless otherwise specified, all items shall be factory-made.

B. Portable Cleaning Equipment: Equipment used in the cleaning of sewer lines shall be as required to complete the work for the size, length, and conditions of the sewer. Portable and mobile equipment shall comply with Water Pollution Control Federation Manual No. 7.

C. Chemicals shall be of the strength required to perform the work. The chemicals shall not be damaging to pipe materials, manholes, pumping equipment, nor treatment process and shall not be contaminated by foreign substances.

1.3 EXECUTION

A. Preparation
1. Protection required to prevent damage to adjacent materials, equipment, fixtures, and finishes shall be provided. Necessary protective clothing and accessories for personnel working with chemicals shall be provided.
2. Ventilation of Sewers: Contractor shall provide proper ventilation for personnel working in the sewer.
3. Alternate Sewage Discharge: Contractor shall provide an alternate routing of sewage discharge to a downstream manhole.
4. Traffic: Contractor shall provide all traffic signs required to safely direct traffic at and around work areas.

B. Installation
1. Direction of Work: Sewer line cleaning work, with the exception of hydraulic scouring, shall proceed in the downstream direction. Cleaning by hydraulic scouring shall proceed in the upstream direction.
2. Testing: Upon completion of cleaning operation, test sewer lines for proper operation and observe for a period of 24 hours. Clean out all stoppages and the retest the line for proper operation.

END OF SECTION 02953

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Task	Specification	Specification Description
02953	02242	Piped Utilities Basic Materials And Methods
02953	02570	Repair And Maintenance Of Imhoff Tanks

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SECTION 02956 - PIPE LINING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of pipe lining. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 PRODUCTS

A. Lining Material:
1. Polyethylene Pipe: Extruded, flexible industrial grade, high density (Type 3 or 4) in 40 foot lengths, complying with ASTM D 2239 and D 2447.
a. Diameter: Outside diameter shall be as large as possible while allowing for ease of pulling into the existing pipes. Pipe dimensions shall comply with ASTM D 2447 and D 2837.
b. Liner Thickness and Class shall be suitable for the use intended. The tolerance on the pipe wall thickness shall be as noted in Table 2 of ASTM D 2447.
c. Gravity Sanitary, Gravity Storm, and Gravity Industrial Sewers shall be Schedule 40.
d. Gravity Thermal Discharge Sewers shall be Schedule 80.
e. Low Pressure Sewers shall be Schedule 40, complying with ASTM D 2239.
f. High Pressure Sewers shall be Schedule 80, complying with ASTM D 2239 and D 2837.
g. Chemical Resistance: Pipe liner shall be resistant to chemical attack, erosion, and corrosion.
h. Fittings shall be fabricated from polyethylene pipe. The polyethylene fittings shall have the same pressure rating as the pipe and shall comply with ASTM D 3261.
2. Cement-Mortar Lining:
a. Portland Cement shall comply with ASTM C 150, Type 1.
b. Pozzolan Cement shall comply with ASTM C 618 and shall not comprise more than 20 percent of total cement amount, by weight.
c. Sand shall be well graded, clean, free from organic and extraneous matter. One hundred percent shall pass the 16-mesh size screen.
d. Lining Thickness: Cement lining shall be not less than 1/8 inch for pipe sizes 4 to 14 inches, not less than 3/16 inch for pipe sized 16 inches and larger, and not less than 1/4 inch for steel pipe 16 inches and larger.
3. Reinforced Mortar Pipe Slip-Lining:
a. Gravity Sewers: Slip-lining shall be of glass fiber reinforced polyester mortar pipe, complying with ASTM D 3262.
b. Pressure Sewers (Force Mains): Slip-lining shall be of glass fiber reinforced polyester mortar pipe complying with ASTM D 2517.
c. Diameter: Outside diameter shall be as large as possible while allowing for ease of pulling into existing pipes, as recommended by the manufacturer.
d. Chemical Resistance: Pipe liner shall be resistant to chemical attack, erosion, and corrosion.
4. Fittings: Fittings shall be manufactured of the same materials as is the glass fiber reinforced polyester mortar pipe.
5. Epoxy-Mortar Lining:
a. Epoxy compound shall comply with ASTM D 1763.
b. Admixtures shall be well graded with one hundred percent passing. The 16-mesh size screen. All admixtures shall improve the workability, density, and strength of the mortar.

c. Lining Thickness: For pipe sizes 4 to 14 inches, epoxy mortar lining thickness shall be not less than 1/8 inch. For pipe sizes 16 inches and larger, epoxy mortar lining shall be not less than 3/16 inch.

B. Joint:
1. Slip-Lining:
a. Polyethylene Pipe Butt Joints: Pipe lengths, fittings, and flanged connections to be joined by thermal butt fusion shall be of the same time, grade, and class of polyethylene compound and supplied by pipe supplier.
b. Flanged Joints shall consist of a polyethylene flange, thermally butt fused to the ends of the pipe. The companion flange shall be steel or cast iron and nylon-coated.
c. Lateral Service Connections: Sidewall connections shall be made with polyethylene pipe sections of the same material, grade, and class as the liner material and shall have the same pressure ratings. Lateral connections shall be watertight.
2. Reinforced Mortar Lining:
a. Bell and spigot joints shall be the inverted type.
b. Manhole Joints and Connections shall be oakum ring and grout as required.

1.3 EXECUTION:

A. Slip-Lining, Polyethylene Pipe:
1. Insertion of Liner: Liner shall be laid at a constant line and grade as the existing pipe, without undulations or damage. Where the existing pipe is not at constant grade, the liner shall follow as true a constant grade as possible.
2. Grouting: At manholes, annular space shall be packed with oakum and expansion grout or nonshrink grout as required. At existing line, after liner has been inserted, grout wherever existing pipe has failed structurally.
3. Concrete Encasement: Crown of liner shall be encased in concrete a minimum thickness of 6 inches for the entire length of the excavated trench and out at least 6 inches each side of the bottom half of the original pipe remaining down to firm soil. Wherever existing concrete encasement has been removed, the liner shall be encased in the same manner as the original pipe.
4. Thrust Blocks: Concrete thrust blocks shall be provided as required.

B. Cement Mortar and Epoxy Mortar Lining:
1. Cement Mortar Mixing: One part cement to one and one-half parts of sand by volume.
2. Application of Lining: The lining shall be applied to produce a smooth, uniform thickness throughout the interior of the pipe line.
3. Curing of the Cement Mortar Lining: Immediately upon completion of the lining of a length of pipe between access openings or at the end of a day's run, the section of pipe shall be closed at each end, the access openings covered to prevent the circulation of air, and the atmosphere kept moist.
4. Reconnection of Pipes After Lining: Close and make watertight all openings in the lines.
5. Pressure Test and Leaks: Hydrostatic and leakage tests shall be conducted on all pipe that is cleaned and lined.

C. Reinforced Mortar Pipe Lining:
1. Joining of Pipe Ends: Liner sections containing bell and spigot joints shall be joined using an O-ring.
2. Grouting Work shall be accomplished following the same techniques as described in paragraph Slip-Lining, Polyethylene Pipe.

D. Cement Mortar Lining:

1. Epoxy Mortar Lining: Excessive mortar shall be removed from the manhole walls and bottom. Manhole bottom shall receive special care in making all transitions smooth.
2. Work at Service Connections: Plugs or caps shall be placed at the access point of the service connection to the lines and shall be removed once the mortar has set. The completed lining shall not be damaged.
3. Reinforced Mortar Pipe Lining: Joining of fiberglass reinforced polyester mortar pipe shall be carried out in the trench, with the first section of liner already inserted.
4. Lateral Connections: Service to connections shall be provided for and continued after installation of the lining.
5. Testing: Upon completion of lining operation, the sewer line shall be tested for proper operation and shall be observed for a period of 24 hours. All deficiencies shall be corrected.
6. Pavement Restoration: All disturbed pavement shall be restored to its original condition and shall match existing adjacent.
7. Inspection: Large diameter sewers shall be inspected from inside to ensure that all lateral connections and joints are in proper order. Sewers that have been cement-lined may be inspected for a smooth finish, while plugs and caps are being removed.

END OF SECTION 02956

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Task	Specification	Specification Description
02956	01352	No Specification Required
02956	02242	Piped Utilities Basic Materials And Methods

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Task	Specification	Specification Description
03110	01352	No Specification Required

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SECTION 03302 - CAST-IN-PLACE ARCHITECTURAL CONCRETE

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for cast-in-place architectural concrete. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section specifies cast-in-place architectural concrete including form facings, reinforcement accessories, concrete materials, concrete mixture design, placement procedures, and finishes.

C. Definitions
1. Cast-in-Place Architectural Concrete: Formed concrete that is exposed to view on surfaces of completed structure or building and that requires special concrete materials, formwork, placement, or finishes to obtain specified architectural appearance.
2. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.
3. Design Reference Sample: Sample designated by the Owner in the Contract Documents that reflects acceptable surface quality and appearance of cast-in-place architectural concrete.
4. Reveal: Projection of coarse aggregate from matrix or mortar after completion of exposure operations.

D. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
   a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
      1) Include statement indicating costs for each product having recycled content.
   b. Design Mixtures for Credit ID 1.1: For each concrete mixture containing fly ash as a replacement for portland cement or other portland cement replacements and for equivalent concrete mixtures that do not contain portland cement replacements.
3. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
   a. Indicate amounts of mixing water to be withheld for later addition at Project site.
4. Formwork Shop Drawings: Show formwork construction including form-facing joints, rustications, construction and contraction joints, form joint-sealant details, form tie locations and patterns, inserts and embedments, cutouts, cleanout panels, and other items that visually affect cast-in-place architectural concrete.
5. Placement Schedule: Submit concrete placement schedule before start of placement operations. Include locations of all joints including construction joints.
6. Samples: For each of the following materials:
   a. Form-facing panel.
   b. Form ties.
   c. Form liners.
   d. Coarse- and fine-aggregate gradations.
   e. Chamfers and rustications.
7. Material test reports **OR** certificates, **as directed**.

E. Quality Assurance
1. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
   a. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
2. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
   a. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
   b. Personnel performing laboratory tests shall be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
3. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
   a. ACI 301, "Specification for Structural Concrete," Sections 1 through 5 **OR** Sections 1 through 5 and Section 6, "Architectural Concrete", **as directed**.
   b. ACI 303.1, "Specification for Cast-in-Place Architectural Concrete."
4. Field Sample Panels: After approval of verification sample and before casting architectural concrete, produce field sample panels to demonstrate the approved range of selections made under sample submittals. Produce a minimum of 3 sets of full-scale panels, cast vertically, approximately 48 by 48 by 6 inches (1200 by 1200 by 150 mm) minimum, to demonstrate the expected range of finish, color, and texture variations.
5. Preinstallation Conference: Conduct conference at Project site.

1.2 PRODUCTS

A. Form-Facing Materials
1. General: Comply with Division 03 Section "Cast-in-place Concrete" for formwork and other form-facing material requirements.
2. Form-Facing Panels for As-Cast **OR** Exposed-Aggregate, **as directed**, Finishes: Steel, glass-fiber-reinforced plastic, or other approved nonabsorptive panel materials that will provide continuous, true, and smooth architectural concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
3. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will provide surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.
4. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.
5. Form Liners: Units of face design, texture, arrangement, and configuration indicated **OR** to match design reference sample, **as directed**. Furnish with manufacturer's recommended liquid-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent surface treatments of concrete.
6. Rustication Strips: Metal, rigid plastic, or dressed wood with sides beveled and back kerfed; nonstaining; in longest practicable lengths.
7. Chamfer Strips: Metal, rigid plastic, elastomeric rubber, or dressed wood, 3/4 by 3/4 inch (19 by 19 mm), minimum; nonstaining; in longest practicable lengths.
8. Form Joint Tape: Compressible foam tape; pressure sensitive; AAMA 800, "Specification 810.1, Expanded Cellular Glazing Tape"; minimum 1/4 inch (6 mm) thick.
9. Form Joint Sealant: Elastomeric sealant complying with ASTM C 920, Type M or S, Grade NS, that adheres to form joint substrates.
10. Sealer: Penetrating, clear, polyurethane wood form sealer formulated to reduce absorption of bleed water and prevent migration of set-retarding chemicals from wood.

11. Form-Release Agent: Commercially formulated colorless form-release agent that will not bond with, stain, or adversely affect architectural concrete surfaces and will not impair subsequent treatments of those surfaces.
    a. Formulate form-release agent with rust inhibitor for steel form-facing materials.
12. Surface Retarder: Chemical liquid set retarder, for application on form-facing materials, capable of temporarily delaying final hardening of newly placed concrete surface to depth of reveal specified.
13. Form Ties: Factory-fabricated, glass-fiber-reinforced plastic **OR** internally disconnecting **OR** removable, **as directed**, ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
    a. Furnish ties with tapered tie cone spreaders, **as directed**, that, when removed, will leave holes 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** 1-1/4 inches (32 mm) **OR** 1-1/2 inches (38 mm), **as directed**, in diameter on concrete surface.
    b. Furnish internally disconnecting ties that will leave no metal closer than 1-1/2 inches (38 mm), after exposing aggregate, **as directed**, from the architectural concrete surface.
    c. Furnish glass-fiber-reinforced plastic ties, not less than 1/2 inch (13 mm) in diameter, of color to match the Owner's sample **OR** selected by the Owner from manufacturer's full range, **as directed**.
    d. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

B. Steel Reinforcement And Accessories
1. General: Comply with Division 03 Section "Cast-in-place Concrete" for steel reinforcement and other requirements for reinforcement accessories.
2. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 **OR** 60, **as directed**, percent.
3. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire fabric in place; manufacture according to CRSI's "Manual of Standard Practice."
    a. Where legs of wire bar supports contact forms, use gray, all-plastic **OR** CRSI Class 1, gray, plastic-protected **OR** CRSI Class 2, stainless-steel, **as directed**, bar supports.

C. Concrete Materials
1. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
    a. Portland Cement: ASTM C 150, Type I **OR** II **OR** I/II **OR** III, **as directed**, gray **OR** white, **as directed**. Supplement with the following:, **as directed**
        1) Fly Ash: ASTM C 618, Class C **OR** F, **as directed**.
        2) Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
        3) Silica Fume: ASTM C 1240, amorphous silica.
    b. Blended Hydraulic Cement: ASTM C 595, Type IS, portland blast-furnace slag **OR** IP, portland-pozzolan **OR** (PM), pozzolan-modified Portland **OR** I (SM), slag-modified Portland, **as directed**, cement.
2. Normal-Weight Aggregates: ASTM C 33, Class 5S **OR** 5M **OR** 1N, **as directed**, coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials, **as directed**.
    a. Maximum Coarse Aggregate Size: 1 inch (25 mm) **OR** 3/4 inch (19 mm) **OR** 1/2 inch (13 mm) **OR** 3/8 inch (10 mm), **as directed**.
    b. Gradation: Uniformly **OR** Gap, **as directed**, graded.
3. Normal-Weight Fine Aggregate: ASTM C 33 **OR** ASTM C 144, **as directed**, manufactured or natural sand, from same source for entire Project.
4. Water: Potable, complying with ASTM C 94/C 94M except free of wash water from mixer washout operations.

D. Admixtures
   1. Air-Entraining Admixture: ASTM C 260.
   2. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
      a. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
      b. Retarding Admixture: ASTM C 494/C 494M, Type B.
      c. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
      d. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
      e. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
      f. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
   3. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, **as directed**, nonfading, and resistant to lime and other alkalis.
      a. Color: As indicated by manufacturer's designation **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.

E. Curing Materials
   1. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.
   2. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
   3. Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.
      a. For integrally colored concrete, curing compound shall be pigmented type, **as directed**, approved by color pigment manufacturer.
      b. For concrete indicated to be sealed, curing compound shall be compatible with sealer.

F. Repair Materials
   1. Bonding Agent: ASTM C 1059, Type II, nonredispersible, acrylic emulsion or styrene butadiene.
   2. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements.
      a. Types I and II, non-load bearing **OR** IV and V, load bearing, **as directed**, for bonding hardened or freshly mixed concrete to hardened concrete.

G. Concrete Mixtures, General
   1. Prepare design mixtures for each type and strength of cast-in-place architectural concrete proportioned on basis of laboratory trial mixture or field test data, or both, according to ACI 301.
      a. Use a qualified independent testing agency for preparing and reporting proposed design mixtures based on laboratory trial mixtures.
   2. Proportion concrete mixtures as follows:
      a. Compressive Strength (28 Days): 5000 psi (34.5 MPa) **OR** 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**.
      b. Maximum Water-Cementitious Materials Ratio: 0.46.
      c. Slump Limit: 3 inches (75 mm) **OR** 4 inches (100 mm) **OR** 8 inches (200 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, **as directed**, plus or minus 1 inch (25 mm).
      d. Air Content:
         1) 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch (38-mm) nominal maximum aggregate size.
         2) 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch (25-mm) **OR** 3/4-inch (19-mm), **as directed**, nominal maximum aggregate size.
   3. Cementitious Materials: For cast-in-place architectural concrete exposed to deicers, limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements. Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica

fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent, **as directed**.

4. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 **OR** 0.15 **OR** 0.30 **OR** 1.00, **as directed**, percent by weight of cement.
5. Admixtures: Use admixtures according to manufacturer's written instructions.
6. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

H. Concrete Mixing

1. Ready-Mixed or Site-Mixed Architectural Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and furnish batch ticket information.
   a. Clean equipment used to mix and deliver cast-in-place architectural concrete to prevent contamination from other concrete.
   b. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

1.3 EXECUTION

A. Formwork

1. General: Comply with Division 03 Section "Cast-in-place Concrete" for formwork, embedded items, and shoring and reshoring.
2. Limit deflection of form-facing panels to not exceed ACI 303.1 requirements.
3. In addition to ACI 303.1 limits on form-facing panel deflection, limit cast-in-place architectural concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
   a. Class A, 1/8 inch (3.2 mm) **OR** B, 1/4 inch (6 mm) **OR** C, 1/2 inch (13 mm), **as directed**.
4. Fabricate forms to result in cast-in-place architectural concrete that complies with ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
   a. In addition to ACI 117, comply with the following tolerances: <**Insert tolerances.**>
5. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast-in-place surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical. Kerf wood rustications, keyways, reglets, recesses, and the like, for easy removal.
   a. Seal form joints and penetrations at form ties with form joint tape or form joint sealant to prevent cement paste leakage.
   b. Do not use rust-stained steel form-facing material.
6. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
7. Chamfer **OR** Do not chamfer, **as directed**, exterior corners and edges of cast-in-place architectural concrete.
8. Coat contact surfaces of wood rustications and chamfer strips with sealer before placing reinforcement, anchoring devices, and embedded items.
9. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
10. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
11. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
12. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.
13. Coat contact surfaces of forms with surface retarder, according to manufacturer's written instructions, before placing reinforcement.
14. Place form liners accurately to provide finished surface texture indicated. Provide solid backing and attach securely to prevent deflection and maintain stability of liners during concreting.

Prevent form liners from sagging and stretching in hot weather. Seal joints of form liners and form liner accessories to prevent mortar leaks. Coat form liner with form-release agent.

B. Reinforcement And Inserts
   1. General: Comply with Division 03 Section "Cast-in-place Concrete" for fabricating and installing steel reinforcement. Securely fasten steel reinforcement and wire ties against shifting during concrete placement.
   2. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

C. Removing And Reusing Forms
   1. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.
      a. Schedule form removal to maintain surface appearance that matches approved field sample panels.
      b. Cut off and grind glass-fiber-reinforced plastic form ties flush with surface of concrete.
   2. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved 28-day design compressive strength **OR** at least 70 percent of 28-day design compressive strength, **as directed**. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
   3. Clean and repair surfaces of forms to be reused in the Work. Do not use split, frayed, delaminated, or otherwise damaged form-facing material. Apply new form-release agent.
   4. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for cast-in-place architectural concrete surfaces.

D. Joints
   1. Construction Joints: Install construction joints true to line with faces perpendicular to surface plane of cast-in-place architectural concrete so strength and appearance of concrete are not impaired, at locations indicated or as approved by the Owner.
      a. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated.
      b. Form keyed joints as indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete, **as directed**. Align construction joint within rustications attached to form-facing material.
      c. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
      d. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
      e. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
      f. Use bonding agent **OR** epoxy-bonding adhesive, **as directed**, at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
   2. Contraction Joints: Form weakened-plane contraction joints true to line with faces perpendicular to surface plane of cast-in-place architectural concrete so strength and appearance of concrete are not impaired, at locations indicated or as approved by the Owner.

E. Concrete Placement
   1. Before placing concrete, verify that installation of formwork, form-release agent, reinforcement, and embedded items is complete and that required inspections have been performed.
   2. Do not add water to concrete during delivery, at Project site, or during placement unless approved by the Owner.
   3. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

a. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

4. Deposit concrete continuously between construction joints. Deposit concrete to avoid segregation.
   a. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
   b. Consolidate placed concrete with mechanical vibrating equipment according to ACI 303.1.
   c. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. Do not permit vibrators to contact forms.
5. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
   a. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
   b. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
   c. Do not use calcium chloride, salt, or other materials containing antifreeze agents.
   d. Do not use chemical accelerators unless otherwise specified and approved in design mixtures.
6. Hot-Weather Placement: Comply with ACI 301 and as follows:
   a. Maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
   b. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

F. Finishes, General
1. Architectural Concrete Finish: Match the Owner's design reference sample, identified and described as indicated, to satisfaction of the Owner.
2. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces.
   a. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.
3. Maintain uniformity of special finishes over construction joints, unless otherwise indicated.

G. As-Cast Formed Finishes
1. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections exceeding specified limits on formed-surface irregularities.
2. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Remove fins and other projections exceeding specified limits on formed-surface irregularities. Repair **OR** Do not repair, **as directed**, and patch tie holes and defects.
3. Rubbed Finish: Apply the following to smooth-form-finished as-cast concrete where indicated:
   a. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
   b. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland

cement in amounts determined by trial patches so color of dry grout will match surrounding concrete. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.

c. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match surrounding concrete. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

4. Form-Liner Finish: Produce a textured surface free of pockets, streaks, and honeycombs, and of uniform appearance, color, and texture.

H. Exposed-Aggregate Finishes

1. Scrubbed Finish: After concrete has achieved a compressive strength of from 1000 to 1500 psi (6.9 to 10.3 MPa), apply scrubbed finish. Wet concrete surfaces thoroughly and scrub with stiff fiber or wire brushes, using water freely, until top mortar surface is removed and aggregate is uniformly exposed. Rinse scrubbed surfaces with clean water. Maintain continuity of finish on each surface or area of Work. Remove only enough concrete mortar from surfaces to match design reference sample.
2. High-Pressure Water-Jet Finish: Perform high-pressure water jetting on concrete that has achieved a minimum compressive strength of 4500 psi (31 MPa). Coordinate with formwork removal to ensure that surfaces to be high-pressure water-jet finished are treated at same age for uniform results.
   a. Surface Continuity: Perform high-pressure water-jet finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work. Maintain required patterns or variances in reveal projection to match design reference sample.
3. Abrasive-Blast Finish: Perform abrasive blasting after compressive strength of concrete exceeds 2000 psi (13.8 MPa). Coordinate with formwork removal to ensure that surfaces to be abrasive blasted are treated at same age for uniform results.
   a. Surface Continuity: Perform abrasive-blast finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work. Maintain required patterns or variances in depths of blast to match design reference sample.
   b. Abrasive Blasting: Abrasive blast corners and edges of patterns carefully, using backup boards, to maintain uniform corner or edge line. Determine type of nozzle, nozzle pressure, and blasting techniques required to match design reference sample.
   c. Depth of Cut: Use an abrasive grit of proper type and gradation to expose aggregate and surrounding matrix surfaces to match design reference sample, as follows:
      1) Brush: Remove cement matrix to dull surface sheen and expose face of fine aggregate; with no significant reveal.
      2) Light: Expose fine aggregate with occasional exposure of coarse aggregate and uniform color; with maximum reveal of 1/16 inch (1.5 mm).
      3) Medium: Generally expose coarse aggregate; with slight reveal, a maximum of 1/4 inch (6 mm).
      4) Heavy: Expose and reveal coarse aggregate to a maximum projection of one-third its diameter; with reveal range of 1/4 to 1/2 inch (6 to 13 mm).
4. Bushhammer Finish: Allow concrete to cure at least 14 days before starting bushhammer surface finish operations.
   a. Surface Continuity: Perform bushhammer finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work. Maintain required patterns or variances of cut as shown on Drawings or to match design reference sample or mockup.
   b. Surface Cut: Maintain required depth of cut and general aggregate exposure. Use power tool with hammer attachments for large, flat surfaces, and use hand hammers for small areas, at corners and edges, and for restricted locations where power tools cannot reach.
   c. Remove impressions of formwork and form facings with exception of tie holes.

I. Concrete Protecting And Curing
   1. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with ACI 301 for hot-weather protection during curing.
   2. Begin curing cast-in-place architectural concrete immediately after removing forms from **OR** applying as-cast formed finishes to, **as directed**, concrete. Cure according to ACI 308.1, by one or a combination of the following methods that will not mottle, discolor, or stain concrete:
      a. Moisture Curing: Keep exposed surfaces of cast-in-place architectural concrete continuously moist for not less than seven days with the following materials:
         1) Water.
         2) Continuous water-fog spray.
         3) Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.
      b. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period; use cover material and waterproof tape.
      c. Curing Compound: Mist concrete surfaces with water. Apply curing compound uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

J. Field Quality Control
   1. General: Comply with Division 03 Section "Cast-in-place Concrete" for field quality-control requirements.

K. Repairs, Protection, And Cleaning
   1. Repair and cure damaged finished surfaces of cast-in-place architectural concrete when approved by the Owner. Match repairs to color, texture, and uniformity of surrounding surfaces and to repairs on approved mockups.
      a. Remove and replace cast-in-place architectural concrete that cannot be repaired and cured to the Owner's approval.
   2. Protect corners, edges, and surfaces of cast-in-place architectural concrete from damage; use guards and barricades.
   3. Protect cast-in-place architectural concrete from staining, laitance, and contamination during remainder of construction period.
   4. Clean cast-in-place architectural concrete surfaces after finish treatment to remove stains, markings, dust, and debris.
   5. Wash and rinse surfaces according to concrete finish applicator's written recommendations. Protect other Work from staining or damage due to cleaning operations.
      a. Do not use cleaning materials or processes that could change the appearance of cast-in-place architectural concrete finishes.

END OF SECTION 03302

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Task	Specification	Specification Description
03303	03302	Cast-In-Place Architectural Concrete
03311	03302	Cast-In-Place Architectural Concrete
03350	03302	Cast-In-Place Architectural Concrete

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SECTION 03370 - GLASS FIBER REINFORCED CONCRETE

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for glass-fiber-reinforced precast concrete. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes glass-fiber-reinforced concrete (GFRC) panels consisting of GFRC panel frames, anchors, and connection hardware.
   a. GFRC panels include wall units, window wall units, mullions, column covers, fascia units, cornices, and soffits.

C. Definitions
1. Design Reference Sample: Sample of approved GFRC color, finish, and texture; preapproved by the Owner.

D. Performance Requirements
1. Structural Performance: Provide GFRC panels, including panel frames, anchors, and connections, capable of withstanding the following design loads as well as the effects of thermal- and moisture-induced volume changes, according to load factors and combinations established in PCI MNL 128, "Recommended Practice for Glass Fiber Reinforced Concrete Panels."
   a. Design Loads: As required to meet Project requirements.
   b. Deflection Limits: Design panel frames to withstand design loads without lateral deflections greater than 1/240 of wall span.
   c. Thermal Movements: Provide for thermal movements resulting from annual ambient temperature changes of 100 deg F (56 deg C).
   d. Design panel frames and connections to accommodate deflections and other building movements.
   e. Design panel frames to transfer window loads to building structure.

E. Submittals
1. Product Data: For each type of product indicated. Include GFRC design mixes.
2. Shop Drawings: Show fabrication and installation details for GFRC panels including the following:
   a. Structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   b. Panel elevations, sections, and dimensions.
   c. Thickness of facing mix, GFRC backing, and bonding pads for typical panels.
   d. Finishes.
   e. Joint and connection details.
   f. Erection details.
   g. Panel frame details for typical panels including sizes, spacings, thickness, and yield strength of various members.
   h. Location and details of connection hardware attached to structure.
   i. Size, location, and details of flex, gravity, and seismic anchors for typical panels.
   j. Other items sprayed into panels.
   k. Erection sequence for special conditions.
   l. Relationship to adjacent materials.
   m. Description of loose, cast-in, and field hardware.

3. Samples: Representative of finished exposed face of GFRC showing the full range of colors and textures specified, 12 by 12 inches (305 by 305 mm) and of actual thickness.
4. Qualification Data: For qualified GFRC manufacturer, including proof of current Precast/Prestressed Concrete Institute (PCI) or Architectural Precast Association (APA) Plant Certification.
5. Welding certificates.
6. Steel Sheet Certification: For steel sheet used in cold-formed steel panel framing.
7. Mill Certificates: For structural-steel shapes and hollow structural sections used in panel framing.
8. Source Quality-Control Program: For GFRC manufacturer.
9. Source Quality-Control Test Reports: For GFRC, inserts, and anchors.

F. Quality Assurance
1. Manufacturer Qualifications: A qualified manufacturer that participates in PCI's Plant Certification Program and is designated a PCI-Certified Plant for Group G - Glass Fiber Reinforced Concrete or that participates in APA's Plant Certification Program and is certified for GFRC production.
   a. Manufacturer's responsibility includes fabricating and installing GFRC panels and providing professional engineering services needed to assume engineering responsibility for GFRC panels.
   b. Engineering responsibility includes preparation of Shop Drawings and comprehensive engineering analysis, based on GFRC production test values, by a qualified professional engineer experienced in GFRC design.
2. Steel Sheet Certifications: Obtain mill certificates signed by manufacturers of steel sheet, or test reports from a qualified testing agency, indicating that steel sheet used in cold-formed metal panel framing complies with requirements including uncoated steel thickness, yield strength, tensile strength, total elongation, chemical requirements, and galvanized-coating thickness.
3. Mill Certificates: Obtain certified mill test reports from manufacturer of structural-steel shapes and hollow structural sections used in panel framing indicating compliance of these products with requirements.
4. Source Limitations: Obtain GFRC panels from single source from single manufacturer.
5. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," and AWS D1.3, "Structural Welding Code - Sheet Steel."
6. PCI Manuals: Comply with requirements and recommendations in the following PCI manuals unless more stringent requirements are indicated:
   a. PCI MNL 128, "Recommended Practice for Glass Fiber Reinforced Concrete Panels."
   b. PCI MNL 130, "Manual for Quality Control for Plants and Production of Glass Fiber Reinforced Concrete Products."
7. AISC Specifications: Comply with AISC's "Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design" **OR** "Load and Resistance Factor Design Specification for Structural Steel Buildings" **OR** "Specification for the Design of Steel Hollow Structural Sections," **as directed**, if using structural-steel shapes or hollow structural sections for panel frames.
8. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Handle and transport GFRC panels to avoid damage.
   a. Place nonstaining resilient spacers between panels.
   b. Support panels on nonstaining material during shipment.
   c. Protect panels from dirt and damage during handling and transport.
2. Store GFRC panels to protect from contact with soil, staining, and physical damage.
   a. Store panels with nonstaining resilient supports in same positions as when transported.
   b. Store panels on firm, level, and smooth surfaces.
   c. Place stored panels so identification marks are clearly visible.

1.2 PRODUCTS

A. Mold Materials
1. Molds: Rigid, dimensionally stable, nonabsorptive material, warp and buckle free, that will provide continuous and true GFRC surfaces; nonreactive with GFRC and capable of producing required finish surfaces.
a. Mold-Release Agent: Commercially produced liquid-release agent that will not bond with, stain, or adversely affect GFRC surfaces and will not impair subsequent surface or joint treatments of GFRC.
2. Form Liners: Units of face design, texture, arrangement, and configuration indicated **OR** to match GFRC design reference sample, **as directed**. Provide solid backing and form supports to ensure that form liners remain in place during GFRC application. Use with manufacturer's recommended liquid-release agent that will not bond with, stain, or adversely affect GFRC surfaces and will not impair subsequent surface or joint treatments of GFRC.
3. Surface Retarder: Chemical liquid set retarder capable of temporarily delaying hardening of newly placed GFRC face mix to depth of reveal specified.

B. GFRC Materials
1. Portland Cement: ASTM C 150; Type I, II, or III.
a. For surfaces exposed to view in finished structure, use gray **OR** white, **as directed**, of same type, brand, and source throughout GFRC production.
b. Metakaolin: ASTM C 618, Class N.
2. Glass Fibers: Alkali resistant, with a minimum zirconia content of 16 percent, 1 to 2 inches (25 to 50 mm) long, specifically produced for use in GFRC, and complying with PCI MNL 130.
3. Sand: Washed and dried silica, complying with composition requirements in ASTM C 144; passing No. 20 (0.85-mm) sieve with a maximum of 2 percent passing No. 100 (0.15-mm) sieve.
4. Facing Aggregate: ASTM C 33, except for gradation, and PCI MNL 130, 1/4-inch (6-mm) maximum size.
a. Aggregates: Selected, hard, and durable; free of material that reacts with cement or causes staining; to match sample.
5. Coloring Admixture: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures, temperature stable, nonfading, and alkali resistant.
6. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of GFRC and complying with chemical limits of PCI MNL 130.
7. Polymer-Curing Admixture: Acrylic thermoplastic copolymer dispersion complying with PCI MNL 130.
8. Air-Entraining Admixture: ASTM C 260, containing not more than 0.1 percent chloride ions.
9. Chemical Admixtures: ASTM C 494/C 494M, containing not more than 0.1 percent chloride ions.

C. Anchors, Connectors, And Miscellaneous Materials
1. Carbon-Steel Shapes and Plates: ASTM A 36/A 36M. Finish steel shapes and plates less than 3/16 inch (4.76 mm) thick as follows:
a. Finish: Zinc coated by hot-dip process according to ASTM A 123/A 123M, after fabrication, or ASTM A 153/A 153M, as applicable **OR** electrodeposition according to ASTM B 633, SC 3, **as directed**.
OR
Finish: Shop primed with MPI#79 **OR** SSPC-Paint 25, **as directed**, on surfaces prepared to comply with SSPC-SP 2, "Hand Tool Cleaning," or better.
2. Carbon-Steel Bars: ASTM A 108, AISI Grade 1018. Finish steel bars less than 3/16 inch (4.76 mm) thick as follows:
a. Finish: Zinc coated by hot-dip process according to ASTM A 123/A 123M, after fabrication, or ASTM A 153/A 153M, as applicable **OR** electrodeposition according to ASTM B 633, SC 3, **as directed**.
b. Finish: Shop primed with MPI#79 **OR** SSPC-Paint 25, **as directed**, on surfaces prepared to comply with SSPC-SP 2, "Hand Tool Cleaning," or better.
3. Malleable-Iron Castings: ASTM A 47/ A 47M, Grade 32510 (Grade 22010).

4. Carbon-Steel Castings: ASTM A 27/A 27M, Grade 60-30 (Grade 415-205).
5. Bolts: ASTM A 307 or ASTM A 325 (ASTM F 568M or ASTM A 325M).
   a. Finish: Zinc coated by hot-dip process according to ASTM A 123/A 123M, after fabrication, and ASTM A 153/A 153M, as applicable **OR** electrodeposition according to ASTM B 633, SC 3, **as directed**.
6. Reglets: PVC extrusions.

D. Panel Frame Materials
1. Cold-Formed Steel Framing: Manufacturer's standard C-shaped steel studs, complying with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members," minimum uncoated steel thickness of 0.053 inch (1.34 mm) of web depth indicated, with stiffened flanges, U-shaped steel track, and of the following steel sheet:
   a. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, structural-steel sheet, G60 (Z180) **OR** G90 (Z275), **as directed**, zinc coating, of grade required by structural performance of framing.
   b. Painted, Nonmetallic-Coated Steel Sheet: ASTM A 1011/A 1011M, hot rolled; or ASTM A 1008/A 1008M, cold rolled; nonmetallic coated according to ASTM A 1003/A 1003M; of grade required by structural performance of framing.
2. Hollow Structural Sections: Steel tubing, ASTM A 500, Grade B, or ASTM A 513. Finish hollow structural sections with wall thickness less than 3/16 inch (4.76 mm) as follows:
   a. Organic Zinc-Rich Primer: SSPC-Paint 20 on surfaces prepared to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   b. Primer: MPI#79 **OR** SSPC-Paint 25, **as directed**, on surfaces prepared to comply with SSPC-SP 2, "Hand Tool Cleaning," or better.
3. Steel Channels and Angles: ASTM A 36/A 36M, finished as follows:
   a. Organic Zinc-Rich Primer: SSPC-Paint 20 on surfaces prepared to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   b. Primer: MPI#79 **OR** SSPC-Paint 25, **as directed**, on surfaces prepared to comply with SSPC-SP 2, "Hand Tool Cleaning," or better.

E. GFRC Mixes
1. Backing Mix: Proportion backing mix of portland cement, glass fibers, sand, and admixtures to comply with design requirements. Provide nominal glass-fiber content of not less than 5 percent by weight of total mix.
2. Face Mix: Proportion face mix of portland cement, sand, facing aggregates, and admixtures to comply with design requirements.
3. Mist Coat: Portland cement, sand slurry, and admixtures; of same proportions as backing mix without glass fibers.
4. Polymer-Curing Admixture: 6 to 7 percent by weight of polymer-curing admixture solids to dry portland cement.
5. Air Content: 8 to 10 percent; ASTM C 185.
6. Coloring Admixture: Not to exceed 10 percent of cement weight.

F. Panel Frame Fabrication
1. Fabricate panel frames and accessories plumb, square, true to line, and with components securely fastened, according to Shop Drawings and requirements in this Section.
   a. Fabricate panel frames using jigs or templates.
   b. Cut cold-formed metal framing members by sawing or shearing; do not torch cut.
   c. Fasten cold-formed metal framing members by welding. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
   d. Fasten framing members of hollow structural sections, steel channels, or steel angles by welding. Comply with AWS D1.1/D1.1M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
   e. Weld flex, gravity, and seismic anchors to panel frames.

2. Reinforce, stiffen, and brace framing assemblies, if necessary, to withstand handling, delivery, and erection stresses. Lift fabricated assemblies in a manner that prevents damage or significant distortion.
3. Galvanizing Repair: Touch up accessible damaged galvanized surfaces according to ASTM A 780.
4. Painting Repair: Touch up accessible damaged painted surfaces using same primer.

G. Mold Fabrication
1. Construct molds that will result in finished GFRC complying with profiles, dimensions, and tolerances indicated, without damaging GFRC during stripping. Construct molds to prevent water leakage and loss of cement paste.
   a. Coat contact surfaces of molds with form-release agent.
   b. Coat contact surfaces of molds with surface retarder.
2. Place form liners accurately to provide finished surface texture indicated. Provide solid backing and supports to maintain stability of liners during GFRC application. Coat form liner with form-release agent.
3. Locate, place, and secure flashing reglets accurately.

H. GFRC Fabrication
1. Proportioning and Mixing: For backing mix, meter sand/cement slurry and glass fibers to spray head at rates to achieve design mix proportions and glass-fiber content according to PCI MNL 130 procedures.
2. Spray Application: Comply with general procedures as follows:
   a. Spray mist coat over molds to a nominal thickness of 1/8 inch (3 mm) on planar surfaces.
   b. Spray or place face mix in thickness indicated on Shop Drawings.
   c. Proceed with spraying backing mix before face mix **OR** mist coat, **as directed**, has set, using procedures that produce a uniform thickness and even distribution of glass fibers and matrix.
   d. Consolidate backing mix by rolling or other technique to achieve complete encapsulation of glass fibers and compaction.
   e. Measure thickness with a pin gage or other acceptable method at least once for each 5 sq. ft. (0.5 sq. m) of panel surface. Take not less than six measurements per panel.
3. Hand form and consolidate intricate details, incorporate formers or infill materials, and over spray before material reaches initial set to ensure complete bonding.
4. Attach panel frame to GFRC before initial set of GFRC backing, maintaining a minimum clearance of 1/2 inch (13 mm) from GFRC backing, and without anchors protruding into GFRC backing.
5. Build up homogeneous GFRC bonding pads over anchor feet, maintaining a minimum thickness of 1/2 inch (13 mm) over tops of anchor feet, before initial set of GFRC backing.
6. Inserts and Embedments: Build up homogeneous GFRC bosses or bonding pads over inserts and embedments to provide sufficient anchorage and embedment to comply with design requirements.
7. Curing: Employ initial curing method that will ensure sufficient strength for removing units from mold. Comply with PCI MNL 130 procedures.
8. Panel Identification: Mark each GFRC panel to correspond with identification mark on Shop Drawings. Mark each panel with its casting date.

I. Fabrication Tolerances
1. Manufacturing Tolerances: Manufacture GFRC panels so each finished unit complies with PCI MNL 130 for dimension, position, and tolerances.

   OR

   Manufacturing Tolerances: Manufacture GFRC panels so each finished unit complies with the following dimensional tolerances. For dimensional tolerances not listed below, comply with PCI MNL 130.
   a. Overall Height and Width of Units, Measured at the Face Adjacent to Mold: As follows:
      1) 10 feet (3 m) or less, plus or minus 1/8 inch (3 mm).

2) More than 10 feet (3 m), plus or minus 1/8 inch per 10 feet (3 mm per 3 m); 1/4 inch (6 mm) maximum.

b. Edge Return Thickness: Plus 1/2 inch (13 mm), minus 0 inch (0 mm).
c. Architectural Facing Thickness: Plus 1/8 inch (3 mm), minus 0 inch (0 mm).
d. Backing Thickness: Plus 1/4 inch (6 mm), minus 0 inch (0 mm).
e. Panel Depth from Face of Skin to Back of Panel Frame or Integral Rib: Plus 3/8 inch (10 mm), minus 1/4 inch (6 mm).
f. Angular Variation of Plane of Side Mold: Plus or minus 1/32 inch per 3 inches (0.8 mm per 75 mm) of depth or plus or minus 1/16 inch (1.5 mm) total, whichever is greater.
g. Variation from Square or Designated Skew (Difference in Length of Two Diagonal Measurements): Plus or minus 1/8 inch per 72 inches (3 mm per 1800 mm) or plus or minus 1/4 inch (6 mm) total, whichever is greater.
h. Local Smoothness: 1/4 inch per 10 feet (6 mm per 3 m).
i. Bowing: Not to exceed L/240 unless unit meets erection tolerances using connection adjustments.
j. Length and Width of Block Outs and Openings within One Unit: Plus or minus 1/4 inch (6 mm).
k. Location of Window Opening within Panel: Plus or minus 1/4 inch (6 mm).
l. Maximum Permissible Warpage of One Corner out of the Plane of the Other Three: 1/16 inch per 12 inches (1.5 mm per 305 mm) of distance from nearest adjacent corner.

2. Position Tolerances: Measured from datum line locations, as indicated on Shop Drawings.
   a. Panel Frame and Track: Plus or minus 1/4 inch (6 mm).
   b. Flashing Reglets at Edge of Panel: Plus or minus 1/4 inch (6 mm).
   c. Inserts: Plus or minus 1/2 inch (13 mm).
   d. Special Handling Devices: Plus or minus 3 inches (75 mm).
   e. Location of Bearing Devices: Plus or minus 1/4 inch (6 mm).
   f. Blockouts: Plus or minus 3/8 inch (10 mm).
3. Panel Frame Tolerances: As follows:
   a. Vertical and Horizontal Alignment: 1/4 inch per 10 feet (6 mm per 3 m).
   b. Spacing of Framing Member: Plus or minus 3/8 inch (10 mm).
   c. Squareness of Frame: Difference in length of diagonals of 3/8 inch (10 mm).
   d. Overall Size of Frame: Plus or minus 3/8 inch (10 mm).

J. Finishes
1. Finish exposed-face surfaces of GFRC as follows to match approved design reference sample. Panel faces shall be free of joint marks, grain, or other obvious defects.
   a. Design Reference Sample: <Insert description and identify manufacturer and code number of sample>.
   b. As-Cast-Surface Finish: Provide free of sand streaks, honeycombs, and excessive air voids, with uniform color and texture.
   c. Textured-Surface Finish: Impart by form liners to provide surfaces free of sand streaks, honeycombs, and excessive air voids, with uniform color and texture.
   d. Retarded Finish: Use chemical-retarding agents applied to concrete forms and washing and brushing procedures to expose aggregate and surrounding matrix surfaces after form removal.
   e. Sand- or Abrasive-Blast Finish: Use abrasive grit, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces.
   f. Acid-Etched Finish: Use acid and hot-water solution equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces.

K. Source Quality Control
1. Quality-Control Testing: Establish and maintain a quality-control program for manufacturing GFRC panels according to PCI MNL 130.
   a. Test materials and inspect production techniques.

b. Quality-control program shall monitor glass-fiber content, spray rate, unit weight, product physical properties, anchor pull-off and shear strength, and curing period and conditions.
c. Prepare test specimens and test according to ASTM C 1228, PCI MNL 130, and PCI MNL 128 procedures.
d. Test GFRC inserts and anchors according to ASTM C 1230 to validate design values.
e. Produce test boards at a rate not less than one per work shift per operator for each spray machine and for each mix design.
1) For each test board, determine glass-fiber content according to ASTM C 1229, and flexural yield and ultimate strength according to ASTM C 947.

1.3 EXECUTION

A. Examination
1. Examine structure and conditions for compliance with requirements for installation tolerances, true and level bearing surfaces, and other conditions affecting performance of the Work.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Erection
1. Install clips, hangers, and other accessories required for connecting GFRC panels to supporting members and backup materials.
2. Lift GFRC panels and install without damage.
3. Install GFRC panels level, plumb, square, and in alignment. Provide temporary supports and bracing as required to maintain position, stability, and alignment of panels until permanent connections are completed.
a. Maintain horizontal and vertical joint alignment and uniform joint width.
b. Remove projecting hoisting devices.
4. Connect GFRC panels in position by bolting or welding, or both, as indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as possible after connecting is completed.
5. Welding: Comply with applicable AWS D1.1/D1.1M and AWS D1.3 requirements for welding, appearance, quality of welds, and methods used in correcting welding work.
a. Protect GFRC panels from damage by field welding or cutting operations, and provide noncombustible shields as required.
6. At bolted connections, use lock washers or other acceptable means to prevent loosening of nuts.

C. Erection Tolerances
1. Erect GFRC panels to comply with the following noncumulative tolerances:
a. Plan Location from Building Grid Datum: Plus or minus 1/2 inch (13 mm).
b. Top Elevation from Nominal Top Elevation: As follows:
1) Exposed Individual Panel: Plus or minus 1/4 inch (6 mm).
2) Nonexposed Individual Panel: Plus or minus 1/2 inch (13 mm).
3) Exposed Panel Relative to Adjacent Panel: 1/4 inch (6 mm).
4) Nonexposed Panel Relative to Adjacent Panel: 1/2 inch (13 mm).
c. Support Elevation from Nominal Elevation: As follows:
1) Maximum Low: 1/2 inch (13 mm).
2) Maximum High: 1/4 inch (6 mm).
d. Maximum Plumb Variation over the Lesser of Height of Structure or 100 Feet (30 m): 1 inch (25 mm).
e. Plumb in Any 10 Feet (3 m) of Element Height: 1/4 inch (6 mm).
f. Maximum Jog in Alignment of Matching Edges: 1/4 inch (6 mm).
g. Maximum Jog in Alignment of Matching Faces: 1/4 inch (6 mm).
h. Face Width of Joint: As follows (governs over joint taper):
1) Panel Dimension 20 Feet (6 m) or Less: Plus or minus 1/4 inch (6 mm).
2) Panel Dimension More Than 20 Feet (6 m): Plus or minus 5/16 inch (8 mm).
i. Maximum Joint Taper: 3/8 inch (10 mm).

j. Joint Taper in 10 Feet (3 m): 1/4 inch (6 mm).
k. Differential Bowing, as Erected, between Adjacent Members of Same Design: 1/4 inch (6 mm).

D. Repairs
1. Repairs will be permitted provided structural adequacy of GFRC panel and appearance are not impaired, as approved by the Owner.
2. Mix patching materials and repair GFRC so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces.
3. Prepare and repair accessible damaged galvanized coatings with galvanizing repair paint according to ASTM A 780.
4. Wire brush, clean, and paint accessible weld areas on prime-painted components with same type of shop primer.
5. Remove and replace damaged GFRC panels when repairs do not comply with requirements.

E. Cleaning And Protection
1. Perform cleaning procedures, if necessary, according to GFRC manufacturer's written instructions. Clean soiled GFRC surfaces with detergent and water, using soft fiber brushes and sponges, and rinse with clean water. Prevent damage to GFRC surfaces and staining of adjacent materials.

END OF SECTION 03370

Task	Specification	Specification Description
03390	03302	Cast-In-Place Architectural Concrete

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SECTION 03510 - PRECAST LIGHWEIGHT ROOF SLABS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of precast lightweight roof deck concrete channels, concrete planks, and gypsum planks. Products shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 PRODUCTS

A. Channel Slabs: Slabs shall be composed of Portland cement and lightweight aggregate with minimum compressive strength 3,750 psi. Legs shall be reinforced with deformed bars; web shall have welded wire fabric reinforcement. Channels shall support a 30 psf live load plus a 20 psf superimposed dead load.

B. Concrete Planks: Planks shall be composed of Portland cement and lightweight aggregate with a minimum compressive strength of 3,750 psi. Planks shall be reinforced with welded wire fabric. Planks shall support a 30 psf live load plus a 20 psf superimposed dead load.

C. Gypsum Planks shall conform to ASTM C 956, factory-laminated to 2-inch thickness, 2-foot wide panels. Planks shall be continuously supported along sides.

D. Subpurlins shall be bulb-ties, ASTM A 440.

E. Grout shall be lightweight concrete or gypsum concrete.

1.3 EXECUTION

A. Concrete Channels and Planks shall be securely attached to support steel or concrete by metal clips or other approved attachments; minimum support bearing shall be 4 inches. Open joints between channels or planks shall be filled with lightweight concrete grout. Planks with tongue and groove edges may not require grouting.

B. Gypsum Planks shall be snugly fit between bulb-tee subpurlins. Subpurlins shall be tack-welded or screw-attached to supporting steel or weld bar cast in supporting concrete. Joints at bulb-tees shall be grouted with gypsum grout.

END OF SECTION 03510

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SECTION 03510a - GYPSUM PLANK DECKING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for gypsum plank decking for interstitial decks **OR** fire rated interstitial decks, **as directed**, and roof decks. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Fire Tests: Fire tests, data and certifications substantiating that Gypsum Plank Decking complies with fire rating requirements.
2. Shop Drawings: Show typical plank layouts, perimeter and framed opening supports and details of construction, installation, fastenings and grouting.
3. Manufacturer's Literature and Data: Each item specified.
4. Load tables for sub-purlins.

C. Quality Control
1. Work performed by experienced, qualified installers approved by manufacturer of gypsum plank.
2. Gypsum materials products of one manufacturer.

D. Delivery And Storage
1. Deliver materials in original packages, containers, or bundles bearing brand name and name of manufacturer.
2. Store materials in a manner that prevents damage before use. When stored under tarpaulins, provide ventilation to prevent moisture accumulation under tarpaulin.
3. Store gypsum planks flat and off ground. Handle and stack in a manner to prevent damage to face, ends, and edges and keep dry until used.
4. Store gypsum concrete off ground and keep dry until used.

1.2 PRODUCTS

A. Materials
1. Structural Steel Tee Sub-purlins:
a. Open web truss-tees, hot-rolled bulb-tees or folded sheet metal tees as required by design loads, spans and fire ratings.
b. Flanges: Provide 5/8-inch (16 mm) minimum bearing for gypsum planks.
c. Galvanize or factory coat sub-purlins with manufacturer's standard primer.
d. Open web truss-tees: Fabricate from cold-formed steel wire conforming to ASTM A82.
e. Hot-rolled bulb-tees: Rail-shaped, fabricated from hot-rolled steel conforming to ASTM A36/A36M or ASTM A499.
f. Folded sheet metal tees: Fabricate from sheet steel conforming to ASTM A653 and ASTM A568/A568M.
2. Cross-Tees:
a. Cold-Formed, Fabrication from sheet steel conforming to ASTM A653/A653M or ASTM A568/A568M.
b. Size: 1-1/4-inches (30 mm) by 1/2-inch (13 mm) by 0.023-inch (0.6 mm) thick by 24-inches (600 mm) long.
c. Tees shall be galvanized or factory coated with manufacturer's standard primer.
3. Gypsum Deck Plank:
a. Fabricated of gypsum board: ASTM C442.

b. Nominal Size: 2-inches (50 mm) **OR** 2-5/8-inches (65 mm), **as directed**, thick by 24-inches (600 mm) wide by main purlin span. Where possible, length should span two main purlin spans.
c. Factory laminate from two 1-inch (25 mm) thick gypsum panels with top panel edge set back along sub-purlin edge not more than 1/2-inch (13 mm).
d. Offset edges encased in water-resistant paper.

4. Gypsum Deck Panels: ASTM C36, Type "X", 5/8-inch (16 mm) thick by 24-inches (600 mm) wide by main purlin span.
5. Grout: Gypsum Concrete: ASTM C317, Class A, 500 psi (3.5 MPa) minimum compressive strength.
6. Miscellaneous Materials: Adhesives, mastics, cements, tapes and primers shall be as recommended by the gypsum plank manufacturer and shall be compatible with the material to which they are to be bonded.

B. Deck System
1. Interstitial deck: Provide two-hour fire rating as tested by gypsum plank manufacturer under ASTM E119.
2. Roof Deck: Provide one hour **OR** 1-1/2 hour, **as directed**, fire rating per tested assembly by Underwriters' Laboratory Inc. or other testing.

1.3 EXECUTION

A. Installation
1. Weld per AWS D1.1.
2. Sub-purlins:
a. Space at approximately 24-5/8-inches (650 mm) on center to provide minimum 5/8 inch (16 mm) continuous bearing for gypsum plank or deck.
b. Install framing of openings.
c. Touch up welds with same type of rust-inhibitive paint used for primer.
d. Interstitial Decks: Use 3/4-inch (19 mm) fillet welds on both sides of sub-purlins at math purlin.
e. Roof Decks: Use minimum 1/2-inch (13 mm) fillet welds on alternate sides of sub-purlins, both sides at end joints to main purlins.
f. For fire rated roof decks weld per fire test assembly.
3. For Two Hour fire rated interstitial decks **OR** fire-rated roof decks, **as directed**.
a. Place gypsum deck panels on bottom flanges of sub-purlins with 5/8-inch (16 mm) minimum continuous bearing.
b. Place gypsum deck plank over gypsum deck panels, with off-set edges "up" to form a "T" receptacle for gypsum grout.
c. Cut to fit around openings shown.
d. Install plank to conform to fire test assembly.
4. Gypsum Deck Plank for Roof Decks:
a. Place plank on lower flanges of sub-purlins or other framing with ends and edges supported.
b. Stagger joints in adjacent courses.
c. Support end joints with cross-tees not supported by framing.
d. Cut plank to fit at ends and framed openings.
5. Provide continuous 5/8-inch (16 mm) minimum bearing for plank support at deck perimeter, plank ends and openings exceeding 8-inches (200 mm).
6. Grout:
a. Mix gypsum concrete thoroughly using a minimum amount of water to form a thick, pourable consistency.
b. Fill edge joints to slight excess with single pour at sub-purlins.
1) Grout end joints on single span system against steel framing.

2) After initial set, strike of excess to form smooth, flush joint.
3) Form cant strips and curbs where shown.

c. Fill joints at roof ridges, hips and valleys.

7. Patching:
   a. Fill with grout and smooth any surface damage to gypsum plank.
   b. Remove and replace cracked, broken, and plank damaged beyond repair.
8. Cleaning and Protection:
   a. Upon completion of gypsum plank decking, remove, debris and sweep surface clean. Leave ready for subsequent work.
   b. Protect finished deck from weather and subsequent construction operations.
   c. Provide hardboard or plywood temporary protection over decking subject to repetitive impact or wheeled loads.

END OF SECTION 03510a

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SECTION 03620 - PLANT-PRECAST STRUCTURAL CONCRETE

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for plant-precast structural concrete. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Precast structural concrete.
   b. Precast structural concrete with thin-brick or stone facings.
   c. Precast structural concrete with commercial architectural finish.

C. Definition
1. Design Reference Sample: Sample of approved precast structural concrete color, finish, and texture, preapproved by the Owner.

D. Performance Requirements
1. Delegated Design: Design precast structural concrete, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Structural Performance: Precast structural concrete units and connections shall withstand design loads indicated within limits and under conditions indicated.
   a. Fire-Resistance Rating: Select material and minimum thicknesses to provide indicated fire rating.

E. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
   a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
      1) Include statement indicating costs for each product having recycled content.
   b. Design Mixtures for Credit ID 1.1: For each concrete mixture containing fly ash as a replacement for portland cement or other portland cement replacements and for equivalent concrete mixtures that do not contain portland cement replacements.
3. Design Mixtures: For each precast concrete mixture. Include compressive strength and water-absorption tests.
4. Shop Drawings: Include member locations, plans, elevations, dimensions, shapes and sections, openings, support conditions, and types of reinforcement, including special reinforcement. Detail fabrication and installation of precast structural concrete units.
5. Delegated-Design Submittal: For precast structural concrete indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
6. Qualification Data: For Installer **OR** fabricator **OR** testing agency, **as directed**.
7. Welding certificates.
8. Material Certificates.
9. Material Test Reports.
10. Source quality-control reports.
11. Field quality-control and special inspection, **as directed**, reports.

F. Quality Assurance
1. Fabricator Qualifications: A firm that assumes responsibility for engineering precast structural concrete units to comply with performance requirements. Responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.
a. Participates in PCI's Plant Certification program and is designated a PCI-certified plant as follows:
1) Group C, Category C1 - Precast Concrete Products (no prestressed reinforcement) **OR** Category C2 - Prestressed Hollowcore and Repetitively Produced Products **OR** Category C3 - Prestressed Straight Strand Structural Members **OR** Category C4 - Prestressed Deflected Strand Structural Members, **as directed**.
2) Group CA, Category C1A - Precast Concrete Products (no prestressed reinforcement) **OR** Category C2A - Prestressed Hollowcore and Repetitively Produced Products **OR** Category C3A - Prestressed Straight-Strand Structural Members **OR** Category C4A - Prestressed Deflected-Strand Structural Members, **as directed**.
2. Design Standards: Comply with ACI 318 (ACI 318M) and design recommendations in PCI MNL 120, "PCI Design Handbook - Precast and Prestressed Concrete," applicable to types of precast structural concrete units indicated.
3. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and dimensional tolerances for types of units required, comply with PCI MNL 116, "Manual for Quality Control for Plants and Production of Structural Precast Concrete Products."
4. Welding Qualifications: Qualify procedures and personnel according to the following:
a. AWS D1.1/D.1.1M, "Structural Welding Code - Steel."
b. AWS D1.4, "Structural Welding Code - Reinforcing Steel."
5. Fire-Resistance Calculations: Where indicated, provide precast structural concrete units whose fire resistance meets the prescriptive requirements of authorities having jurisdiction or has been calculated according to ACI 216.1/TMS 0216.1, "Standard Method for Determining Fire Resistance of Concrete and Masonry Construction Assemblies," **OR** PCI MNL 124, "Design for Fire Resistance of Precast Prestressed Concrete," **as directed**, and is acceptable to authorities having jurisdiction.
6. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Support units during shipment on nonstaining shock-absorbing material in same position as during storage.
2. Store units with adequate bracing and protect units to prevent contact with soil, to prevent staining, and to prevent cracking, distortion, warping or other physical damage.
a. Store units with dunnage across full width of each bearing point unless otherwise indicated.
b. Place adequate dunnage of even thickness between each unit.
c. Place stored units so identification marks are clearly visible, and units can be inspected.
3. Handle and transport units in a position consistent with their shape and design in order to avoid excessive stresses that would cause cracking or damage.
4. Lift and support units only at designated points shown on Shop Drawings.

H. Coordination
1. Furnish loose connection hardware and anchorage items to be embedded in or attached to other construction before starting that Work. Provide locations, setting diagrams, templates, instructions, and directions, as required, for installation.

1.2 PRODUCTS

A. Mold Materials

1. Molds: Rigid, dimensionally stable, non-absorptive material, warp and buckle free, that will provide continuous and true precast concrete surfaces within fabrication tolerances indicated; nonreactive with concrete and suitable for producing required finishes.
   a. Mold-Release Agent: Commercially produced liquid-release agent that will not bond with, stain or adversely affect precast concrete surfaces and will not impair subsequent surface or joint treatments of precast concrete.
2. Form Liners: Units of face design, texture, arrangement, and configuration indicated **OR** to match those used for precast concrete design reference sample, **as directed**. Furnish with manufacturer's recommended liquid-release agent that will not bond with, stain, or adversely affect precast concrete surfaces and will not impair subsequent surface or joint treatments of precast concrete.
3. Surface Retarder: Chemical set retarder, capable of temporarily delaying final hardening of newly placed concrete mixture to depth of reveal specified.

B. Reinforcing Materials
1. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 **OR** 60, **as directed**, percent.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
3. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.
4. Galvanized Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**, deformed bars, ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized, and chromate wash treated after fabrication and bending, **as directed**.
5. Epoxy-Coated Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**, deformed bars, ASTM A 775/A 775M **OR** ASTM A 934/A 934M, **as directed**, epoxy coated, with less than 2 percent damaged coating in each 12-inch (300-mm) bar length.
6. Steel Bar Mats: ASTM A 184/A 184M, fabricated from ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**, deformed bars, assembled with clips.
7. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel **OR** galvanized-steel, **as directed**, wire into flat sheets.
8. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.
9. Epoxy-Coated-Steel Wire: ASTM A 884/A 884M, Class A coated, plain **OR** deformed, **as directed**, flat sheet, Type 1 bendable **OR** Type 2 nonbendable, **as directed**, coating.
10. Supports: Suspend reinforcement from back of mold or use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 116.

C. Prestressing Tendons
1. Pretensioning Strand: ASTM A 416/A 416M, Grade 250 (Grade 1720) or Grade 270 (Grade 1860), uncoated, 7-wire **OR** ASTM A 886/A 886M, Grade 270 (Grade 1860), indented, 7-wire, **as directed**, low-relaxation strand.
2. Unbonded Post-Tensioning Strand: ASTM A 416/A 416M, Grade 270 (Grade 1860), uncoated, 7-wire, low-relaxation strand.
   a. Coat unbonded post-tensioning strand with post-tensioning coating complying with ACI 423.6 and sheath with polypropylene tendon sheathing complying with ACI 423.6. Include anchorage devices and coupler assemblies.
3. Post-Tensioning Bars: ASTM A 722, uncoated high-strength steel bar.

D. Concrete Materials
1. Portland Cement: ASTM C 150, Type I or Type III, gray, unless otherwise indicated.
   a. For surfaces exposed to view in finished structure, mix gray with white cement, of same type, brand, and mill source.
2. Supplementary Cementitious Materials:
   a. Fly Ash: ASTM C 618, Class C or F, with maximum loss on ignition of 3 percent.
   b. Metakaolin Admixture: ASTM C 618, Class N.

c. Silica Fume Admixture: ASTM C 1240, with optional chemical and physical requirement.
d. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

3. Normal-Weight Aggregates: Except as modified by PCI MNL 116, ASTM C 33, with coarse aggregates complying with Class 5S **OR** Class 5M **OR** Class 4S **OR** Class 4M, **as directed**. Stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for Project.
   a. Face-Mixture-Coarse Aggregates: Selected, hard, and durable; free of material that reacts with cement or causes staining; to match selected finish sample.
      1) Gradation: Uniformly graded **OR** Gap graded **OR** To match design reference sample, **as directed**.
   b. Face-Mixture-Fine Aggregates: Selected, natural or manufactured sand of same material as coarse aggregate unless otherwise approved by the Owner.
4. Lightweight Aggregates: Except as modified by PCI MNL 116, ASTM C 330, with absorption less than 11 percent.
5. Coloring Admixture: ASTM C 979, synthetic or natural mineral-oxide pigments or colored water-reducing admixtures, temperature stable, and nonfading.
6. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 116.
7. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
8. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture.
   a. Water-Reducing Admixtures: ASTM C 494/C 494M, Type A.
   b. Retarding Admixture: ASTM C 494/C 494M, Type B.
   c. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
   d. Water-Reducing and Accelerating Admixture: ASTM C 494/C 494M, Type E.
   e. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
   f. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
   g. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M.
9. Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.

E. Steel Connection Materials
1. Carbon-Steel Shapes and Plates: ASTM A 36/A 36M.
2. Carbon-Steel-Headed Studs: ASTM A 108, AISI 1018 through AISI 1020, cold finished, AWS D1.1/D1.1M, Type A or B, with arc shields and with minimum mechanical properties of PCI MNL 116.
3. Carbon-Steel Plate: ASTM A 283/A 283M.
4. Malleable-Iron Castings: ASTM A 47/A 47M.
5. Carbon-Steel Castings: ASTM A 27/A 27M, Grade 60-30 (Grade 415-205).
6. High-Strength, Low-Alloy Structural Steel: ASTM A 572/A 572M.
7. Carbon-Steel Structural Tubing: ASTM A 500, Grade B.
8. Wrought Carbon-Steel Bars: ASTM A 675/A 675M, Grade 65 (Grade 450).
9. Deformed-Steel Wire or Bar Anchors: ASTM A 496 or ASTM A 706/A 706M.
10. Carbon-Steel Bolts and Studs: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); carbon-steel, hex-head bolts and studs; carbon-steel nuts, ASTM A 563 (ASTM A 563M); and flat, unhardened steel washers, ASTM F 844.
11. High-Strength Bolts and Nuts: ASTM A 325 (ASTM A 325M) or ASTM A 490 (ASTM A 490M), Type 1, heavy hex steel structural bolts; heavy hex carbon-steel nuts, ASTM A 563 (ASTM A 563M); and hardened carbon-steel washers, ASTM F 436 (ASTM F 436M).
    a. Do not zinc coat ASTM A 490 (ASTM A 490M) bolts.
12. Zinc-Coated Finish: For exterior steel items, steel in exterior walls, **as directed**, and items indicated for galvanizing, apply zinc coating by hot-dip process according to ASTM A 123/A 123M

or ASTM A 153/A 153M **OR** electrodeposition according to ASTM B 633, SC 3, Types 1 and 2, **as directed**.

a. For steel shapes, plates, and tubing to be galvanized, limit silicon content of steel to less than 0.03 percent or to between 0.15 and 0.25 percent or limit sum of silicon and 2.5 times phosphorous content to 0.09 percent.

b. Galvanizing Repair Paint: High-zinc-dust-content paint with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035B or SSPC-Paint 20.

13. Shop-Primed Finish: Prepare surfaces of nongalvanized-steel items, except those surfaces to be embedded in concrete, according to requirements in SSPC-SP 3, and shop apply lead- and chromate-free, rust-inhibitive primer, complying with performance requirements in MPI 79 **OR** SSPC-Paint 25, **as directed**, according to SSPC-PA 1.
14. Welding Electrodes: Comply with AWS standards.
15. Precast Accessories: Provide clips, hangers, plastic or steel shims, and other accessories required to install precast structural concrete units.

F. Stainless-Steel Connection Materials

1. Stainless-Steel Plate: ASTM A 666, Type 304, of grade suitable for application.
2. Stainless-Steel Bolts and Studs: ASTM F 593, Alloy 304 or 316, hex-head bolts and studs; stainless-steel nuts; and flat, stainless-steel washers. Lubricate threaded parts of stainless-steel bolts with an antiseize thread lubricant during assembly.
3. Stainless-Steel-Headed Studs: ASTM A 276, with minimum mechanical properties of PCI MNL 116.

G. Bearing Pads

1. Provide one of the following bearing pads for precast structural concrete units as recommended by precast fabricator for application, **as directed**:

a. Elastomeric Pads: AASHTO M 251, plain, vulcanized, 100 percent polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet, 50 to 70 Shore, Type A durometer hardness, ASTM D 2240; minimum tensile strength 2250 psi (15.5 MPa), ASTM D 412.

b. Random-Oriented, Fiber-Reinforced Elastomeric Pads: Preformed, randomly oriented synthetic fibers set in elastomer. 70 to 90 Shore, Type A durometer hardness, ASTM D 2240; capable of supporting a compressive stress of 3000 psi (20.7 MPa) with no cracking, splitting, or delaminating in the internal portions of pad. Test 1 specimen for every 200 pads used in Project.

c. Cotton-Duck-Fabric-Reinforced Elastomeric Pads: Preformed, horizontally layered cotton-duck fabric bonded to an elastomer; 80 to 100 Shore, Type A durometer hardness, ASTM D 2240; complying with AASHTO's "AASHTO Load and Resistance Factor Design (LRFD) Bridge Specifications," Division II, Section 18.10.2; or with MIL-C-882E.

d. Frictionless Pads: Tetrafluoroethylene, glass-fiber reinforced, bonded to stainless- or mild-steel plate, of type required for in-service stress.

e. High-Density Plastic: Multimonomer, nonleaching, plastic strip.

H. Grout Materials

1. Sand-Cement Grout: Portland cement, ASTM C 150, Type I, and clean, natural sand, ASTM C 144 or ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
2. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107, Grade A for drypack and Grades B and C for flowable grout and of consistency suitable for application within a 30-minute working time.
3. Epoxy-Resin Grout: Two-component, mineral-filled epoxy resin; ASTM C 881/C 881M, of type, grade, and class to suit requirements.

I. Thin-Brick Units And Accessories

1. Thin-Brick Units: ASTM C 216, Type FBX or ASTM C 1088, Grade Exterior, Type TBX, not less than 1/2 inch (13 mm) **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick with a tolerance of plus or minus 1/16 inch (1.6 mm), and as follows:
   a. Face Color and Texture: Match the Owner's samples **OR** Medium brown, wire cut **OR** Full-range red, sand molded **OR** Gray, velour, **as directed**.
   b. Face Size:
      1) 2-1/4 inches (57 mm) high by 8 inches (203 mm) long.
      2) 2-1/4 inches (57 mm) high by 7-1/2 to 7-5/8 inches (190 to 194 mm) long.
      3) 2-3/4 to 2-13/16 inches (70 to 71 mm) high by 7-1/2 to 7-5/8 inches (190 to 194 mm) long.
      4) 3-1/2 to 3-5/8 inches (89 to 92 mm) high by 7-1/2 to 7-5/8 inches (190 to 194 mm) long.
      5) 3-1/2 to 3-5/8 inches (89 to 92 mm) high by 11-1/2 to 11-5/8 inches (292 to 295 mm) long.
   c. Where indicated to "match existing," provide thin brick matching color, texture, and face size of existing adjacent brick work.
   d. Face Size:
      1) 57 mm high by 190 mm long.
      2) 70 mm high by 190 mm long.
      3) 90 mm high by 190 mm long.
      4) 90 mm high by 290 mm long.
   e. Special Shapes: Include corners, edge corners, and end edge corners.
   f. Initial Rate of Absorption: Less than 30 g/30 sq. in. (30 g/194 sq. cm) per minute; ASTM C 67.
   g. Efflorescence: Tested according to ASTM C 67 and rated "not effloresced."
   h. Surface Coating: Thin brick with colors or textures applied as coatings shall withstand 50 cycles of freezing and thawing; ASTM C 67 with no observable difference in applied finish when viewed from 10 feet (3 m).
   i. Back Surface Texture: Scored, combed, wire roughened, ribbed, keybacked, or dovetailed.
2. Sand-Cement Mortar: Portland cement, ASTM C 150, Type I, and clean, natural sand, ASTM C 144. Mix at ratio of 1 part cement to 4 parts sand, by volume, with minimum water required for placement.
3. Latex-Portland Cement Pointing Grout: ANSI A118.6 and as follows:
   a. Dry-grout mixture, factory prepared, of portland cement, graded aggregate, and dry, redispersible, ethylene-vinyl-acetate additive for mixing with water; uniformly colored.
   b. Commercial portland cement grout, factory prepared, with liquid styrene-butadiene rubber or acrylic-resin latex additive; uniformly colored.
   c. Colors: As indicated by manufacturer's designations **OR** Match the Owner's samples **OR** As selected by the Owner from manufacturer's full range, **as directed**.

J. Stone Materials And Accessories
1. Stone facing for precast structural concrete is specified in Division 04 Section "Dimension Stone Cladding".
2. Anchors: Stainless steel, ASTM A 666, Type 304, of temper and diameter required to support loads without exceeding allowable design stresses.
   a. Fit each anchor leg with neoprene grommet collar of width at least twice the diameter and of length at least five times the diameter of anchor.
3. Sealant Filler: ASTM C 920, low-modulus, multicomponent, nonsag urethane sealant complying with requirements in Division 07 Section "Joint Sealants" and that is nonstaining to stone substrate.
4. Epoxy Filler: ASTM C 881/C 881M, 100 percent solids, sand-filled nonshrinking, nonstaining of type, class, and grade to suit application.
   a. Elastomeric Anchor Sleeve: 1/2 inch (13 mm) long; 60 Shore, Type A durometer hardness; ASTM D 2240.

5. Bond Breaker: Preformed, compressible, resilient, nonstaining, nonwaxing, closed-cell polyethylene foam pad, nonabsorbent to liquid and gas, 1/8 inch (3.2 mm) thick **OR** Polyethylene sheet, ASTM D 4397, 6 to 10 mils (0.15 to 0.25 mm) thick, **as directed**.

K. Insulated Flat Wall Panel Accessories
1. Molded-Polystyrene Board Insulation: ASTM C 578, Type I, 0.90 lb/cu. ft. (15 kg/cu. m) **OR** Type VIII, 1.15 lb/cu. ft. (18 kg/cu. m) **OR** Type II, 1.35 lb/cu. ft. (22 kg/cu. m), **as directed**; square **OR** ship-lap, **as directed**, edges; with R-value and thickness as directed by the Owner.
2. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.60 lb/cu. ft. (26 kg/cu. m) **OR** Type X, 1.30 lb/cu. ft. (21 kg/cu. m) **OR** Type VI, 1.80 lb/cu. ft. (29 kg/cu. m), **as directed**; square **OR** ship-lap, **as directed**, edges; with R-value and thickness as directed by the Owner.
3. Polyisocyanurate Board Insulation: ASTM C 591, Type I, 1.8 lb/cu. ft. (29 kg/cu. m) **OR** Type IV, 2 lb/cu. ft. (32 kg/cu. m) **OR** Type II, 2.5 lb/cu. ft. (40 kg/cu. m), **as directed**, unfaced, with R-value and thickness as directed by the Owner.
4. Wythe Connectors: Glass-fiber connectors **OR** Vinyl-ester polymer connectors **OR** Polypropylene pin connectors **OR** Stainless-steel pin connectors **OR** Bent galvanized reinforcing bars **OR** Galvanized welded wire trusses **OR** Galvanized bent wire connectors **OR** Cylindrical metal sleeve anchors, **as directed**, manufactured to connect wythes of precast concrete panels.

L. Concrete Mixtures
1. Prepare design mixtures for each type of precast concrete required.
   a. Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.
   b. Limit use of fly ash to 25 percent replacement of portland cement by weight and granulated blast-furnace slag to 40 percent of portland cement by weight; metakaolin and silica fume to 10 percent of portland cement by weight.
2. Design mixtures may be prepared by a qualified independent testing agency or by qualified precast plant personnel at precast structural concrete fabricator's option.
3. Limit water-soluble chloride ions to maximum percentage by weight of cement permitted by ACI 318 (ACI 318M) or PCI MNL 116 when tested according to ASTM C 1218/C 1218M.
4. Normal-Weight Concrete Mixtures: Proportion face mixtures **OR** face and backup mixtures **OR** full-depth mixture, **as directed,** by either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:
   a. Compressive Strength (28 Days): 5000 psi (34.5 MPa).
   b. Maximum Water-Cementitious Materials Ratio: 0.45.
5. Water Absorption: 6 percent by weight or 14 percent by volume, tested according to PCI MNL 116.
6. Lightweight Concrete Backup Mixtures: Proportion mixtures by either laboratory trial batch or field test data methods according to ACI 211.2, with materials to be used on Project, to provide lightweight concrete with the following properties:
   a. Compressive Strength (28 Days): 5000 psi (34.5 MPa).
   b. Unit Weight: Calculated equilibrium unit weight of 115 lb/cu. ft. (1842 kg/cu. m), plus or minus 3 lb/cu. ft. (48 kg/cu. m), according to ASTM C 567.
7. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 116.
8. When included in design mixtures, add other admixtures to concrete mixtures according to manufacturer's written instructions.
9. Concrete Mix Adjustments: Concrete mix design adjustments may be proposed if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.

M. Mold Fabrication
1. Molds: Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete-placement operations and temperature changes and for prestressing and

detensioning operations. Coat contact surfaces of molds with release agent before reinforcement is placed. Avoid contamination of reinforcement and prestressing tendons by release agent.

a. Place form liners accurately to provide finished surface texture indicated. Provide solid backing and supports to maintain stability of liners during concrete placement. Coat form liner with form-release agent.

2. Maintain molds to provide completed precast structural concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified.
   a. Form joints are not permitted on faces exposed to view in the finished work.
   b. Edge and Corner Treatment: Uniformly chamfered **OR** radiused, **as directed**.

N. Thin-Brick Facings
1. Place form-liner templates accurately to provide grid for thin-brick facings. Provide solid backing and supports to maintain stability of liners while placing thin bricks and during concrete placement.
2. Securely place thin-brick units face down into form-liner pockets and place concrete backing mixture.
3. Completely fill joint cavities between thin-brick units with sand-cement mortar, and place precast concrete backing mixture while sand-cement mortar is still fluid enough to ensure bond.
4. Mix and install pointing grout according to ANSI A108.10. Completely fill joint cavities between thin-brick units with pointing grout, and compress into place without spreading pointing grout onto faces of thin-brick units. Remove excess pointing grout immediately to prevent staining of brick.
   a. Tool joints to a slightly concave shape **OR** grapevine shape **OR** V-shape, **as directed**, when pointing grout is thumbprint hard.
5. Clean faces and joints of brick facing.

O. Stone Facings
1. Clean stone surfaces before placing in molds to remove soil, stains, and foreign materials. Use cleaning methods and materials recommended by stone supplier.
2. Accurately position stone facings to comply with requirements and in locations indicated on Shop Drawings. Install anchors, supports, and other attachments indicated or necessary to secure stone in place. Keep concrete reinforcement a minimum of 3/4 inch (19 mm) from the back surface of stone. Use continuous spacers to obtain uniform joints of widths indicated and with edges and faces aligned according to established relationships and indicated tolerances.
   a. Stone to Precast Anchorages: Provide anchors in numbers, types and locations required to satisfy specified performance criteria, but not less than 2 anchors per stone unit of less than 2 sq. ft. (0.19 sq. m) in area and 4 anchors per unit of less than 12 sq. ft. (1.1 sq. m) in area; for units larger than 12 sq. ft. (1.1 sq. m) in area, provide anchors spaced not more than 24 inches (600 mm) o.c. horizontally and vertically. Locate anchors a minimum of 6 inches (150 mm) from stone edge.
3. Fill anchor holes with sealant filler and install anchors **OR** epoxy filler and install anchors with elastomeric anchor sleeve at back surface of stone, **as directed**.
   a. Install polyethylene sheet to prevent bond between back of stone facing and concrete substrate and to ensure no passage of precast matrix to stone surface.
   b. Install 1/8-inch (3-mm) polyethylene-foam bond breaker to prevent bond between back of stone facing and concrete substrate and to ensure no passage of precast matrix to stone surface. Maintain minimum projection requirements of stone anchors into concrete substrate.

P. Fabrication
1. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware, and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.

a. Weld-headed studs and deformed bar anchors used for anchorage according to AWS D1.1/D1.1M and AWS C5.4, "Recommended Practices for Stud Welding."

2. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing precast structural concrete units to supporting and adjacent construction.
3. Cast-in reglets, slots, holes, and other accessories in precast structural concrete units as indicated on the Contract Drawings.
4. Cast-in openings larger than 10 inches (250 mm) in any dimension. Do not drill or cut openings or prestressing strand without the Owner's approval.
5. Reinforcement: Comply with recommendations in PCI MNL 116 for fabricating, placing, and supporting reinforcement.
   a. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete. When damage to epoxy-coated reinforcement exceeds limits specified, repair with patching material compatible with coating material and epoxy coat bar ends after cutting.
   b. Accurately position, support, and secure reinforcement against displacement during concrete-placement and consolidation operations. Completely conceal support devices to prevent exposure on finished surfaces.
   c. Place reinforcement to maintain at least 3/4-inch (19-mm) minimum coverage. Increase cover requirements according to ACI 318 (ACI 318M) when units are exposed to corrosive environment or severe exposure conditions. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.
   d. Place reinforcing steel and prestressing strand to maintain at least 3/4-inch (19-mm) minimum concrete cover. Increase cover requirements for reinforcing steel to 1-1/2 inches (38 mm) when units are exposed to corrosive environment or severe exposure conditions. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.
   e. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh spacing and wire tie laps, where required by design. Offset laps of adjoining widths to prevent continuous laps in either direction.
6. Reinforce precast structural concrete units to resist handling, transportation, and erection stresses.
7. Prestress tendons for precast structural concrete units by either pretensioning or post-tensioning methods. Comply with PCI MNL 116.
   a. Delay detensioning or post-tensioning of precast, prestressed structural concrete units until concrete has reached its indicated minimum design release compressive strength as established by test cylinders cured under same conditions as concrete.
   b. Detension pretensioned tendons either by gradually releasing tensioning jacks or by heat cutting tendons, using a sequence and pattern to prevent shock or unbalanced loading.
   c. If concrete has been heat cured, detension while concrete is still warm and moist to avoid dimensional changes that may cause cracking or undesirable stresses.
   d. Protect strand ends and anchorages with bituminous, zinc-rich, or epoxy paint to avoid corrosion and possible rust spots.
   e. Protect strand ends and anchorages with a minimum of 1-inch- (25-mm-) thick, nonmetallic, nonshrink, grout mortar and sack rub surface. Coat or spray the inside surfaces of pocket with bonding agent before installing grout.
8. Comply with requirements in PCI MNL 116 and in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.
9. Place face mixture to a minimum thickness after consolidation of the greater of 1 inch (25 mm) or 1.5 times the maximum aggregate size, but not less than the minimum reinforcing cover specified.
10. Place concrete in a continuous operation to prevent seams or planes of weakness from forming in precast concrete units.
    a. Place backup concrete mixture to ensure bond with face-mixture concrete.

11. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air on surfaces. Use equipment and procedures complying with PCI MNL 116.
    a. Place self-consolidating concrete without vibration according to PCI TR-6, "Interim Guidelines for the Use of Self-Consolidating Concrete in Precast/Prestressed Concrete Institute Member Plants."
12. Comply with ACI 306.1 procedures for cold-weather concrete placement.
13. Comply with PCI MNL 116 procedures for hot-weather concrete placement.
14. Identify pickup points of precast structural concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each precast structural concrete unit on a surface that will not show in finished structure.
15. Cure concrete, according to requirements in PCI MNL 116, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.
16. Discard and replace precast structural concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs meet requirements in PCI MNL 116 and meet the Owner's approval.

Q. Casting Insulated Wall Panels
1. Cast and screed wythe supported by mold.
2. Place insulation boards abutting edges and ends of adjacent boards. Insert wythe connectors through insulation, and consolidate concrete around connectors according to connector manufacturer's written instructions.
3. Cast and screed top wythe to meet required finish.

R. Fabrication Tolerances
1. Fabricate precast structural concrete units straight and true to size and shape with exposed edges and corners precise and true so each finished unit complies with PCI MNL 116 product dimension tolerances.
2. Brick-Faced Precast Structural Concrete Units: Restrict the following misalignments to 2 percent of number of bricks in a unit:
    a. Alignment of Mortar Joints:
        1) Jog in Alignment: 1/8 inch (3 mm).
        2) Alignment with Panel Centerline: Plus or minus 1/8 inch (3 mm).
    b. Variation in Width of Exposed Mortar Joints: Plus or minus 1/8 inch (3 mm).
    c. Tipping of Individual Bricks from the Panel Plane of Exposed Brick Surface: Plus 1/16 inch (1.6 mm); minus 1/4 inch (6 mm) less than or equal to depth of form-liner joint.
    d. Exposed Brick Surface Parallel to Primary Control Surface of Panel: Plus 1/4 inch (6 mm); minus 1/8 inch (3 mm).
    e. Individual Brick Step in Face from Panel Plane of Exposed Brick Surface: Plus 1/16 inch (1.6 mm); minus 1/4 inch (6 mm) less than or equal to depth of form-liner joint.
3. Stone Veneer-Faced Precast Structural Concrete Units:
    a. Variation in Cross-Sectional Dimensions: For thickness of walls from dimensions indicated: Plus or minus 1/4 inch (6 mm).
    b. Variation in Joint Width: 1/8 inch in 36 inches (3 mm in 900 mm) or a quarter of nominal joint width, whichever is less.
    c. Variation in Plane between Adjacent Stone Units (Lipping): 1/16-inch (1.6-mm) difference between planes of adjacent units.

S. Commercial Finishes
1. Commercial Grade: Remove fins and large protrusions and fill large holes. Rub or grind ragged edges. Faces must have true, well-defined surfaces. Air holes, water marks, and color variations are permitted. Limit form joint offsets to 3/16 inch (5 mm).

2. Standard Grade: Normal plant-run finish produced in molds that impart a smooth finish to concrete. Surface holes smaller than 1/2 inch (13 mm) caused by air bubbles, normal color variations, form joint marks, and minor chips and spalls are permitted. Fill air holes greater than 1/4 inch (6 mm) in width that occur more than once per 2 sq. in (1300 sq. mm). Major or unsightly imperfections, honeycombs, or structural defects are not permitted. Limit joint offsets to 1/8 inch (3 mm).
3. Grade B Finish: Fill air pockets and holes larger than 1/4 inch (6 mm) in diameter with sand-cement paste matching color of adjacent surfaces. Fill air holes greater than 1/8 inch (3 mm) in width that occur more than once per 2 sq. in. (1300 sq. mm). Grind smooth form offsets or fins larger than 1/8 inch (3 mm). Repair surface blemishes due to holes or dents in molds. Discoloration at form joints is permitted.
4. Grade A Finish: Fill surface blemishes with the exception of air holes 1/16 inch (1.6 mm) in width or smaller, and form marks where the surface deviation is less than 1/16 inch (1.6 mm). Float apply a neat cement-paste coating to exposed surfaces. Rub dried paste coat with burlap to remove loose particles. Discoloration at form joints is permitted. Grind smooth all form joints.
5. Screed or float finish unformed surfaces. Strike off and consolidate concrete with vibrating screeds to a uniform finish. Hand screed at projections. Normal color variations, minor indentations, minor chips, and spalls are permitted. Major imperfections, honeycombing, or defects are not permitted.
6. Smooth, steel trowel finish unformed surfaces. Consolidate concrete, bring to proper level with straightedge, float, and trowel to a smooth, uniform finish.
7. Apply roughened surface finish according to ACI 318 (ACI 318M) to precast concrete units that will receive concrete topping after installation.

T. Commercial Architectural Finishes
1. Manufacture member faces free of joint marks, grain, and other obvious defects with corners, including false joints, uniform, straight, and sharp. Finish exposed-face surfaces of precast concrete units to match approved design reference sample **OR** sample panels, **as directed**, and as follows:
   a. PCI's "Architectural Precast Concrete - Color and Texture Selection Guide," of plate numbers indicated.
   b. Smooth-Surface Finish: Provide surfaces free of excessive air voids, sand streaks, and honeycombs, with uniform color and texture.
   c. Textured-Surface Finish: Impart by form liners or inserts to provide surfaces free of pockets, streaks, and honeycombs, with uniform color and texture.
   d. Bushhammer Finish: Use power or hand tools to remove matrix and fracture coarse aggregates.
   e. Exposed-Aggregate Finish: Use chemical-retarding agents applied to concrete molds and washing and brushing procedures to expose aggregate and surrounding matrix surfaces after form removal.
   f. Abrasive-Blast Finish: Use abrasive grit, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces.
   g. Acid-Etched Finish: Use acid and hot-water solution, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces. Protect hardware, connections, and insulation from acid attach.
   h. Honed Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.
   i. Polished Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.
   j. Sand-Embedment Finish: Use selected stones placed in a sand bed in bottom of mold, with sand removed after curing.

U. Source Quality Control
1. Testing: Test and inspect precast structural concrete according to PCI MNL 116 requirements.
   a. Test and inspect self-consolidating concrete according to PCI TR-6.

2. Strength of precast structural concrete units will be considered deficient if units fail to comply with ACI 318 (ACI 318M) requirements for concrete strength.
3. If there is evidence that strength of precast concrete units may be deficient or may not comply with ACI 318 (ACI 318M) requirements, employ a qualified testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C 42/C 42M.
   a. A minimum of three representative cores will be taken from units of suspect strength, from locations directed by the Owner.
   b. Cores will be tested in an air-dry condition or, if units will be wet under service conditions, test cores after immersion in water in a wet condition.
   c. Strength of concrete for each series of 3 cores will be considered satisfactory if average compressive strength is equal to at least 85 percent of 28-day design compressive strength and no single core is less than 75 percent of 28-day design compressive strength.
   d. Test results will be made in writing on same day that tests are performed, with copies to the Owner, Contractor, and precast concrete fabricator. Test reports will include the following:
      1) Project identification name and number.
      2) Date when tests were performed.
      3) Name of precast concrete fabricator.
      4) Name of concrete testing agency.
      5) Identification letter, name, and type of precast concrete unit(s) represented by core tests; design compressive strength; type of break; compressive strength at breaks, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed.
4. Patching: If core test results are satisfactory and precast structural concrete units comply with requirements, clean and dampen core holes and solidly fill with same precast concrete mixture that has no coarse aggregate, and finish to match adjacent precast concrete surfaces.
5. Defective Units: Discard and replace precast structural concrete units that do not comply with requirements, including strength, manufacturing tolerances, and color and texture range. Chipped, spalled, or cracked units may be repaired, subject to the Owner's approval. the Owner reserves the right to reject precast units that do not match approved samples and sample panels.

1.3 EXECUTION

A. Installation
1. Install clips, hangers, bearing pads, and other accessories required for connecting precast structural concrete units to supporting members and backup materials.
2. Erect precast structural concrete level, plumb, and square within specified allowable tolerances. Provide temporary structural framing, supports, and bracing as required to maintain position, stability, and alignment of units until permanent connection.
   a. Install temporary steel or plastic spacing shims or bearing pads as precast structural concrete units are being erected. Tack weld steel shims to each other to prevent shims from separating.
   b. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
   c. Remove projecting lifting devices and grout fill voids within recessed lifting devices flush with surface of adjacent precast surfaces when recess is exposed.
   d. For hollow-core slab voids used as electrical raceways or mechanical ducts, align voids between units and tape butt joint at end of slabs.
3. Connect precast structural concrete units in position by bolting, welding, grouting, or as otherwise indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and grouting are completed.
   a. Do not permit connections to disrupt continuity of roof flashing.
4. Field cutting of precast units is not permitted without approval of the the Owner.

5. Fasteners: Do not use drilled or powder-actuated fasteners for attaching accessory items to precast, prestressed concrete units.
6. Welding: Comply with applicable AWS D1.1/D1.1M and AWS D1.4 for welding, welding electrodes, appearance, quality of welds, and methods used in correcting welding work.
   a. Protect precast structural concrete units and bearing pads from damage by field welding or cutting operations, and provide noncombustible shields as required.
   b. Clean weld-affected steel surfaces with chipping hammer followed by brushing, and apply a minimum 4.0-mil- (0.1-mm-) thick coat of galvanized repair paint to galvanized surfaces according to ASTM A 780.
   c. Clean weld-affected steel surfaces with chipping hammer followed by brushing, and reprime damaged painted surfaces.
   d. Remove, reweld, or repair incomplete and defective welds.
7. At bolted connections, use lock washers, tack welding, or other approved means to prevent loosening of nuts after final adjustment.
   a. Where slotted connections are used, verify bolt position and tightness. For sliding connections, properly secure bolt but allow bolt to move within connection slot. For friction connections, apply specified bolt torque and check 25 percent of bolts at random by calibrated torque wrench.
8. Grouting: Grout connections and joints and open spaces at keyways, connections, and joints where required or indicated on Shop Drawings. Retain grout in place until hard enough to support itself. Pack spaces with stiff grout material, tamping until voids are completely filled.
   a. Place grout to finish smooth, level, and plumb with adjacent concrete surfaces.
   b. Fill joints completely without seepage to other surfaces.
   c. Trowel top of grout joints on roofs smooth and uniform. Finish transitions between different surface levels not steeper than 1 to 12.
   d. Place grout end cap or dam in voids at ends of hollow-core slabs.
   e. Promptly remove grout material from exposed surfaces before it affects finishes or hardens.
   f. Keep grouted joints damp for not less than 24 hours after initial set.

B. Erection Tolerances
1. Erect precast structural concrete units level, plumb, square, true, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 135.
2. Minimize variations between adjacent slab members by jacking, loading, or other method recommended by fabricator and approved by the Owner.

C. Field Quality Control
1. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
   a. Erection of precast structural concrete members.
2. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
3. Field welds will be visually inspected and nondestructive tested according to ASTM E 165 or ASTM E 709. High-strength bolted connections will be subject to inspections.
4. Testing agency will report test results promptly and in writing to Contractor and the Owner.
5. Repair or remove and replace work where tests and inspections indicate that it does not comply with specified requirements.
6. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
7. Prepare test and inspection reports.

D. Repairs
1. Repair precast structural concrete units if permitted by the Owner.
   a. Repairs may be permitted if structural adequacy, serviceability, durability, and appearance of units has not been impaired.

2. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 20 feet (6 m).
3. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A 780.
4. Wire brush, clean, and paint damaged prime-painted components with same type of shop primer.
5. Remove and replace damaged precast structural concrete units that cannot be repaired or when repairs do not comply with requirements as determined by the Owner.

E. Cleaning
1. Clean mortar, plaster, fireproofing, weld slag, and other deleterious material from concrete surfaces and adjacent materials immediately.
2. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.
   a. Perform cleaning procedures, if necessary, according to precast concrete fabricator's written recommendations. Clean soiled precast concrete surfaces with detergent and water, using stiff fiber brushes and sponges, and rinse with clean water. Protect other work from staining or damage due to cleaning operations.
   b. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION 03620

Task	Specification	Specification Description
03630	01352	No Specification Required
03640	01352	No Specification Required
03640	03620	Plant-Precast Structural Concrete

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SECTION 03920 - CONCRETE REHABILITATION

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for concrete rehabilitation. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
   a. Removal of deteriorated concrete and reinforcement and subsequent replacement and patching.
   b. Floor joint repair.
   c. Epoxy crack injection.
   d. Corrosion-inhibiting treatment.
   e. Polymer overlays.
   f. Polymer sealers.
   g. Steel structural reinforcement.
   h. Composite structural reinforcement.

C. Submittals
1. Product Data: For each type of product indicated. Include material descriptions, chemical composition, physical properties, test data, and mixing, preparation, and application instructions.
2. Formwork and Shoring Drawings: Prepared by or under the supervision of a qualified professional engineer detailing formwork and temporary shoring and supports. Include schedule and sequence for erection and removal relative to removal of deteriorated concrete and reinforcement and subsequent repair and reinforcement.
3. Samples: Cured Samples of overlay and patching materials.
4. Rehabilitation Program: For each phase of rehabilitation process, including protection of surrounding materials and Project site during operations. Describe in detail materials, methods, equipment, and sequence of operations to be used for each phase of the Work.
   a. If alternative materials and methods to those indicated are proposed for any phase of rehabilitation work, submit substitution request and provide a written description of proposed materials and methods, including evidence of successful use on other comparable projects, and a testing program to demonstrate their effectiveness for this Project.

D. Delivery, Storage, And Handling
1. Deliver materials to Project site in manufacturer's original and unopened containers, labeled with type and name of products and manufacturers.
2. Comply with manufacturer's written instructions for minimum and maximum temperature requirements and other conditions for storage.
3. Store cementitious materials off the ground, under cover, and in a dry location.
4. Store aggregates, covered and in a dry location, where grading and other required characteristics can be maintained and contamination avoided.

E. Project Conditions
1. Environmental Limitations for Epoxies: Do not apply when air and substrate temperatures are outside limits permitted by manufacturer. During hot weather, cool epoxy components before mixing, store mixed products in shade, and cool unused mixed products to retard setting. Do not apply to wet substrates unless approved by manufacturer.

a. Use only Class A epoxies when substrate temperatures are below or are expected to go below 40 deg F (5 deg C) within 8 hours.
b. Use only Class A or B epoxies when substrate temperatures are below or are expected to go below 60 deg F (16 deg C) within 8 hours.
c. Use only Class C epoxies when substrate temperatures are above and are expected to stay above 60 deg F (16 deg C) for 8 hours.

2. Cold-Weather Requirements for Cementitious Materials:
   a. Do not apply unless air temperature is above 40 deg F (5 deg C) and will remain so for at least 48 hours after completion of Work.
      OR
      Comply with the following procedures:
      1) When air temperature is below 40 deg F (5 deg C), heat patching material ingredients and existing concrete to produce temperatures between 40 and 90 deg F (5 and 32 deg C).
      2) When mean daily air temperature is between 25 and 40 deg F (minus 4 and plus 5 deg C), cover completed Work with weather-resistant insulating blankets for 48 hours after repair or provide enclosure and heat to maintain temperatures above 32 deg F (0 deg C) within the enclosure for 48 hours after repair.
      3) When mean daily air temperature is below 25 deg F (minus 4 deg C), provide enclosure and heat to maintain temperatures above 32 deg F (0 deg C) within the enclosure for 48 hours after repair.
3. Hot-Weather Requirements for Cementitious Materials: Protect repair work when temperature and humidity conditions produce excessive evaporation of water from patching materials. Provide artificial shade and wind breaks, and use cooled materials as required. Do not apply to substrates with temperatures of 90 deg F (32 deg C) and above.
4. Environmental Limitations for High-Molecular-Weight Methacrylate Sealers: Do not apply when concrete surface temperature is below 55 deg F (13 deg C) or above 75 deg F (24 deg C) **OR** 90 deg F (32 deg C), **as directed**. Apply only to dry substrates **OR** substrates that have been dry for at least 72 hours.

1.2 PRODUCTS

A. Bonding Agents
1. Epoxy-Modified, Cementitious Bonding and Anticorrosion Agent: Product that consists of water-insensitive epoxy adhesive, portland cement, and water-based solution of corrosion-inhibiting chemicals that forms a protective film on steel reinforcement.
2. Epoxy Bonding Agent: ASTM C 881/C 881M, Type II **OR** V, **as directed**.
   a. Thin Film Open Time: Not less than two **OR** six **OR** 24, **as directed**, hours.
3. Latex Bonding Agent: ASTM C 1059, Type I **OR** II **OR** II at exterior locations and where indicated, Type I at other locations, **as directed**.
4. Mortar Scrub-Coat: 1 part portland cement complying with ASTM C 150, Type I, II, or III and 1 part fine aggregate complying with ASTM C 144, except 100 percent passing a No. 16 (1.18-mm) sieve.

B. Patching Mortar
1. Patching Mortar, General:
   a. Overhead Patching Mortar: For overhead repairs, use patching mortar recommended by manufacturer for overhead use and as specified in this Article.
   b. Coarse Aggregate for Adding to Patching Mortar: Washed aggregate complying with ASTM C 33, Size No. 8, Class 5S. Add only as permitted by patching mortar manufacturer.
2. Job-Mixed Patching Mortar: 1 part portland cement complying with ASTM C 150, Type I, II, or III and 2-1/2 parts fine aggregate complying with ASTM C 144, except 100 percent passing a No. 16 (1.18-mm) sieve.

3. Cementitious Patching Mortar: Packaged, dry mix complying with ASTM C 928.
4. Polymer-Modified, Cementitious Patching Mortar: Packaged, dry mix complying with ASTM C 928, that contains a non-redispersible latex additive as either a dry powder or a separate liquid that is added during mixing.
5. Polymer-Modified, Silica-Fume-Enhanced, Cementitious Patching Mortar: Packaged, dry mix complying with ASTM C 928, that contains silica fume complying with ASTM C 1240 and a non-redispersible latex additive as either a dry powder or a separate liquid that is added during mixing.

C. Concrete
1. Concrete Materials and Admixtures: Comply with Division 03 Section "Cast-in-place Concrete".
2. Steel and Fiber Reinforcement and Reinforcement Accessories: Comply with Division 03 Section "Cast-in-place Concrete".
3. Form-Facing Materials: Comply with Division 03 Section "Cast-in-place Concrete".
4. Shotcrete: Comply with Division 03 Section "Shotcrete".
5. Preplaced Aggregate: Washed aggregate complying with ASTM C 33, Class 5S, with 95 to 100 percent passing a 1-1/2-inch (37.5-mm) sieve, 40 to 80 percent passing a 1-inch (25-mm) sieve, 20 to 45 percent passing a 3/4-inch (19-mm) sieve, 0 to 10 percent passing a 1/2-inch (12.5-mm) sieve, and 0 to 2 percent passing a 3/8-inch ((9.5-mm)) sieve **OR** 100 percent passing a 1-1/2-inch (37.5-mm) sieve, 95 to 100 percent passing a 1-inch (25-mm) sieve, 40 to 80 percent passing a 3/4-inch (19-mm) sieve, 0 to 15 percent passing a 1/2-inch (12.5-mm) sieve, and 0 to 2 percent passing a 3/8-inch (9.5-mm) sieve, **as directed**.
6. Fine Aggregate for Grout Used with Preplaced Aggregate: Fine aggregate complying with ASTM C 33, but with 100 percent passing a No. 8 (2.36-mm) sieve, 95 to 100 percent passing a No. 16 (1.18-mm) sieve, 55 to 80 percent passing a No. 30 (0.6-mm) sieve, 30 to 55 percent passing a No. 50 (0.3-mm) sieve, 10 to 30 percent passing a No. 100 (0.15-mm) sieve, 0 to 10 percent passing a No. 200 (0.075-mm) sieve, and having a fineness modulus of 1.30 to 2.10.
7. Grout Fluidifier for Grout Used with Preplaced Aggregate: ASTM C 937.
8. Portland Cement for Grout Used with Preplaced Aggregate: ASTM C 150.
9. Pozzolans for Grout Used with Preplaced Aggregate: ASTM C 618.

D. Miscellaneous Materials
1. Epoxy Joint Filler: 2-component, semirigid, 100 percent solids, epoxy resin with a Type A Shore durometer hardness of at least 80 per ASTM D 2240.
2. Polyurea Joint Filler: 2-component, semirigid, 100 percent solids, polyurea resin with a Type A Shore durometer hardness of at least 80 per ASTM D 2240.
3. Epoxy Crack Injection Adhesive: ASTM C 881/C 881M, Type I **OR** IV, **as directed**, Grade 1, except for gel time **OR** solvent free, **as directed**.
4. Capping Adhesive: Product manufactured for use with crack injection adhesive by same manufacturer.
5. Corrosion-Inhibiting Treatment Materials: Water-based solution of alkaline corrosion-inhibiting chemicals that penetrates concrete by diffusion and forms a protective film on steel reinforcement.
6. Polymer Overlay: Epoxy adhesive complying with ASTM C 881/C 881M, Type III.
7. Aggregate for Use with Polymer Overlay: Oven-dried, washed silica sand complying with ACI 503.3.
8. Polymer Sealer: Low-viscosity epoxy or high-molecular-weight methacrylate penetrating sealer recommended by manufacturer for application to exterior concrete traffic surfaces.
9. Methylmethacrylate Sealer/Brighteners: Clear low-viscosity sealer recommended by manufacturer for sealing exterior exposed-aggregate concrete, and formulated to bring out color of aggregates and give concrete a wet look.
10. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
    a. After fabricating, prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

b. For minimum protection to steel after preparation, apply one coat of lead- and chromate-free, modified-alkyd primer complying with MPI#76 and one coat of alkyd-gloss enamel complying with MPI#96.
c. After preparation, apply two-coat high-performance coating system consisting of organic zinc-rich primer, complying with SSPC-Paint 20 or SSPC-Paint 29 and topcoat of high-build, urethane or epoxy coating recommended by manufacturer for application over specified zinc-rich primer. Comply with coating manufacturer's written directions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

11. Bolts, Nuts, and Washers: Carbon steel; ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), for bolts; ASTM A 563 (ASTM A 563M), Grade A, for nuts; and ASTM F 436 (ASTM F 436M) for washers; hot-dip or mechanically zinc coated.
12. Postinstalled Anchors: Chemical or expansion anchors, made from stainless-steel components complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Alloy Group A1 or A4) for bolts and nuts; ASTM A 666 or ASTM A 276, Type 304 or 316, for anchors, with capability to sustain, without failure, a load equal to four times the load imposed, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
13. Composite Structural Reinforcement: Manufacturer's system consisting of carbon **OR** glass, **as directed**,-fiber reinforcement in the form of preimpregnated sheets or tow sheet with field-applied saturant, and epoxy primers, fillers, adhesives, saturants, and topcoats, designed for use as external structural reinforcement for concrete.

E. Mixes
1. Mix products, in clean containers, according to manufacturer's written instructions.
a. Add clean silica sand and coarse aggregates to products only as recommended by manufacturer.
b. Do not add water, thinners, or additives unless recommended by manufacturer.
c. When practical, use manufacturer's premeasured packages to ensure that materials are mixed in proper proportions. When premeasured packages are not used, measure ingredients using graduated measuring containers; do not estimate quantities or use shovel or trowel as unit of measure.
d. Do not mix more materials than can be used within recommended open time. Discard materials that have begun to set.
2. Mortar Scrub-Coat: Mix with enough water to provide consistency of thick cream.
3. Dry-Pack Mortar: Mix with just enough liquid to form damp cohesive mixture that can be squeezed by hand into a ball but is not plastic.
4. Concrete: Comply with Division 03 Section "Cast-in-place Concrete".
5. Shotcrete: Comply with Division 03 Section "Shotcrete".
6. Grout for Use with Preplaced Aggregate: Proportion according to ASTM C 938. Add grout fluidifier to mixing water followed by cementitious materials and then fine aggregate.

1.3 EXECUTION

A. Examination
1. Notify the Owner seven days in advance of dates when areas of deteriorated or delaminated concrete and deteriorated reinforcing bars will be located.
2. Locate areas of deteriorated or delaminated concrete using hammer or chain drag sounding and mark boundaries. Mark areas for removal by simplifying and squaring off boundaries. At columns and walls make boundaries level and plumb, unless otherwise indicated.
3. Locate at least three reinforcing bars using a pachometer, and drill test holes to determine depth of cover. Calibrate pachometer, using depth of cover measurements, and verify depth of cover in removal areas using pachometer.

B. Preparation

1. Protect people, motor vehicles, equipment, surrounding construction, Project site, plants, and surrounding buildings from injury resulting from concrete rehabilitation work.
    a. Erect and maintain temporary protective covers over pedestrian walkways and at points of entrance and exit for people and vehicles, unless such areas are made inaccessible during the course of concrete rehabilitation work. Construct covers of tightly fitted, 3/4-inch (19-mm) exterior-grade plywood supported at 16 inches (405 mm) o.c. and covered with asphalt roll roofing.
    b. Protect adjacent equipment and surfaces by covering them with heavy polyethylene film and waterproof masking tape or a liquid strippable masking agent. If practical, remove items, store, and reinstall after potentially damaging operations are complete.
    c. Neutralize and collect alkaline and acid wastes according to requirements of authorities having jurisdiction, and dispose of by legal means off Owner's property.
    d. Dispose of runoff from wet operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.
    e. Collect runoff from wet operations and dispose of by legal means off Owner's property.
2. Shoring: Install temporary supports before beginning concrete removal.
3. Concrete Removal:
    a. Saw-cut perimeter of areas indicated for removal to a depth of at least 1/2 inch (13 mm). Make cuts perpendicular to concrete surfaces and no deeper than cover on reinforcement.
    b. Remove deteriorated and delaminated concrete by breaking up and dislodging from reinforcement.
    c. Remove additional concrete, if necessary, to provide a depth of removal of at least 1/2 inch (13 mm) over entire removal area.
    d. Where half or more of the perimeter of reinforcing bar is exposed, bond between reinforcing bar and surrounding concrete is broken, or reinforcing bar is corroded, remove concrete from entire perimeter of bar and to provide at least a 3/4-inch (19-mm) clearance around bar.
    e. Test areas where concrete has been removed by tapping with hammer, and remove additional concrete until unsound and disbonded concrete is completely removed.
    f. Provide fractured aggregate surfaces with a profile of at least 1/8 inch (3 mm) that are approximately perpendicular or parallel to original concrete surfaces. At columns and walls, make top and bottom surfaces level, unless otherwise directed.
    g. Thoroughly clean removal areas of loose concrete, dust, and debris.
4. Reinforcing Bar Preparation: Remove loose and flaking rust from reinforcing bars by high-pressure water cleaning **OR** abrasive blast cleaning **OR** needle scaling **OR** wire brushing, **as directed**, until only tightly bonded light rust remains.
    a. Where section loss of reinforcing bar is more than 25 percent, or 20 percent in 2 or more adjacent bars, cut bars and remove and replace. Remove additional concrete as necessary to provide at least 3/4-inch (19-mm) clearance at existing and replacement bars. Splice replacement bars to existing bars according to ACI 318 (ACI 318M), by lapping, welding, or using mechanical couplings.
5. Preparation of Floor Joints for Repair: Saw-cut joints full width to edges and depth of spalls, but not less than 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**, deep. Clean out debris and loose concrete; vacuum or blow clear with compressed air.
6. Surface Preparation for Corrosion-Inhibiting Treatment: Clean concrete by low-pressure water cleaning **OR** detergent scrubbing **OR** sand blasting, **as directed**, to remove dirt, oils, films, and other materials detrimental to treatment application. Allow surface to dry before applying corrosion-inhibiting treatment.
7. Surface Preparation for Overlays: Remove delaminated material and deteriorated concrete surface material. Roughen surface of concrete by sand blasting **OR** shot blasting **OR** scarifying **OR** needle scaling **OR** high-pressure water jetting **OR** scabbling **OR** flame blasting **OR** milling, **as directed**, to produce a surface profile matching CSP 3 **OR** 4 **OR** 5 **OR** 6 **OR** 7 **OR** 8 **OR** 9, **as directed**, per ICRI 03732. Sweep and vacuum roughened surface to remove debris followed by low-pressure water cleaning.

8. Surface Preparation for Sealers: Clean concrete by shot blasting **OR** low-pressure water cleaning **OR** detergent scrubbing, **as directed**, to remove dirt, oils, films, and other materials detrimental to sealer application.
9. Surface Preparation for Sealers: Acid etch surface of concrete to produce a surface profile matching CSP 1 per ICRI 03732. Prepare surface for acid etching by detergent scrubbing to remove oils and films that may prevent acid penetration.
    a. Remove excess acid solution, reaction products, and debris by squeegeeing or vacuuming.
    b. Scrub surface with an alkaline detergent, rinse, and squeegee or vacuum.
    c. Check acidity of surface with pH test paper and continue rinsing until pH is acceptable.
    d. When pH is acceptable and surface is clean, vacuum dry.
10. Surface Preparation for Composite Structural Reinforcement: Remove delaminated material and deteriorated concrete surface material. Clean concrete where reinforcement and epoxy patching mortar is to be applied by low-pressure water cleaning **OR** detergent scrubbing, **as directed**, to remove dirt, oils, films, and other materials detrimental to epoxy application. Roughen surface of concrete by sand blasting.

C. Application
1. General: Comply with manufacturer's written instructions and recommendations for application of products, including surface preparation.
2. Epoxy-Modified, Cementitious Bonding and Anticorrosion Agent: Apply to reinforcing bars and concrete by stiff brush or hopper spray according to manufacturer's written instructions. Apply to reinforcing bars in two coats, allowing first coat to dry two to three hours before applying second coat. Allow to dry before placing patching mortar or concrete.
3. Epoxy Bonding Agent: Apply to reinforcing bars and concrete by brush, roller, or spray according to manufacturer's written instructions, leaving no pinholes or other uncoated areas. Apply to reinforcing bars in at least two coats, allowing first coat to dry before applying second coat. Apply patching mortar or concrete while epoxy is still tacky. If epoxy dries, recoat before placing patching mortar or concrete.
4. Latex Bonding Agent, Type II: Mix with portland cement and scrub into concrete surface according to manufacturer's written instructions. Apply patching mortar or concrete while bonding agent is still wet. If bonding agent dries, recoat before placing patching mortar or concrete.
5. Latex Bonding Agent, Type I: Apply to concrete by brush roller or spray. Allow to dry before placing patching mortar or concrete.
6. Mortar Scrub-Coat: Dampen repair area and surrounding concrete 6 inches (150 mm) beyond repair area. Remove standing water and apply scrub-coat with a brush, scrubbing it into surface and thoroughly coating repair area. If scrub-coat dries, recoat before applying patching mortar or concrete.
7. Patching Mortar: Unless otherwise recommended by manufacturer, apply as follows:
    a. Wet substrate thoroughly and then remove standing water. Scrub a slurry of neat patching mortar mixed with latex bonding agent into substrate, filling pores and voids.
    b. Place patching mortar by troweling toward edges of patch to force intimate contact with edge surfaces. For large patches, fill edges first and then work toward center, always troweling toward edges of patch. At fully exposed reinforcing bars, force patching mortar to fill space behind bars by compacting with trowel from sides of bars.
    c. For vertical patching, place material in lifts of not more than 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, nor less than 1/8 inch (3 mm) **OR** 1/4 inch (6 mm), **as directed**. Do not feather edge.
    d. For overhead patching, place material in lifts of not more than 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, nor less than 1/8 inch (3 mm) **OR** 1/4 inch (6 mm), **as directed**. Do not feather edge.
    e. After each lift is placed, consolidate material and screed surface.
    f. Where multiple lifts are used, score surface of lifts to provide a rough surface for application of subsequent lifts. Allow each lift to reach final set before placing subsequent lifts.

g. Allow surfaces of lifts that are to remain exposed to become firm and then finish to a smooth **OR** rough, **as directed**, surface with a wood or sponge float **OR** broom or burlap drag, **as directed**.
h. Wet-cure cementitious patching materials, including polymer-modified, cementitious patching materials, for not less than seven days by water-fog spray or water-saturated absorptive cover.

8. Dry-Pack Mortar: Use for deep cavities and where indicated. Unless otherwise recommended by manufacturer, apply as follows:
   a. Provide forms where necessary to confine patch to required shape.
   b. Wet substrate and forms thoroughly and then remove standing water.
   c. Place dry-pack mortar into cavity by hand, and compact into place with a hardwood drive stick and mallet or hammer. Do not place more material at a time than can be properly compacted. Continue placing and compacting until patch is approximately level with surrounding surface.
   d. After cavity is filled and patch is compacted, trowel surface to match profile and finish of surrounding concrete. A thin coat of patching mortar may be troweled into the surface of patch to help obtain required finish.
   e. Wet-cure patch for not less than seven days by water-fog spray or water-saturated absorptive cover.
9. Concrete: Place according to Division 03 Section "Cast-in-place Concrete" and as follows:
   a. Apply epoxy-modified, cementitious bonding and anticorrosion agent **OR** epoxy bonding agent, **as directed**, to reinforcement and concrete substrate.
   b. Apply latex bonding agent **OR** Type I, latex bonding agent **OR** mortar scrub-coat, **as directed**, to concrete substrate.
   c. Use vibrators to consolidate concrete as it is placed.
   d. At unformed surfaces, screed concrete to produce a surface that when finished with patching mortar will match required profile and surrounding concrete.
   e. Where indicated place concrete by form and pump method.
      1) Design and construct forms to resist pumping pressure in addition to weight of wet concrete. Seal joints and seams in forms and junctions of forms with existing concrete.
      2) Pump concrete into place, releasing air from forms as concrete is introduced. When formed space is full, close air vents and pressurize to 14 psi (96 kPa).
   f. Wet-cure concrete for not less than seven days by leaving forms in place or keeping surfaces continuously wet by water-fog spray or water-saturated absorptive cover.
   g. Fill placement cavities with dry-pack mortar and repair voids with patching mortar. Finish to match surrounding concrete.
10. Shotcrete: Place according to Division 03 Section "Shotcrete" and as follows:
   a. Apply epoxy-modified, cementitious bonding and anticorrosion agent **OR** epoxy bonding agent, **as directed**, to reinforcement and concrete substrate.
   b. Apply latex bonding agent **OR** Type I, latex bonding agent **OR** mortar scrub-coat, **as directed**, to concrete substrate.
   c. Screed and finish shotcrete to produce a surface matching required profile and surrounding concrete.
11. Grouted Preplaced Aggregate Concrete: Use for column and wall repairs **OR** where indicated, **as directed**. Place as follows:
   a. Design and construct forms to resist pumping pressure in addition to weight of wet grout. Seal joints and seams in forms and junctions of forms with existing concrete.
   b. Apply epoxy-modified, cementitious bonding and anticorrosion agent **OR** epoxy bonding agent, **as directed**, to reinforcement and concrete substrate.
   c. Place aggregate in forms, consolidating aggregate as it is placed. Pack aggregate into upper areas of forms to achieve intimate contact with concrete surfaces.
   d. Fill forms with water to thoroughly dampen aggregate and substrates. Drain water from forms before placing grout.

e. Pump grout into place at bottom of preplaced aggregate, forcing grout upward. Release air from forms at top as grout is introduced. When formed space is full and grout flows from air vents, close vents and pressurize to 14 psi (96 kPa).
f. Wet-cure concrete for not less than seven days by leaving forms in place or keeping surfaces continuously wet by water-fog spray or water-saturated absorptive cover.
g. Repair voids with patching mortar and finish to match surrounding concrete.

12. Joint Filler: Install in nonmoving floor joints where indicated.
    a. Install filler to a depth of at least 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**. Use fine silica sand no more than 1/4 inch (6 mm) deep to close base of joint. Do not use sealant backer rods or compressible fillers below joint filler.
    b. Install filler so that when cured, it is flush at top surface of adjacent concrete. If necessary, overfill joint and remove excess when filler has cured.
13. Epoxy Crack Injection: Comply with manufacturer's written instructions and the following:
    a. Clean areas to receive capping adhesive of oil, dirt, and other substances that would interfere with bond, and clean cracks with oil-free compressed air or low-pressure water to remove loose particles.
    b. Place injection ports as recommended by epoxy manufacturer, spacing no farther apart than thickness of member being injected. Seal injection ports in place with capping adhesive.
    c. Seal cracks at exposed surfaces with a ribbon of capping adhesive at least 1/4 inch (6 mm) thick by 1 inch (25 mm) wider than crack.
    d. Inject cracks wider than 0.003 inch (0.075 mm) to a depth of 8 inches (200 mm) or to a width of less than 0.003 inch (0.075 mm), whichever is less.
    e. Inject epoxy adhesive, beginning at widest part of crack and working toward narrower parts. Inject adhesive into ports to refusal, capping adjacent ports when they extrude epoxy. Cap injected ports and inject through adjacent ports until crack is filled.
    f. After epoxy adhesive has set, remove injection ports and grind surfaces smooth.
14. Corrosion-Inhibiting Treatment: Apply by brush, roller, or airless spray in two coats at manufacturer's recommended application rate. Remove film of excess treatment by high-pressure washing before patching treated concrete or applying a sealer or overlay.
15. Polymer Overlay: Apply according to ACI 503.3.
    a. Apply to traffic-bearing surfaces, including parking areas and walks.
16. Polymer Sealer: Apply by brush, roller, or airless spray at manufacturer's recommended application rate.
    a. Apply to traffic-bearing surfaces, including parking areas and walks.
17. Methylmethacrylate Sealer/Brighteners: Apply by brush, roller, or airless spray at manufacturer's recommended application rate.
    a. Apply to exterior concrete surfaces that are exposed to view, excluding traffic-bearing surfaces.
18. Composite Structural Reinforcement Using Preimpregnated Fiber Sheet: Unless otherwise recommended by manufacturer, apply as follows:
    a. Patch surface defects with epoxy mortar and allow to set before beginning reinforcement application.
    b. Apply epoxy adhesive to a thickness of 1/16 inch (1.6 mm) to prepared concrete surfaces in areas where composite structural reinforcement will be applied.
    c. Clean preimpregnated fiber sheet with acetone or other suitable solvent, and apply epoxy adhesive to a thickness of 1/16 inch (1.6 mm).
    d. Apply adhesive-coated fiber sheet to adhesive-coated concrete within open time of epoxy adhesive, and roll with a hard rubber roller until fiber sheet is fully embedded in adhesive, air pockets are removed, and adhesive is forced out from beneath fiber sheet at edges.
    e. Apply additional layers as indicated using same procedure.
19. Composite Structural Reinforcement Using Fiber Tow Sheet and Saturant: Unless otherwise recommended by manufacturer, apply as follows:
    a. Apply epoxy primer using brush or short nap roller to prepared concrete surfaces in areas where composite structural reinforcement will be applied.

b. After primer has set, patch surface defects with epoxy filler and allow to set before beginning reinforcement application.
c. Apply epoxy saturant to fiber tow sheet or primed and patched surface with 3/8-inch- (10-mm-) nap roller. Apply fiber tow sheet to primed and patched surface while saturant is still wet, using pressure roller to remove air pockets. Remove paper backing from fiber tow sheet and apply additional epoxy as needed to fully saturate tow sheet.
d. Apply additional layers as indicated, fully saturating each with epoxy.
e. After saturant has cured, apply protective topcoat by brush, roller or spray.

D. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to sample materials and perform tests as follows:
a. Patching Mortar, Packaged Mixes: <**Insert number**> randomly selected samples tested according to ASTM C 928.
b. Patching Mortar, Field Mixed: <**Insert number**> randomly selected samples tested for compressive strength according to ASTM C 109/C 109M.
c. Concrete: As specified in Division 03 Section "Cast-in-place Concrete".
d. Shotcrete: As specified in Division 03 Section "Shotcrete".
e. Grouted Preplaced Aggregate: Tested for compressive strength of grout according to ASTM C 942.
1) Testing Frequency: One sample for each 25 cu. yd. (19 cu. m) of grout or fraction thereof, but not less than one sample for each day's work.
f. Joint Filler: Core drilled samples to verify proper installation.
1) Testing Frequency: One sample for each 100 feet (30 m) of joint filled.
2) Where samples are taken, fill holes with joint filler.
g. Epoxy Crack Injection: Core drilled samples to verify proper installation.
1) Testing Frequency: 3 samples from mockup and 1 sample for each 100 feet (30 m) of crack injected.
2) Where samples are taken, fill holes with epoxy mortar.

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SECTION 04110 - UNIT MASONRY ASSEMBLIES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for unit masonry assemblies. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes unit masonry assemblies consisting of the following:
   a. Concrete masonry units (CMUs).
   b. Decorative concrete masonry units.
   c. Pre-faced concrete masonry units.
   d. Concrete brick.
   e. Face brick.
   f. Building (common) brick.
   g. Hollow brick.
   h. Glazed brick.
   i. Structural-clay facing tile.
   j. Firebox brick.
   k. Clay flue lining units.
   l. Stone trim units.
   m. Mortar and grout.
   n. Reinforcing steel.
   o. Masonry joint reinforcement.
   p. Ties and anchors.
   q. Embedded flashing.
   r. Miscellaneous masonry accessories.
   s. Masonry-cell insulation.
   t. Cavity-wall insulation.

C. Definitions
1. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

D. Performance Requirements
1. Provide structural unit masonry that develops indicated net-area compressive strengths (f'_m) at 28 days.
2. Determine net-area compressive strength (f'_m) of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602 **OR** Table 21-D in the Uniform Building Code, **as directed**.
   OR
   Determine net-area compressive strength (f'_m) of masonry by testing masonry prisms according to ASTM C 1314 **OR** UBC Standard 21-17, **as directed**.

E. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: For reinforcing steel. Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls.
3. Samples for each type and color of exposed masonry units and colored mortars.

4. Material Certificates: For each type of product indicated. Include statements of material properties indicating compliance with requirements including compliance with standards and type designations within standards.
5. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
   a. For masonry units include material test reports substantiating compliance with requirements.
6. Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold-weather requirements.

F. Quality Assurance
1. Preconstruction Testing Service: Owner will engage a qualified independent testing agency to perform preconstruction testing indicated below. Payment for these services will be made by Owner.
   a. Clay Masonry Unit Test: For each type of unit required, per ASTM C 67.
   b. Concrete Masonry Unit Test: For each type of unit required, per ASTM C 140.
   c. Mortar Test (Property Specification): For each mix required, per ASTM C 780 **OR** UBC Standard 21-16, **as directed**.
   d. Grout Test (Compressive Strength): For each mix required, per ASTM C 1019 **OR** UBC Standard 21-18, **as directed**.
2. Fire-Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire-resistance ratings determined per ASTM E 119 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by other means, as acceptable to authorities having jurisdiction.
3. Sample Panels: Build sample panels to verify selections made under sample submittals and to demonstrate aesthetic effects.
   a. Build sample panels for each type of exposed unit masonry construction **OR** typical exterior wall, **as directed,** in sizes approximately 48 inches (1200 mm) long by 48 inches (1200 mm) high.

G. Delivery, Storage, And Handling
1. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
2. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
3. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
4. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.
5. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

H. Project Conditions
1. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602 **OR** Section 2104.3 in the Uniform Building Code, **as directed**.
2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

1.2 PRODUCTS

A. Concrete Masonry Units (CMUs)
1. Shapes: Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
2. Integral Water Repellent: Provide units made with liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength for exposed units and where indicated.
3. Concrete Masonry Units: ASTM C 90 **OR** UBC Standard 21-4, **as directed**.
   a. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi (13.1 MPa) **OR** 2150 psi (14.8 MPa) **OR** 2800 psi (19.3 MPa) **OR** 3050 psi (21.0 MPa), **as directed**.
   b. Weight Classification: Lightweight **OR** Medium weight **OR** Normal weight, **as directed**.
4. Decorative Concrete Masonry Units: ASTM C 90 **OR** UBC Standard 21-4, **as directed**.
   a. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi (13.1 MPa) **OR** 2150 psi (14.8 MPa) **OR** 2800 psi (19.3 MPa) **OR** 3050 psi (21.0 MPa), **as directed**.
   b. Weight Classification: Lightweight **OR** Medium weight **OR** Normal weight, **as directed**.
   c. Pattern and Texture:
      1) Standard pattern, ground finish.
      2) Standard pattern, split-face finish.
      3) Standard pattern, split-ribbed finish.
      4) Scored vertically, standard finish.
      5) Triple scored vertically, standard finish.
5. Pre-faced Concrete Masonry Units: Lightweight hollow **OR** solid, **as directed,** concrete units complying with ASTM C 90 **OR** UBC Standard 21-4, **as directed**, with manufacturer's standard smooth resinous facing complying with ASTM C 744.
   a. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi (13.1 MPa) **OR** 2150 psi (14.8 MPa) **OR** 2800 psi (19.3 MPa) **OR** 3050 psi (21.0 MPa), **as directed**.
   b. Size: Manufactured with pre-faced surfaces having 1/16-inch- (1.5-mm-) wide returns of facing to create 1/4-inch- (6.5-mm-) wide mortar joints with modular coursing.
6. Concrete Building Brick: ASTM C 55 **OR** UBC Standard 21-3, **as directed**.
   a. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2500 psi (17.3 MPa) **OR** 3500 psi (24.1 MPa), **as directed**.
   b. Weight Classification: Lightweight **OR** Medium weight **OR** Normal weight, **as directed**.

B. Concrete And Masonry Lintels
1. General: Provide either concrete or masonry lintels, at Contractor's option, complying with requirements below.
2. Concrete Lintels:
   a. Precast units matching concrete masonry units and with reinforcing bars indicated or required to support loads indicated.
      OR
      Precast or formed-in-place concrete lintels complying with requirements in Division 03 Section "Cast-in-place Concrete".
3. Masonry Lintels: Made from bond beam concrete masonry units with reinforcing bars placed as indicated and filled with coarse grout.

C. Brick
1. General: Provide shapes indicated and as follows:
   a. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
   b. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.

2. Face Brick: ASTM C 216 **OR** UBC Standard 21-1, **as directed**, Grade SW **OR** MW or SW, **as directed**, Type FBX **OR** FBS **OR** FBA, **as directed**.
   a. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 3000 psi (20.7 MPa) **OR** 4400 psi (30.3 MPa) **OR** 5500 psi (37.9 MPa) **OR** 6400 psi (44.1 MPa) **OR** 8000 psi (55.2 MPa) **OR** 8400 psi (57.9 MPa), **as directed**.
   b. Initial Rate of Absorption: Less than 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested per ASTM C 67.
   c. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
   d. Surface Coating: Brick with colors or textures produced by application of coatings shall withstand 50 cycles of freezing and thawing per ASTM C 67 with no observable difference in the applied finish when viewed from 10 feet (3 m).
   e. Size: **As directed**.
3. Building (Common) Brick: ASTM C 62 **OR** UBC Standard 21-1, **as directed**, Grade SW **OR** MW or SW **OR** NW, MW, or SW, **as directed**.
   a. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 3000 psi (20.7 MPa) **OR** 4400 psi (30.3 MPa) **OR** 5500 psi (37.9 MPa) **OR** 6400 psi (44.1 MPa) **OR** 8000 psi (55.2 MPa) **OR** 8400 psi (57.9 MPa), **as directed**.
   b. Size: Match size of face brick.
4. Hollow Brick: ASTM C 652 **OR** UBC Standard 21-1, **as directed**, Grade SW **OR** MW or SW, **as directed**, Class H40V (void areas between 25 and 40 percent of gross cross-sectional area) **OR** H60V (void areas between 40 and 60 percent of gross cross-sectional area) , **as directed**, Type HBX **OR** HBS **OR** HBA **OR** HBB, **as directed**.
   a. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 3000 psi (20.7 MPa) **OR** 4400 psi (30.3 MPa) **OR** 5500 psi (37.9 MPa) **OR** 6400 psi (44.1 MPa) **OR** 8000 psi (55.2 MPa) **OR** 8400 psi (57.9 MPa), **as directed**.
   b. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
   c. Surface Coating: Brick with colors or textures produced by application of coatings shall withstand 50 cycles of freezing and thawing per ASTM C 67 with no observable difference in the applied finish when viewed from 10 feet (3 m).
   d. Size: **As directed**.
5. Glazed Face Brick: ASTM C 216 **OR** UBC Standard 21-1, **as directed**, Grade SW **OR** MW or SW, **as directed**, Type FBX **OR** FBS **OR** FBA, **as directed**; with glaze complying with ASTM C 126.
6. Glazed Face Brick: ASTM C 1405, Class Exterior **OR** Interior, **as directed**, Grade S (Select) **OR** SS (Select Sized or Ground Edge), **as directed**.
7. Glazed Face Brick: Either ASTM C 1405, Class Exterior **OR** Interior, **as directed**, Grade S (Select) or ASTM C 216 **OR** UBC Standard 21-1, **as directed**, Grade SW **OR** MW or SW, **as directed**, Type FBX; with glaze complying with ASTM C 126.
8. Glazed Hollow Brick: Hollow brick complying with ASTM C 652 **OR** UBC Standard 21-1, **as directed**, Grade SW **OR** MW or SW, **as directed**, Class H40V (void areas between 25 and 40 percent of gross cross-sectional area) **OR** H60V (void areas between 40 and 60 percent of gross cross-sectional area), **as directed**, Type HBX **OR** HBS **OR** HBA, **as directed**; with glaze complying with ASTM C 126.
   a. Size: **As directed**.
   b. Provide Type I (single-faced units) where only one finished face is exposed when units are installed, and Type II (double-faced units) where two opposite finished faces are exposed when units are installed.

D. Structural-Clay Facing Tile
   1. General:
      a. Provide solid, multicored, or hollow units, with shape and direction of cores optional, unless otherwise indicated.
      b. Provide multicored units designed for use in reinforced, grouted masonry.

c. Provide special shapes where required for corners, jambs, coved bases, sills, and other special conditions indicated that cannot be produced by sawing standard units.

2. Glazed Structural-Clay Facing Tile: ASTM C 126, Grade S (Select) **OR** SS (Select Sized or Ground Edged), **as directed**.
   a. Size: **As directed**.
   b. Provide Type I (single-faced units) where only one finished face is exposed when units are installed, and Type II (double-faced units) where two opposite finished faces are exposed when units are installed.
3. Unglazed Structural-Clay Facing Tile: ASTM C 212, Type FTX **OR** FTS, **as directed**, Standard **OR** Special-Duty, **as directed,** class.
   a. Number of Faces: Single faced where only one finished face is exposed when units are installed **OR** Double faced where both finished faces are exposed when units are installed, **as directed**.

E. Fireplace And Chimney Lining Units
1. Firebox Brick: ASTM C 1261, size required to produce lining thickness indicated.
2. Clay Flue Lining Units: ASTM C 315.

F. Stone Trim Units
1. Granite: ASTM C 615.
   a. Description: Fine **OR** Medium, **as directed**,-grained, white **OR** pink **OR** gray **OR** black, **as directed,** stone. Uniform pattern, without veining.
2. Limestone: ASTM C 568, Classification I Low **OR** II Medium **OR** III High, **as directed**,-Density.
3. Marble: ASTM C 503, Classification I Calcite **OR** II Dolomite **OR** III Serpentine **OR** IV Travertine, **as directed**.
   a. Description: Uniform, fine- to medium-grained, white stone with only slight veining.
4. Quartz-Based Stone: ASTM C 616, Classification I Sandstone **OR** II Quartzitic Sandstone **OR** III Quartzite, **as directed**.
5. Finish: Polished **OR** Honed **OR** Smooth **OR** Machine tooled, 4 bats per 1 inch (25 mm) **OR** Machine tooled, 6 bats per 1 inch (25 mm) **OR** Machine tooled, 8 bats per 1 inch (25 mm) **OR** Chat sawed **OR** Split face **OR** Rock face (pitched face), **as directed**.
   a. Finish for Tops of Sills and Soffits of Lintels: Sand rubbed **OR** Split face, **as directed**.
6. Provide stone units accurately shaped, with exposed faces dressed true, and with beds and joints at right angles to faces.
   a. For granite, comply with recommendations in NBGQA's "Specifications for Architectural Granite."
   b. For limestone, comply with recommendations in ILI's "Indiana Limestone Handbook."
   c. For marble, comply with recommendations in MIA's "Dimensional Stone--Design Manual IV."

G. Mortar And Grout Materials
1. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction.
2. Hydrated Lime: ASTM C 207 **OR** UBC Standard 21-13, **as directed**, Type S.
3. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or Type III, and hydrated lime complying with ASTM C 207, Type S.
4. Masonry Cement: ASTM C 91 **OR** UBC Standard 21-11, **as directed**.
5. Mortar Cement: ASTM C 1329 **OR** UBC Standard 21-14, **as directed**.
6. Mortar Pigments: Iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortar.
7. Colored Cement Product: Packaged blend made from portland cement and lime or masonry cement and mortar pigments, all complying with specified requirements, and containing no other ingredients.
   a. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
   b. Pigments shall not exceed 10 percent of portland cement by weight.

c. Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight.

8. Aggregate for Mortar: ASTM C 144.
   a. For joints less than 1/4 inch (6.5 mm) thick, use aggregate graded with 100 percent passing the No. 16 (1.18-mm) sieve.
   b. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
   c. White-Mortar Aggregates: Natural white sand or crushed white stone.
   d. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
9. Aggregate for Grout: ASTM C 404.
10. Epoxy Pointing Mortar: ASTM C 395, epoxy-resin-based material formulated for use as pointing mortar for structural-clay tile facing units.
11. Refractory Mortar Mix: Ground fireclay or non-water-soluble, calcium aluminate, medium-duty refractory mortar that passes ASTM C 199 test; or an equivalent product acceptable to authorities having jurisdiction.
12. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
13. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with concrete masonry units, containing integral water repellent by same manufacturer.
14. Water: Potable.

H. Reinforcement
1. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60 (Grade 420).
2. Masonry Joint Reinforcement, General: ASTM A 951 **OR** UBC Standard 21-10, **as directed**.
   a. Interior Walls: Mill- **OR** Hot-dip, **as directed,** galvanized, carbon steel.
   b. Exterior Walls: Hot-dip galvanized, carbon **OR** Stainless, **as directed,** steel.
   c. Wire Size for Side Rods: W1.7 or 0.148-inch (3.8-mm) **OR** W2.8 or 0.188-inch (4.8-mm), **as directed,** diameter.
   d. Wire Size for Cross Rods: W1.7 or 0.148-inch (3.8-mm) **OR** W2.8 or 0.188-inch (4.8-mm), **as directed** diameter.
   e. Wire Size for Veneer Ties: W1.7 or 0.148-inch (3.8-mm) **OR** W2.8 or 0.188-inch (4.8-mm), **as directed** diameter.
   f. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches (407 mm) o.c.
   g. Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.
   h. Multiwythe Masonry:
      1) Ladder type with 1 side rod at each face shell of hollow masonry units more than 4 inches (100 mm) in width, plus 1 side rod at each wythe of masonry 4 inches (100 mm) or less in width.
      2) Tab type, with 1 side rod at each face shell of backing wythe and with rectangular tabs sized to extend at least halfway through facing wythe but with at least 5/8-inch (16-mm) cover on outside face.
      3) Adjustable (two-piece) type, with one side rod at each face shell of backing wythe and with ties that extend into facing wythe. Ties engage eyes or slots in reinforcement and extend at least halfway through facing wythe but with at least 5/8-inch (16-mm) cover on outside face. Ties have hooks or clips to engage a continuous wire in the facing wythe.
   i. Veneers Anchored with Seismic Masonry-Veneer Anchors: Single 0.188-inch- (4.8-mm-) diameter, hot-dip galvanized, carbon-steel continuous wire.

I. Ties And Anchors
1. Materials:
   a. Mill-Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 641/A 641M, Class 1 coating.

b. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 153/A 153M, Class B-2 coating.
c. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304 **OR** 316, **as directed**.
d. Galvanized Steel Sheet: ASTM A 653/A 653M, Commercial Steel, G60 (Z180) zinc coating.
e. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, hot-dip galvanized after fabrication to comply with ASTM A 153/A 153M.
f. Stainless-Steel Sheet: ASTM A 666, Type 304 **OR** 316, **as directed**.
g. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
h. Stainless Steel bars: ASTM A 276 or ASTM a 666, Type 304.

2. Corrugated Metal Ties: Metal strips not less than 7/8 inch (22 mm) wide with corrugations having a wavelength of 0.3 to 0.5 inch (7.6 to 12.7 mm) and an amplitude of 0.06 to 0.10 inch (1.5 to 2.5 mm) made from steel sheet, galvanized after fabrication **OR** stainless-steel sheet, **as directed**, not less than 0.043 inch (1.1 mm) **OR** 0.053 inch (1.3 mm) **OR** 0.067 inch (1.7 mm) **OR** 0.097 inch (2.5 mm), **as directed**, thick. Ties made from galvanized steel sheet may be used in interior walls, unless otherwise indicated.
3. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch (16-mm) cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches (50 mm) parallel to face of veneer.
4. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches (100 mm) wide.
   a. Z-shaped ties with ends bent 90 degrees to provide hooks not less than 2 inches (50 mm) long may be used for masonry constructed from solid units or hollow units laid with cells horizontal.
   b. Where wythes do not align **OR** are of different materials, **as directed**, use adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches (32 mm).
   c. Wire: Fabricate from 3/16-inch- (4.8-mm-) **OR** 1/4-inch- (6.4-mm-), **as directed,** diameter, hot-dip galvanized steel **OR** stainless-steel, **as directed,** wire. Mill-galvanized wire ties may be used in interior walls, unless otherwise indicated.
5. Adjustable Anchors for Connecting to Structure: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
   a. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- (6.4-mm-) diameter, hot-dip galvanized steel **OR** stainless-steel, **as directed,** wire. Mill-galvanized wire may be used at interior walls, unless otherwise indicated.
   b. Tie Section for Steel Frame: Triangular-shaped wire tie, sized to extend within 1 inch (25 mm) of masonry face, made from 0.188-inch- (4.8-mm-) **OR** 0.25-inch- (6.4-mm-), **as directed**, diameter, hot-dip galvanized steel **OR** stainless-steel, **as directed** wire. Mill-galvanized wire may be used at interior walls, unless otherwise indicated.
   c. Connector Section for Concrete: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 0.053-inch- (1.3-mm-) thick, steel sheet, galvanized after fabrication **OR** 0.097-inch- (2.5-mm-) thick, steel sheet, galvanized after fabrication **OR** 0.062-inch- (1.6-mm-) thick, stainless-steel sheet **OR** 0.109-inch- (2.8-mm-) thick, stainless-steel sheet, **as directed**. 0.064-inch- (1.6-mm-) **OR** 0.108-inch- (2.7-mm-), **as directed**, thick, galvanized sheet may be used at interior walls, unless otherwise indicated.
   d. Tie Section for Concrete: Corrugated metal ties with dovetail tabs for inserting into dovetail slots in concrete and sized to extend to within 1 inch (25 mm) of masonry face.
6. Partition Top anchors: 0.097-inch- (2.5-mm-) thick metal plate with 3/8-inch- (10-mm-) diameter metal rod 6 inches (150 mm) long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication **OR** stainless-steel, **as directed**.
7. Rigid Anchors: Fabricate from steel bars 1-1/2 inches (38 mm) wide by 1/4 inch (6.4 mm) thick by 24 inches (600 mm) long, with ends turned up 2 inches (50 mm) or with cross pins.
   a. Corrosion Protection: Hot-dip galvanized to comply with ASTM A 153/A 153M **OR** Epoxy coating 0.020 inch (0.51 mm) thick **OR** Rust-inhibitive paint, **as directed**.
8. Stone Anchors: Fabricate dowels, cramps, and other stone anchors from stainless steel.

9. Adjustable Masonry-Veneer Anchors
   a. General: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, and as follows:
      1) Structural Performance Characteristics: Capable of withstanding a 100-lbf (445-N) load in both tension and compression without deforming or developing play in excess of 0.05 inch (1.3 mm).
   b. Screw-Attached, Masonry-Veneer Anchors: Units consisting of a wire tie and a metal anchor section.
      1) Anchor Section:
         a) Rib-stiffened, sheet metal plate with screw holes top and bottom, and slotted holes for inserting wire tie.
         b) Sheet metal plate with screw holes top and bottom and with raised rib-stiffened strap, stamped into center to provide a slot between strap and plate for inserting wire tie.
         c) Gasketed sheet metal plate with screw holes top and bottom; top and bottom ends bent to form pronged legs of length to match thickness of insulation or sheathing; and raised rib-stiffened strap, stamped into center to provide a slot between strap and plate for inserting wire tie. Provide anchor manufacturer's standard, self-adhering, modified bituminous gaskets manufactured to fit behind anchor plate and extend beyond pronged legs.
      2) Fabricate sheet metal anchor sections and other sheet metal parts from 0.067-inch- (1.7-mm-) thick, steel sheet, galvanized after fabrication **OR** 0.097-inch- (2.5-mm-) thick, steel sheet, galvanized after fabrication **OR** 0.078-inch- (2.0-mm-) thick, stainless-steel sheet **OR** 0.109-inch- (2.8-mm-) thick, stainless-steel sheet, **as directed**.
      3) Wire Ties: Triangular-, rectangular-, or T-shaped wire ties fabricated from 0.188-inch- (4.8-mm-) **OR** 0.25-inch- (6.4-mm-), **as directed**, diameter, hot-dip galvanized steel **OR** stainless-steel, **as directed,** wire.
   c. Slip-in, Masonry-Veneer Anchors: Units consisting of a wire tie section and an anchor section designed to interlock with metal studs and be slipped into place as sheathing is installed.
      1) Wire-Type Anchor: Bent wire anchor section with an eye to receive the wire tie. Wire tie has a vertical leg that slips into the eye of anchor section and allows vertical adjustment. Both sections are made from 3/16-inch (4.8-mm), hot-dip galvanized wire.
      2) Strap-and-Wire Type Anchor: Flat metal strap with notch to interlock with flange of metal stud and two holes for inserting vertical legs of wire tie specially formed to fit anchor section. Strap is made from 0.067-inch- (1.7-mm-) thick, steel sheet, galvanized after fabrication; anchor wire tie is made from 3/16-inch (4.8-mm), hot-dip galvanized wire.
   d. Seismic Masonry-Veneer Anchors: Units consisting of a metal anchor section and a connector section designed to engage a continuous wire embedded in the veneer mortar joint.
      1) Anchor Section: Rib-stiffened, sheet metal plate with screw holes top and bottom, and slotted holes for inserting connector section.
      2) Connector Section: Rib-stiffened, sheet metal bent plate; sheet metal clip; or wire tie and rigid extruded vinyl clip designed to engage continuous wire. Size connector to extend at least halfway through veneer but with at least 5/8-inch (16-mm) cover on outside face.
      3) Fabricate sheet metal anchor sections and other sheet metal parts from 0.067-inch- (1.7-mm-) thick, steel sheet, galvanized after fabrication **OR** 0.097-inch- (2.5-mm-) thick, steel sheet, galvanized after fabrication **OR** 0.078-inch- (2.0-mm-) thick, stainless-steel sheet **OR** 0.109-inch- (2.8-mm-) thick, stainless-steel sheet, **as directed**.

4) Fabricate wire connector sections from 0.188-inch- (4.8-mm-) -**OR** 0.25-inch- (6.4-mm-), **as directed**, diameter, hot-dip galvanized, carbon **OR** stainless, **as directed,**-steel wire.

e. Polymer-Coated, Steel Drill Screws for Steel Studs: ASTM C 954 except manufactured with hex washer head and neoprene washer, No. 10 (4.8-mm) diameter by length required to penetrate steel stud flange with not less than 3 exposed threads, and with organic polymer coating with salt-spray resistance to red rust of more than 800 hours per ASTM B 117.

f. Stainless-Steel Drill Screws for Steel Studs: Proprietary fastener consisting of carbon-steel drill point and 300 Series stainless-steel shank, complying with ASTM C 954 except manufactured with hex washer head and neoprene washer, No. 10 (4.8-mm) diameter by length required to penetrate steel stud flange with not less than three exposed threads.

J. Miscellaneous Anchors

1. Unit Type Inserts in Concrete: Cast-iron or malleable-iron wedge-type inserts.
2. Dovetail Slots in Concrete: Furnish dovetail slots with filler strips, of slot size indicated, fabricated from 0.034-inch (0.9-mm), galvanized steel sheet.
3. Anchor Bolts: Headed or L-shaped steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.
4. Postinstalled Anchors: Provide chemical or torque-controlled expansion anchors, with capability to sustain, without failure, a load equal to six times the load imposed when installed in solid or grouted unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.
   a. Corrosion Protection:
      1) Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (5 microns) for Class SC 1 service condition (mild).
      2) Stainless-steel components complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Alloy Group 1 or 4) for bolts and nuts; ASTM A 666 or ASTM A 276, Type 304 or 316, for anchors.

K. Embedded Flashing Materials

1. Metal Flashing: Provide metal flashing, where flashing is exposed or partly exposed and where indicated, complying with SMACNA's "Architectural Sheet Metal Manual OR Division 07 Section "Sheet Metal Flashing And Trim" as directed.
   a. Stainless Steel: ASTM A 240/A 240M, Type 304, 0.016 inch (0.4 mm) thick.
   b. Copper: ASTM B 370, Temper H00 or H01, cold-rolled copper sheet, 10-oz./sq. ft. (3-kg/sq. m) weight or 0.0135 inch (0.34 mm) thick for fully concealed flashing; 16-oz./sq. ft. (5-kg/sq. m) weight or 0.0216 inch (0.55 mm) thick elsewhere.
   c. Fabricate continuous flashings in sections 96 inches (2400 mm) long minimum, but not exceeding 12 feet (3.6 m). Provide splice plates at joints of formed, smooth metal flashing.
   d. Fabricate through-wall metal flashing embedded in masonry from stainless steel **OR** copper, **as directed**, with ribs at 3-inch (75-mm) intervals along length of flashing to provide an integral mortar bond.
   e. Metal Drip Edges: Fabricate from stainless steel. Extend at least 3 inches (75 mm) into wall and 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees and hemmed.
   f. Metal Flashing Terminations: Fabricate from stainless steel. Extend at least 3 inches (75 mm) into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch (19 mm) and down into joint 3/8 inch (10 mm) to form a stop for retaining sealant backer rod.
   g. Metal Expansion-Joint Strips: Fabricate from stainless steel **OR** copper, **as directed,** to shapes indicated.
2. Flexible Flashing: For flashing not exposed to the exterior, use one of the following, unless otherwise indicated:

a. Copper-Laminated Flashing: 5-oz./sq. ft. (1.5-kg/sq. m) **OR** 7-oz./sq. ft. (2-kg/sq. m), **as directed**, copper sheet bonded with asphalt between 2 layers of glass-fiber cloth. Use only where flashing is fully concealed in masonry.
b. Asphalt-Coated Copper Flashing: 5-oz./sq. ft. (1.5-kg/sq. m) **OR** 7-oz./sq. ft. (2-kg/sq. m), **as directed**, copper sheet coated with flexible asphalt. Use only where flashing is fully concealed in masonry.
c. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.030 inch (0.8 mm) **OR** 0.040 inch (1.0 mm), **as directed**.
d. Elastomeric Thermoplastic Flashing: Composite flashing product consisting of a polyester-reinforced ethylene interpolymer alloy 0.025 inch (0.6 mm) thick, with a 0.015-inch- (0.4-mm-) thick coating of rubberized-asphalt adhesive.
e. EPDM Flashing: Sheet flashing product made from ethylene-propylene-diene terpolymer, complying with ASTM D 4637, 0.040 inch (1.0 mm) thick.

3. Single-Wythe CMU Flashing System: System of CMU cell flashing pans and interlocking CMU web covers made from high-density polyethylene incorporating chemical stabilizers that prevent UV degradation. Cell flashing pans have integral weep spouts that are designed to be built into mortar bed joints and weep collected moisture to the exterior of CMU walls and that extend into the cell to prevent clogging with mortar.
4. Solder and Sealants for Sheet Metal Flashings:
   a. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.
   b. Solder for Copper: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead.
   c. Elastomeric Sealant: ASTM C 920, chemically curing urethane **OR** polysulfide silicone **as directed,** sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
5. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer.

L. Miscellaneous Masonry Accessories
1. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; formulated from neoprene, urethane or PVC.
2. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 or PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall.
3. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).
4. Weep/Vent Products: Use one of the following, unless otherwise indicated:
   a. Wicking Material: Absorbent rope, made from cotton or UV-resistant synthetic fiber, 1/4 to 3/8 inch (6 to 10 mm) in diameter, in length required to produce 2-inch (50-mm) exposure on exterior and 18 inches (450 mm) in cavity between wythes. Use only for weeps.
   b. Round Plastic Weep/Vent Tubing: Medium-density polyethylene, 3/8-inch (9-mm) OD by 4 inches (100 mm) long.
   c. Rectangular Plastic Weep/Vent Tubing: Clear butyrate, 3/8 by 1-1/2 by 3-1/2 inches (9 by 38 by 89 mm) long.
   d. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch (3 mm) less than depth of outer wythe, in color selected from manufacturer's standard.
   e. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth 1/8 inch (3 mm) less than depth of outer wythe; in color selected from manufacturer's standard.
   f. Aluminum Weep Hole/Vent: One-piece, L-shaped units made from sheet aluminum, designed to fit into a head joint and consisting of a vertical channel with louvers stamped in web and with a top flap to keep mortar out of the head joint; painted before installation to

comply with Division 09 Section(s) "Exterior Painting" OR "Interior Painting", in color approved to match that of mortar.

g. Vinyl Weep Hole/Vent: One-piece, offset, T-shaped units made from flexible, injection-molded PVC, designed to fit into a head joint and consisting of a louvered vertical leg, flexible wings to seal against ends of masonry units, and a top flap to keep mortar out of the head joint; in color approved by Architect to match that of mortar.

5. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
   a. Provide one of the following configurations:
      1) Strips, full-depth of cavity and 10 inches (250 mm) wide, with dovetail shaped notches 7 inches (175 mm) deep.
      2) Strips, not less than 1-1/2 inches (38 mm) thick and 10 inches (250 mm) wide, with dimpled surface designed to catch mortar droppings and prevent weep holes from being clogged with mortar.
      3) Sheets or strips full depth of cavity and installed to full height of cavity.
6. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells with loops for holding reinforcing bars in center of cells. Units are formed from 0.142-inch (3.6-mm) steel wire, hot-dip galvanized after fabrication. Provide units with either two loops or four loops as needed for number of bars indicated.

M. Insulation
1. Loose-Granular Fill Insulation: Perlite complying with ASTM C 549, Type II (surface treated for water repellency and limited moisture absorption) or Type IV (surface treated for water repellency and to limit dust generation).
2. Molded-Polystyrene Insulation Units: Rigid, cellular thermal insulation formed by the expansion of polystyrene-resin beads or granules in a closed mold to comply with ASTM C 578, Type I. Provide specially shaped units designed for installing in cores of masonry units.
3. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV **OR** X, **as directed**, closed-cell product extruded with an integral skin.
4. Molded-Polystyrene Board Insulation: ASTM C 578, Type I.
5. Polyisocyanurate Board Insulation: ASTM C 1289, Type I (aluminum-foil-faced), Class 2 (glass-fiber-reinforced).
6. Adhesive: Type recommended by insulation board manufacturer for application indicated.

N. Masonry Cleaners
1. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains from new masonry without damaging masonry. Use product approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

O. Mortar And Grout Mixes
1. General: Do not use admixtures, unless otherwise indicated.
   a. Do not use calcium chloride in mortar or grout.
   b. Limit cementitious materials in mortar for exterior and reinforced masonry to portland cement and lime.
   c. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
2. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
3. Mortar for Unit Masonry: Comply with ASTM C 270 **OR** BIA Technical Notes 8A **OR** UBC Standard 21-15, **as directed,** Proportion Specification.
4. Mortar for Unit Masonry: Comply with ASTM C 270 **OR** BIA Technical Notes 8A **OR** UBC Standard 21-15, **as directed,** Property Specification.
   a. For masonry below grade or in contact with earth, use Type M **OR** S, **as directed**.
   b. For reinforced masonry, use Type S **OR** N, **as directed**.
   c. For mortar parge coats, use Type S or N.

d. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.
e. For interior non-load-bearing partitions, Type O may be used instead of Type N.

5. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.
   a. Pigments shall not exceed 10 percent of portland cement by weight.
   b. Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight.
6. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.
7. Grout for Unit Masonry: Comply with ASTM C 476 **OR** UBC Standard 21-19, **as directed**.
   a. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 **OR** Table 21-C in the Uniform Building Code, **as directed,** for dimensions of grout spaces and pour height.
   b. Provide grout with a slump of 8 to 11 inches (200 to 280 mm) as measured according to ASTM C 143/C 143M.
8. Epoxy Pointing Mortar: Mix epoxy pointing mortar to comply with mortar manufacturer's written instructions.

1.3 EXECUTION

A. Installation, General
1. Use full-size units without cutting if possible. If cutting is required, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
2. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
3. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.
4. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.
5. Comply with tolerances in ACI 530.1/ASCE 6/TMS 602 and with the following:
   a. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
   b. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.

B. Laying Masonry Walls
1. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
2. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.
3. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
4. Fill space between steel frames and masonry solidly with mortar, unless otherwise indicated.
5. Fill cores in hollow concrete masonry units with grout 24 inches (600 mm) under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.

C. Mortar Bedding And Jointing

1. Lay hollow brick and concrete masonry units as follows:
   a. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
   b. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
   c. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
   d. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.
2. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
3. Lay structural-clay tile as follows:
   a. Lay vertical-cell units with full head joints, unless otherwise indicated. Provide bed joints with full mortar coverage on face shells and webs.
   b. Lay horizontal-cell units with full bed joints, unless otherwise indicated. Keep drainage channels, if any, free of mortar. Form head joints with sufficient mortar so excess will be squeezed out as units are placed in position.
   c. Maintain joint thicknesses indicated except for minor variations required to maintain bond alignment. If not indicated, lay walls with 1/4- to 3/8-inch- (6- to 10-mm-) thick joints.
   d. Where epoxy-mortar pointed joints are indicated, rake out setting mortar to a uniform depth of 1/4 inch (6 mm) and point with epoxy mortar.
4. Set firebox brick in full bed of refractory mortar with full head joints. Form joints by buttering both surfaces of adjoining brick and sliding it into place. Make joints just wide enough to accommodate variations in size of brick, approximately 1/8 inch (3 mm). Tool joints smooth on surfaces exposed to fire or smoke.
5. Install clay flue liners to comply with ASTM C 1283. Install flue liners ahead of surrounding masonry. Set clay flue liners in full bed of refractory mortar 1/16 to 1/8 inch (1.6 to 3 mm) thick. Strike joints flush on inside of flue to provide smooth surface. Maintain expansion space between flue liner and surrounding masonry except where surrounding masonry is required to provide lateral support for flue liners.
6. Set stone **OR** cast-stone, **as directed,** trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.
7. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness, unless otherwise indicated.
8. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint), unless otherwise indicated.

D. Composite Masonry
1. Bond wythes of composite masonry together using one of the following methods:
   a. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one metal tie for 4.5 sq. ft. (0.42 sq. m) **OR** 2.67 sq. ft. (0.25 sq. m), **as directed**, of wall area spaced not to exceed 36 inches (914 mm) **OR** 24 inches (610 mm), **as directed**, o.c. horizontally and 16 inches (406 mm) o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches (305 mm) of openings and space not more than 36 inches (915 mm) apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches (610 mm) o.c. vertically.
      1) Where bed joints of wythes do not align, use adjustable (two-piece) type ties.
   b. Masonry Joint Reinforcement: Installed in horizontal mortar joints.
      1) Where bed joints of both wythes align, use ladder-type reinforcement extending across both wythes **OR** tab-type reinforcement, **as directed**.
      2) Where bed joints of wythes do not align, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties.
2. Collar Joints: Solidly fill collar joints by parging face of first wythe that is laid and shoving units of other wythe into place.
3. Collar Joints in Clay Tile Masonry: After each course is laid, fill the vertical, longitudinal joint between wythes solidly with mortar at exterior walls, except cavity walls, and interior walls and partitions.

4. Corners: Provide interlocking masonry unit bond in each wythe and course at corners, unless otherwise indicated.
5. Intersecting and Abutting Walls: Unless vertical expansion or control joints are shown at juncture, bond walls together as follows:
   a. Provide individual metal ties not more than 8 inches (203 mm) **OR** 16 inches (406 mm), **as directed**, o.c.
   b. Provide continuity with masonry joint reinforcement by using prefabricated T-shaped units.
   c. Provide rigid metal anchors not more than 24 inches (610 mm) **OR** 48 inches (1220 mm), **as directed**, o.c. If used with hollow masonry units, embed ends in mortar-filled cores.

E. Cavity Walls
1. Bond wythes of cavity walls together using one of the following methods:
   a. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one metal tie for 4.5 sq. ft. (0.42 sq. m) **OR** 2.67 sq. ft. (0.25 sq. m), **as directed**, of wall area spaced not to exceed 36 inches (914 mm) **OR** 24 inches (610 mm), **as directed**, o.c. horizontally and 16 inches (406 mm) o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches (305 mm) of openings and space not more than 36 inches (915 mm) apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches (610 mm) o.c. vertically.
   b. Masonry Joint Reinforcement: Installed in horizontal mortar joints.
      1) Where bed joints of both wythes align, use ladder-type reinforcement extending across both wythes **OR** tab-type reinforcement, **as directed**.
      2) Where bed joints of wythes do not align, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties.
      3) Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties to allow for differential movement regardless of whether bed joints align.
   c. Masonry Veneer Anchors: Comply with requirements for anchoring masonry veneers.
2. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.
3. Parge cavity face of backup wythe in a single coat approximately 3/8 inch (10 mm) thick. Trowel face of parge coat smooth.
   OR
   Coat cavity face of backup wythe to comply with Division 07 Section "Bituminous Dampproofing".

F. Installing Cavity-Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches (300 mm) o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit insulation between wall ties and other confining obstructions, with edges butted tightly. Press units firmly against inside wythe of masonry.

G. Masonry-Cell Insulation
1. Pour granular insulation into cavities to fill void spaces. Maintain inspection ports to show presence of insulation at extremities of each pour area. Close the ports after filling has been confirmed. Limit the fall of insulation to 1 story in height, but not more than 20 feet (6 m).
2. Install molded-polystyrene insulation units into masonry unit cells before laying units.

H. Masonry Joint Reinforcement
1. General: Install in mortar with a minimum cover of 5/8 inch (16 mm) on exterior side of walls, 1/2 inch (13 mm) elsewhere. Lap reinforcement a minimum of 6 inches (150 mm).
2. Interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.
3. Provide continuity at wall intersections by using prefabricated T-shaped units.
4. Provide continuity at corners by using prefabricated L-shaped units.

I. Anchoring Masonry To Structural Members
   1. Anchor masonry to structural members where masonry abuts or faces structural members to comply with the following:
      a. Provide an open space not less than 1/2 inch (13 mm) **OR** 1 inch (25 mm), **as directed**, in width between masonry and structural member, unless otherwise indicated.
      b. Anchor masonry to structural members with anchors embedded in masonry joints and attached to structure.
      c. Space anchors as indicated, but not more than 24 inches (610 mm) o.c. vertically and 36 inches (915 mm) o.c. horizontally.

J. Anchoring Masonry Veneers
   1. Anchor masonry veneers to wall framing **OR** concrete and masonry backup, **as directed,** with seismic masonry-veneer anchors to comply with the following requirements:
      a. Fasten screw-attached and seismic anchors through sheathing to wall framing and to concrete and masonry backup with metal fasteners of type indicated. Use two fasteners.
      b. Insert slip-in anchors in metal studs as sheathing is installed. Provide one anchor at each stud in each horizontal joint between sheathing boards.
      c. Embed tie sections **OR** connector sections and continuous wire, **as directed,** in masonry joints. Provide not less than 2 inches (50 mm) of air space between back of masonry veneer and face of sheathing.
      d. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
      e. Space anchors as indicated, but not more than 16 inches (406 mm) o.c. vertically and 32 inches (813 mm) **OR** 24 inches (610 mm), **as directed**, o.c. horizontally with not less than 1 anchor for each 3.5 sq. ft. (0.33 sq. m) **OR** 2.67 sq. ft. (0.25 sq. m), **as directed**, of wall area. Install additional anchors within 12 inches (305 mm) of openings and at intervals, not exceeding 36 inches (914 mm), around perimeter.

K. Control And Expansion Joints
   1. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
   2. Provide horizontal, pressure-relieving joints by either leaving an air space or inserting a compressible filler of width required for installing sealant and backer rod specified in Division 07 Section "Joint Sealants", but not less than 3/8 inch (10 mm).
      a. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

L. Lintels
   1. Provide concrete or masonry lintels where shown and where openings of more than 12 inches (305 mm) for brick-size units and 24 inches (610 mm) for block-size units are shown without structural steel or other supporting lintels.
   2. Provide minimum bearing of 8 inches (200 mm) at each jamb, unless otherwise indicated.

M. Flashing, Weep Holes, Cavity Drainage, And Vents
   1. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.
   2. Install flashing as follows, unless otherwise indicated:
      a. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing as recommended by flashing manufacturer.
      b. At lintels and shelf angles, extend flashing a minimum of 6 inches (150 mm) into masonry at each end. At heads and sills, extend flashing 6 inches (150 mm) at ends and turn up not less than 2 inches (50 mm) to form end dams.

c. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (13 mm) back from outside face of wall and adhere flexible flashing to top of metal drip edge.
d. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (13 mm) back from outside face of wall and adhere flexible flashing to top of metal flashing termination.

3. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.
4. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.
5. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:
   a. Use specified weep/vent products or open head joints to form weep holes.
   b. Space weep holes 24 inches (600 mm) o.c., unless otherwise indicated.
   c. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.
6. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in Part 2 "Miscellaneous Masonry Accessories" Article.
7. Install vents in head joints in exterior wythes at spacing indicated. Use specified weep/vent products or open head joints to form vents.
   a. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

N. Reinforced Unit Masonry Installation
1. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
   a. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
   b. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.
2. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602 **OR** Section 2104.5 in the Uniform Building Code, **as directed**.
   a. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
   b. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 **OR** Section 2104.6 in the Uniform Building Code, **as directed,** for cleanouts and for grout placement, including minimum grout space and maximum pour height.
   c. Limit height of vertical grout pours to not more than 60 inches (1520 mm).

O. Field Quality Control
1. Inspectors: Owner will engage qualified independent inspectors to perform inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform inspections.
   a. Place grout only after inspectors have verified compliance of grout spaces and grades, sizes, and locations of reinforcement.
2. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections indicated below and prepare test reports:
   a. Payment for these services will be made by Owner.

3. Testing Frequency: One set of tests for each 5000 sq. ft. (465 sq. m) of wall area or portion thereof.
4. Clay Masonry Unit Test: For each type of unit provided, per ASTM C 67.
5. Concrete Masonry Unit Test: For each type of unit provided, per ASTM C 140.
6. Mortar Test (Property Specification): For each mix provided, per ASTM C 780 **OR** UBC Standard 21-16, **as directed**. Test mortar for mortar air content and compressive strength.
7. Grout Test (Compressive Strength): For each mix provided, per ASTM C 1019 **OR** UBC Standard 21-18, **as directed**.

P. Parging
1. Parge exterior faces of below-grade masonry walls, where indicated, in 2 uniform coats to a total thickness of 3/4 inch (19 mm) with a steel-trowel finish. Form a wash at top of parging and a cove at bottom. Damp-cure parging for at least 24 hours and protect parging until cured.

Q. Cleaning
1. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
2. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
   a. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes.
   b. Protect adjacent surfaces from contact with cleaner.
   c. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
   d. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
   e. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
   f. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

R. Masonry Waste Disposal
1. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
   a. Do not dispose of masonry waste as fill within 18 inches (450 mm) of finished grade.
   b. Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 04110

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Task	Specification	Specification Description
04130	04110	Unit Masonry Assemblies
04160	04110	Unit Masonry Assemblies
04170	04110	Unit Masonry Assemblies
04180	04110	Unit Masonry Assemblies

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SECTION 04205 - SCAFFOLDING TUBULAR STEEL

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of scaffolding-tubular steel. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Tubular steel or aluminum scaffolding system shall comply with OSHA Safety and Health Standards, Section 29 CFR, 1926/1910.

1.3 EXECUTION - (Section not used.)

END OF SECTION 04205

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Task	Specification	Specification Description
04205	04110	Unit Masonry Assemblies
04210	04110	Unit Masonry Assemblies
04213	04110	Unit Masonry Assemblies
04220	04110	Unit Masonry Assemblies
04221	04110	Unit Masonry Assemblies

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SECTION 04222 - ARCHITECTURAL PRECAST CONCRETE

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for architectural precast concrete. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
   a. Architectural precast concrete cladding and load-bearing units.
   b. Insulated, architectural precast concrete units.
   c. Brick-faced, architectural precast concrete units.
   d. Stone-faced, architectural precast concrete units.

C. Definition
1. Design Reference Sample: Sample of approved architectural precast concrete color, finish and texture, preapproved by the Owner.

D. Performance Requirements
1. Structural Performance: Provide architectural precast concrete units and connections capable of withstanding the following design loads within limits and under conditions indicated:
   a. Loads: As indicated.

E. Submittals
1. Product Data: For each type of product indicated.
2. Design Mixtures: For each precast concrete mixture. Include compressive strength and water-absorption tests.
3. Shop Drawings: Detail fabrication and installation of architectural precast concrete units. Indicate locations, plans, elevations, dimensions, shapes, and cross sections of each unit. Indicate joints, reveals, and extent and location of each surface finish. Indicate details at building corners.
   NOTE: The following paragraph is not required if Architect or Engineer assumes or is required by law to assume design responsibility.
   a. Comprehensive engineering analysis signed and sealed **OR** certified, **as directed**, by the qualified professional engineer responsible for its preparation. Show governing panel types, connections, and types of reinforcement, including special reinforcement. Indicate location, type, magnitude, and direction of loads imposed on the building structural frame from architectural precast concrete.
4. Samples: For each type of finish indicated on exposed surfaces of architectural precast concrete units, in sets of 3, illustrating full range of finish, color, and texture variations expected; approximately 12 by 12 by 2 inches (300 by 300 by 50 mm).
5. Welding certificates.
6. Material Test Reports: For aggregates.
7. Material Certificates: Signed by manufacturers:
8. Field quality-control test and special inspection reports.

F. Quality Assurance
1. Fabricator Qualifications: A firm that assumes responsibility for engineering architectural precast concrete units to comply with performance requirements. This responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

a. Participates in PCI's plant certification program and is designated a PCI-certified plant for Group A, Category A1 - Architectural Cladding and Load Bearing Units or participates in APA's "Plant Certification Program for Production of Architectural Precast Concrete Products" and is designated an APA-certified plant.

2. Design Standards: Comply with ACI 318 (ACI 318M) and design recommendations of PCI MNL 120, "PCI Design Handbook - Precast and Prestressed Concrete," applicable to types of architectural precast concrete units indicated.
3. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and dimensional tolerances for types of units required, comply with PCI MNL 117, "Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products."
4. Welding: Qualify procedures and personnel according to AWS D1.1/D.1.1M, "Structural Welding Code - Steel"; and AWS D1.4, "Structural Welding Code - Reinforcing Steel."
5. Calculated Fire-Test-Response Characteristics: Where indicated, provide architectural precast concrete units whose fire resistance has been calculated according to ACI 216.1/TMS 0216.1, "Standard Method for Determining Fire Resistance of Concrete and Masonry Construction Assemblies," **OR** PCI MNL 124, "Design for Fire Resistance of Precast Prestressed Concrete," **as directed**, and is acceptable to authorities having jurisdiction.
6. Sample Panels: After sample approval and before fabricating architectural precast concrete units, produce a minimum of 2 sample panels approximately 16 sq. ft. (1.5 sq. m) in area for review by the Owner. Incorporate full-scale details of architectural features, finishes, textures, and transitions in sample panels.

G. Delivery, Storage, And Handling

1. Deliver architectural precast concrete units in such quantities and at such times to limit unloading units temporarily on the ground.
2. Support units during shipment on nonstaining shock-absorbing material.
3. Store units with adequate dunnage and bracing and protect units to prevent contact with soil, to prevent staining, and to prevent cracking, distortion, warping or other physical damage.
4. Place stored units so identification marks are clearly visible, and units can be inspected.
5. Handle and transport units in a position consistent with their shape and design in order to avoid excessive stresses which would cause cracking or damage.
6. Lift and support units only at designated points shown on Shop Drawings.

1.2 PRODUCTS

A. Mold Materials

1. Molds: Rigid, dimensionally stable, non-absorptive material, warp and buckle free, that will provide continuous and true precast concrete surfaces within fabrication tolerances indicated; nonreactive with concrete and suitable for producing required finishes.
   a. Mold-Release Agent: Commercially produced liquid-release agent that will not bond with, stain or adversely affect precast concrete surfaces and will not impair subsequent surface or joint treatments of precast concrete.
2. Form Liners: Units of face design, texture, arrangement, and configuration indicated **OR** to match those used for precast concrete design reference sample, **as directed**. Furnish with manufacturer's recommended liquid-release agent that will not bond with, stain, or adversely affect precast concrete surfaces and will not impair subsequent surface or joint treatments of precast concrete.
3. Surface Retarder: Chemical set retarder, capable of temporarily delaying final hardening of newly placed concrete mixture to depth of reveal specified.

B. Reinforcing Materials

1. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
2. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.

3. Galvanized Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**, deformed bars, ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized, and chromate wash treated after fabrication and bending, **as directed**.
4. Epoxy-Coated Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**, deformed bars, ASTM A 775/A 775M or ASTM A 934/A 934M epoxy coated.
5. Steel Bar Mats: ASTM A 184/A 184M, fabricated from ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**, deformed bars, assembled with clips.
6. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn **OR** galvanized, **as directed**, steel wire into flat sheets.
7. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.
8. Epoxy-Coated-Steel Wire: ASTM A 884/A 884M, Class A coated, plain **OR** deformed, **as directed**, flat sheet, Type 1 bendable **OR** 2 nonbendable, **as directed**, coating.
9. Supports: Suspend reinforcement from back of mold or use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 117.

C. Prestressing Tendons
1. Prestressing Strand: ASTM A 416/A 416M, Grade 270 (Grade 1860), uncoated, 7-wire, low-relaxation strand.
   a. Coat unbonded post-tensioning strand with corrosion inhibitor passing ASTM D 1743 and sheath with polypropylene tendon sheathing. Include anchorage devices and coupler assemblies.

D. Concrete Materials
1. Portland Cement: ASTM C 150, Type I or Type III, gray, unless otherwise indicated.
   a. For surfaces exposed to view in finished structure, mix gray with white cement, of same type, brand, and mill source.
2. Supplementary Cementitious Materials:
   a. Fly Ash: ASTM C 618, Class C or F, with maximum loss on ignition of 3 percent.
   b. Metakaolin Admixture: ASTM C 618, Class N.
   c. Silica Fume Admixture: ASTM C 1240, with optional chemical and physical requirement.
   d. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
3. Normal-Weight Aggregates: Except as modified by PCI MNL 117, ASTM C 33, with coarse aggregates complying with Class 5S. Stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for Project.
   a. Face-Mixture-Coarse Aggregates: Selected, hard, and durable; free of material that reacts with cement or causes staining; to match selected finish sample.
      1) Gradation: Uniformly graded **OR** Gap graded **OR** To match design reference sample, **as directed**.
   b. Face-Mixture-Fine Aggregates: Selected, natural or manufactured sand of same material as coarse aggregate, unless otherwise approved by the Owner.
4. Lightweight Aggregates: Except as modified by PCI MNL 117, ASTM C 330, with absorption less than 11 percent.
5. Coloring Admixture: ASTM C 979, synthetic or natural mineral-oxide pigments or colored water-reducing admixtures, temperature stable, and nonfading.
6. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 117.
7. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
8. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture.
   a. Water-Reducing Admixtures: ASTM C 494/C 494M, Type A.
   b. Retarding Admixture: ASTM C 494/C 494M, Type B.
   c. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.

d. Water-Reducing and Accelerating Admixture: ASTM C 494/C 494M, Type E.
e. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
f. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
g. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017 M.

E. Steel Connection Materials
1. Carbon-Steel Shapes and Plates: ASTM A 36/A 36M.
2. Carbon-Steel-Headed Studs: ASTM A 108, AISI 1018 through AISI 1020, cold finished, AWS D1.1/D1.1M, Type A or B, with arc shields and with minimum mechanical properties of PCI MNL 117, Table 3.2.3.
3. Carbon-Steel Plate: ASTM A 283/A 283M.
4. Malleable Iron Castings: ASTM A 47/A 47M.
5. Carbon-Steel Castings: ASTM A 27/A 27M, Grade 60-30 (Grade 415-205).
6. High-Strength, Low-Alloy Structural Steel: ASTM A 572/A 572M.
7. Carbon-Steel Structural Tubing: ASTM A 500, Grade B.
8. Wrought Carbon-Steel Bars: ASTM A 675/A 675M, Grade 65 (Grade 450).
9. Deformed-Steel Wire or Bar Anchors: ASTM A 496 or ASTM A 706/A 706M.
10. Carbon-Steel Bolts and Studs: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); carbon-steel, hex-head bolts and studs; carbon-steel nuts, ASTM A 563 (ASTM A 563M); and flat, unhardened steel washers, ASTM F 844.
11. High-Strength Bolts and Nuts: ASTM A 325 (ASTM A 325M), Type 1, heavy hex steel structural bolts; heavy hex carbon-steel nuts, ASTM A 563 (ASTM A 563M); and hardened carbon-steel washers, ASTM F 436 (ASTM F 436M).
12. Zinc-Coated Finish: For exterior steel items, steel in exterior walls, and items indicated for galvanizing, apply zinc coating by hot-dip process according to ASTM A 123/A 123M or ASTM A 153/A 153M **OR** electrodeposition according to ASTM B 633, SC 3, Types 1 and 2, **as directed**.
    a. For steel shapes, plates, and tubing to be galvanized, limit silicon content of steel to less than 0.03 percent or to between 0.15 and 0.25 percent or limit sum of silicon and 2.5 times phosphorous content to 0.09 percent.
    b. Galvanizing Repair Paint: High-zinc-dust-content paint with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035A or SSPC-Paint 20.
13. Shop-Primed Finish: Prepare surfaces of nongalvanized steel items, except those surfaces to be embedded in concrete, according to requirements in SSPC-SP 3 and shop-apply lead- and chromate-free, rust-inhibitive primer, complying with performance requirements in MPI 79 **OR** SSPC-Paint 25, **as directed**, according to SSPC-PA 1.
14. Welding Electrodes: Comply with AWS standards.

F. Stainless-Steel Connection Materials
1. Stainless-Steel Plate: ASTM A 666, Type 304, of grade suitable for application.
2. Stainless-Steel Bolts and Studs: ASTM F 593, Alloy 304 or 316, hex-head bolts and studs; stainless-steel nuts; and flat, stainless-steel washers.
    a. Lubricate threaded parts of stainless-steel bolts with an antiseize thread lubricant during assembly.
3. Stainless-Steel-Headed Studs: ASTM A 276, with minimum mechanical properties of PCI MNL 117, Table 3.2.3.

G. Bearing Pads
1. Provide one of the following bearing pads for architectural precast concrete units as recommended by precast fabricator for application:
    a. Elastomeric Pads: AASHTO M 251, plain, vulcanized, 100 percent polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet, Type A durometer hardness of 50 to 70, ASTM D 2240, minimum tensile strength 2250 psi (15.5 MPa), ASTM D 412.

b. Random-Oriented, Fiber-Reinforced Elastomeric Pads: Preformed, randomly oriented synthetic fibers set in elastomer. Type A durometer hardness of 70 to 90, ASTM D 2240; capable of supporting a compressive stress of 3000 psi (20.7 MPa) with no cracking, splitting, or delaminating in the internal portions of pad. Test one specimen for every 200 pads used in Project.
c. Cotton-Duck-Fabric-Reinforced Elastomeric Pads: Preformed, horizontally layered cotton-duck fabric bonded to an elastomer; Type A durometer hardness of 80 to 100, ASTM D 2240; complying with AASHTO's "AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, Division II, Section 18.10.2, or with MIL-C-882E.
d. Frictionless Pads: Tetrafluoroethylene (Teflon), glass-fiber reinforced, bonded to stainless or mild-steel plate, of type required for in-service stress.
e. High-Density Plastic: Multimonomer, nonleaching, plastic strip.

H. Accessories
1. Reglets: Specified in Division 07 Section "Sheet Metal Flashing And Trim".
OR
Reglets: PVC extrusions, **OR** Stainless steel, Type 302 or 304, **OR** Copper, **as directed**, felt or fiber filled, or with face opening of slots covered.
2. Precast Accessories: Provide clips, hangers, plastic or steel shims, and other accessories required to install architectural precast concrete units.

I. Grout Materials
1. Sand-Cement Grout: Portland cement, ASTM C 150, Type I, and clean, natural sand, ASTM C 144 or ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
2. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107, Grade A for drypack and Grades B and C for flowable grout and of consistency suitable for application within a 30-minute working time.
3. Epoxy-Resin Grout: Two-component, mineral-filled epoxy resin; ASTM C 881/C 881M, of type, grade, and class to suit requirements.

J. Thin Brick Units And Accessories
1. Thin Brick Units: ASTM C 216, Type FBX or ASTM C 1088, Grade Exterior, Type TBX, not less than 1/2 inch (13 mm) **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick with a tolerance of plus or minus 1/16 inch (1.6 mm), and as follows:
a. Face Size: 2-1/4 inches (57 mm) high by 8 inches (203 mm) long.
b. Face Size: 2-1/4 inches (57 mm) high by 7-1/2 to 7-5/8 inches (190 to 194 mm) long.
c. Face Size: 2-3/4 to 2-13/16 inches (70 to 71 mm) high by 7-1/2 to 7-5/8 inches (190 to 194 mm) long.
d. Face Size: 3-1/2 to 3-5/8 inches (89 to 92 mm) high by 7-1/2 to 7-5/8 inches (190 to 194 mm) long.
e. Face Size: 3-1/2 to 3-5/8 inches (89 to 92 mm) high by 11-1/2 to 11-5/8 inches (292 to 295 mm) long.
f. Where indicated to "match existing," provide thin brick matching color, texture, and face size of existing adjacent brick work.
g. Face Size: 57 mm high by 190 mm long.
h. Face Size: 70 mm high by 190 mm long.
i. Face Size: 90 mm high by 190 mm long.
j. Face Size: 90 mm high by 290 mm long.
k. Special Shapes: Include corners, edge corners, and end edge corners.
l. Initial Rate of Absorption: Less than 30 g/30 sq. in. (30 g/194 sq. cm) per minute; ASTM C 67.
m. Efflorescence: Tested according to ASTM C 67 and rated "not effloresced."

n. Surface Coating: Thin brick with colors or textures applied as coatings shall withstand 50 cycles of freezing and thawing; ASTM C 67 with no observable difference in applied finish when viewed from 10 feet (3 m).
o. Face Color and Texture: Match approved samples **OR** Medium brown, wire cut **OR** Full-range red, sand molded **OR** Gray, velour, **as directed**.
p. Back Surface Texture: Scored, combed, wire roughened, ribbed, keybacked, or dovetailed.

2. Sand-Cement Mortar: Portland cement, ASTM C 150, Type I, and clean, natural sand, ASTM C 144. Mix at ratio of 1 part cement to 4 parts sand, by volume, with minimum water required for placement.
3. Latex-Portland Cement Pointing Grout: ANSI A118.6 and as follows:
   a. Dry-grout mixture, factory prepared, of portland cement, graded aggregate, and dry, redispersible, ethylene-vinyl-acetate additive for mixing with water; uniformly colored.
   b. Commercial portland cement grout, factory prepared, with liquid styrene-butadiene rubber or acrylic-resin latex additive; uniformly colored.
   c. Colors: As selected by the Owner from manufacturer's full range.

K. Stone Materials And Accessories
1. Stone facing for architectural precast concrete is specified in Division 04 Section "Dimension Stone Cladding".
2. Anchors: Stainless steel, ASTM A 666, Type 304, of temper and diameter required to support loads without exceeding allowable design stresses.
   a. Fit each anchor leg with neoprene grommet collar of width at least twice the diameter and of length at least five times the diameter of anchor.
3. Sealant Filler: ASTM C 920, low-modulus, multicomponent, nonsag urethane sealant complying with requirements in Division 07 Section "Joint Sealants" and that is nonstaining to stone substrate.
4. Epoxy Filler: ASTM C 881/C 881M, 100 percent solids, sand-filled nonshrinking, nonstaining of type, class, and grade to suit application.
   a. Elastomeric Anchor Sleeve: 1/2 inch (13 mm) long, Type A durometer hardness of 60, ASTM D 2240.
5. Bond Breaker: Preformed, compressible, resilient, nonstaining, nonwaxing, closed-cell polyethylene foam pad, nonabsorbent to liquid and gas, 1/8 inch (3.2 mm) thick **OR** Polyethylene sheet, ASTM D 4397, 6 to 10 mils (0.15 to 0.25 mm) thick, **as directed**.

L. Insulated Panel Accessories
1. Molded-Polystyrene Board Insulation: ASTM C 578, Type I, 0.90 lb/cu. ft. (15 kg/cu. m) **OR** VIII, 1.15 lb/cu. ft. (18 kg/cu. m) **OR** II, 1.35 lb/cu. ft. (22 kg/cu. m), **as directed**; square **OR** ship-lap, **as directed**, edges; with R-value and thickness as required to meet Project requirements.
2. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.60 lb/cu. ft. (26 kg/cu. m) **OR** X, 1.30 lb/cu. ft. (21 kg/cu. m) **OR** VI, 1.80 lb/cu. ft. (29 kg/cu. m), **as directed**; square **OR** ship-lap, **as directed**, edges; with R-value and thickness as required to meet Project requirements.
3. Polyisocyanurate Board Insulation: ASTM C 591, Type I, 1.8 lb/cu. ft. (29 kg/cu. m) **OR** IV, 2 lb/cu. ft. (32 kg/cu. m) **OR** II, 2.5 lb/cu. ft. (40 kg/cu. m), **as directed**, unfaced, with R-value and thickness as required to meet Project requirements.
4. Wythe Connectors: Glass-fiber and vinyl-ester polymer connectors **OR** Polypropylene pin connectors **OR** Stainless-steel pin connectors **OR** Bent galvanized reinforcing bars or galvanized welded wire trusses **OR** Cylindrical metal sleeve anchors, **as directed**, manufactured to connect wythes of precast concrete panels.

M. Concrete Mixtures
1. Prepare design mixtures for each type of precast concrete required.
   a. Limit use of fly ash and silica fume to 20 percent of portland cement by weight; limit metakaolin and silica fume to 10 percent of portland cement by weight.

2. Design mixtures may be prepared by a qualified independent testing agency or by qualified precast plant personnel at architectural precast concrete fabricator's option.
3. Limit water-soluble chloride ions to maximum percentage by weight of cement permitted by ACI 318 (ACI 318M) or PCI MNL 117 when tested according to ASTM C 1218/C 1218M.
4. Normal-Weight Concrete Mixtures: Proportion mixtures by either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:
   a. Compressive Strength (28 Days): 5000 psi (34.5 MPa) minimum.
   b. Maximum Water-Cementitious Materials Ratio: 0.45.
5. Water Absorption: 6 percent by weight or 14 percent by volume, tested according to PCI MNL 117.
6. Lightweight Concrete Backup Mixtures: Proportion mixtures by either laboratory trial batch or field test data methods according to ACI 211.2, with materials to be used on Project, to provide lightweight concrete with the following properties:
   a. Compressive Strength (28 Days): 5000 psi (34.5 MPa).
   b. Unit Weight: Calculated equilibrium unit weight of 115 lb/cu. ft. (1842 kg/cu. m), plus or minus 3 lb/cu. ft. (48 kg/cu. m), according to ASTM C 567.
7. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 117.
8. When included in design mixtures, add other admixtures to concrete mixtures according to manufacturer's written instructions.

N. Mold Fabrication
1. Molds: Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete-placement operations and temperature changes and for prestressing and detensioning operations. Coat contact surfaces of molds with release agent before reinforcement is placed. Avoid contamination of reinforcement and prestressing tendons by release agent.
   a. Place form liners accurately to provide finished surface texture indicated. Provide solid backing and supports to maintain stability of liners during concrete placement. Coat form liner with form-release agent.
2. Maintain molds to provide completed architectural precast concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified.
   a. Form joints are not permitted on faces exposed to view in the finished work.
   b. Edge and Corner Treatment: Uniformly chamfered **OR** radiused, **as directed**.

O. Thin Brick Facings

NOTE: The following 2 paragraphs are not applicable if bonding back of thin brick directly to concrete instead of using mortar.

1. Place form liner templates accurately to provide grid for thin brick facings. Provide solid backing and supports to maintain stability of liners while placing thin bricks and during concrete placement.
2. Securely place thin brick units face down into form liner pockets and place concrete backing mixture.
3. Completely fill joint cavities between thin brick units with sand-cement mortar, and place precast concrete backing mixture while sand-cement mortar is still fluid enough to ensure bond.
4. Mix and install grout according to ANSI A108.10. Completely fill joint cavities between thin brick units with grout, and compress into place without spreading grout onto faces of thin brick units. Remove excess grout immediately to prevent staining of brick.
   a. Tool joints to a slightly concave **OR** grapevine **OR** V-, **as directed**,shape when pointing grout is thumbprint hard.
5. Clean faces and joints of brick facing.

P. Stone Facings
1. Accurately position stone facings to comply with requirements and in locations indicated on Shop Drawings. Install anchors, supports, and other attachments indicated or necessary to secure

stone in place. Keep concrete reinforcement a minimum of 3/4 inch (19 mm) from the back surface of stone. Use continuous spacers to obtain uniform joints of widths indicated and with edges and faces aligned according to established relationships and indicated tolerances.

a. Stone to Precast Anchorages: Provide anchors in numbers, types and locations required to satisfy specified performance criteria, but not less than 2 anchors per stone unit of less than 2 sq. ft. (0.19 sq. m) in area and 4 anchors per unit of less than 12 sq. ft. (1.1 sq. m) in area; for units larger than 12 sq. ft. (1.1 sq. m) in area, provide anchors spaced not more than 24 inches (600 mm) o.c. horizontally and vertically. Locate anchors a minimum of 6 inches (150 mm) from stone edge.

2. Fill anchor holes with sealant filler and install anchors **OR** epoxy filler and install anchors with elastomeric anchor sleeve at back surface of stone, **as directed**.

a. Install polyethylene sheet to prevent bond between back of stone facing and concrete substrate and to ensure no passage of precast matrix to stone surface.

OR

Install 1/8-inch (3-mm) polyethylene-foam bond breaker to prevent bond between back of stone facing and concrete substrate and to ensure no passage of precast matrix to stone surface. Maintain minimum projection requirements of stone anchors into concrete substrate.

Q. Fabrication

1. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware, and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.

a. Weld-headed studs and deformed bar anchors used for anchorage according to AWS D1.1/D1.1M and AWS C5.4, "Recommended Practices for Stud Welding."

2. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing architectural precast concrete units to supporting and adjacent construction.

3. Cast-in reglets, slots, holes, and other accessories in architectural precast concrete units as indicated on the Contract Drawings.

4. Cast-in openings larger than 10 inches (250 mm) in any dimension. Do not drill or cut openings or prestressing strand without the Owner's approval.

5. Reinforcement: Comply with recommendations in PCI MNL 117 for fabricating, placing, and supporting reinforcement.

a. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete. When damage to epoxy-coated reinforcing exceeds limits specified in ASTM A 775/A 775M, repair with patching material compatible with coating material and epoxy coat bar ends after cutting.

b. Accurately position, support, and secure reinforcement against displacement during concrete-placement and consolidation operations. Completely conceal support devices to prevent exposure on finished surfaces.

c. Place reinforcement to maintain at least 3/4-inch (19-mm) minimum coverage. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.

d. Place reinforcing steel and prestressing strand to maintain at least 3/4-inch (19-mm) minimum concrete cover. Increase cover requirements for reinforcing steel to 1-1/2 inches (38 mm) when units are exposed to corrosive environment or severe exposure conditions. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.

e. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh spacing and wire tie laps, where required by design. Offset laps of adjoining widths to prevent continuous laps in either direction.

6. Reinforce architectural precast concrete units to resist handling, transportation, and erection stresses.
7. Prestress tendons for architectural precast concrete units by either pretensioning or post-tensioning methods. Comply with PCI MNL 117.
   a. Delay detensioning or post-tensioning of precast, prestressed architectural concrete units until concrete has reached its indicated minimum design release compressive strength as established by test cylinders cured under same conditions as concrete.
   b. Detension pretensioned tendons either by gradually releasing tensioning jacks or by heat-cutting tendons, using a sequence and pattern to prevent shock or unbalanced loading.
   c. If concrete has been heat cured, detension while concrete is still warm and moist to avoid dimensional changes that may cause cracking or undesirable stresses.
   d. Protect strand ends and anchorages with bituminous, zinc-rich, or epoxy paint to avoid corrosion and possible rust spots.
8. Comply with requirements in PCI MNL 117 and requirements in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.
9. Place face mixture to a minimum thickness after consolidation of the greater of 1 inch (25 mm) or 1.5 times the maximum aggregate size, but not less than the minimum reinforcing cover specified.
10. Place concrete in a continuous operation to prevent seams or planes of weakness from forming in precast concrete units.
    a. Place backup concrete mixture to ensure bond with face-mixture concrete.
11. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air on surfaces. Use equipment and procedures complying with PCI MNL 117.
    a. Place self-consolidating concrete without vibration according to PCI TR-6, "Interim Guidelines for the Use of Self-Consolidating Concrete in Precast/Prestressed Concrete Institute Member Plants."
12. Comply with PCI MNL 117 for hot- and cold-weather concrete placement.
13. Identify pickup points of architectural precast concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each architectural precast concrete unit on a surface that will not show in finished structure.
14. Cure concrete, according to requirements in PCI MNL 117, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.
15. Discard and replace architectural precast concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs meet requirements in PCI MNL 117 and the Owner's approval.

R. Insulated Panel Casting
1. Cast and screed supported wythe over mold.
2. Place insulation boards abutting edges and ends of adjacent boards. Insert wythe connectors through insulation, and consolidate concrete around connectors according to connector manufacturer's written instructions.
3. Cast and screed top wythe to meet required finish.

S. Fabrication Tolerances
1. Fabricate architectural precast concrete units straight and true to size and shape with exposed edges and corners precise and true so each finished panel complies with PCI MNL 117 product tolerances as well as position tolerances for cast-in items.
   OR
   Fabricate architectural precast concrete units straight and true to size and shape with exposed edges and corners precise and true so each finished panel complies with the following product tolerances:

a. Overall Height and Width of Units, Measured at the Face Exposed to View: As follows:
   1) 10 feet (3 m) or under, plus or minus 1/8 inch (3 mm).
   2) 10 to 20 feet (3 to 6 m), plus 1/8 inch (3 mm), minus 3/16 inch (5 mm).
   3) 20 to 40 feet (6 to 12 m), plus or minus 1/4 inch (6 mm).
   4) Each additional 10 feet (3 m), plus or minus 1/16 inch (1.5 mm).
b. Overall Height and Width of Units, Measured at the Face Not Exposed to View: As follows:
   1) 10 feet (3 m) or under, plus or minus 1/4 inch (6 mm).
   2) 10 to 20 feet (3 to 6 m), plus 1/4 inch (6 mm), minus 3/8 inch (10 mm).
   3) 20 to 40 feet (6 to 12 m), plus or minus 3/8 inch (10 mm).
   4) Each additional 10 feet (3 m), plus or minus 1/8 inch (3 mm).
c. Total Thickness or Flange Thickness: Plus 1/4 inch (6 mm), minus 1/8 inch (3 mm).
d. Rib Thickness: Plus or minus 1/8 inch (3 mm).
e. Rib to Edge of Flange: Plus or minus 1/8 inch (3 mm).
f. Distance between Ribs: Plus or minus 1/8 inch (3 mm).
g. Variation from Square or Designated Skew (Difference in Length of the Two Diagonal Measurements): Plus or minus 1/8 inch per 72 inches (3 mm per 1830 mm) or 1/2 inch (13 mm) total, whichever is greater.
h. Length and Width of Block-outs and Openings within One Unit: Plus or minus 1/4 inch (6 mm).
i. Location and Dimension of Block-outs Hidden from View and Used for HVAC and Utility Penetrations: Plus or minus 3/4 inch (19 mm).
j. Dimensions of Haunches: Plus or minus 1/4 inch (6 mm).
k. Haunch Bearing Surface Deviation from Specified Plane: Plus or minus 1/8 inch (3 mm).
l. Difference in Relative Position of Adjacent Haunch Bearing Surfaces from Specified Relative Position: Plus or minus 1/4 inch (6 mm).
m. Bowing: Plus or minus L/360, maximum 1 inch (25 mm).
n. Local Smoothness: 1/4 inch per 10 feet (6 mm per 3 m).
o. Warping: 1/16 inch per 12 inches (1.5 mm per 300 mm) of distance from nearest adjacent corner.
p. Tipping and Flushness of Plates: Plus or minus 1/4 inch (6 mm).
q. Dimensions of Architectural Features and Rustications: Plus or minus 1/8 inch (3 mm).

2. Position Tolerances: For cast-in items measured from datum line location, as indicated on Shop Drawings.
   a. Weld Plates: Plus or minus 1 inch (25 mm).
   b. Inserts: Plus or minus 1/2 inch (13 mm).
   c. Handling Devices: Plus or minus 3 inches (75 mm).
   d. Reinforcing Steel and Welded Wire Fabric: Plus or minus 1/4 inch (6 mm) where position has structural implications or affects concrete cover; otherwise, plus or minus 1/2 inch (13 mm).
   e. Reinforcing Steel Extending out of Member: Plus or minus 1/2 inch (13 mm) of plan dimensions.
   f. Tendons: Plus or minus 1/4 inch (6 mm), vertical; plus or minus 1 inch (25 mm), horizontal.
   g. Location of Rustication Joints: Plus or minus 1/8 inch (3 mm).
   h. Location of Opening within Panel: Plus or minus 1/4 inch (6 mm).
   i. Location of Flashing Reglets: Plus or minus 1/4 inch (6 mm).
   j. Location of Flashing Reglets at Edge of Panel: Plus or minus 1/8 inch (3 mm).
   k. Reglets for Glazing Gaskets: Plus or minus 1/8 inch (3 mm).
   l. Electrical Outlets, Hose Bibs: Plus or minus 1/2 inch (13 mm).
   m. Location of Bearing Surface from End of Member: Plus or minus 1/4 inch (6 mm).
   n. Allowable Rotation of Plate, Channel Inserts, and Electrical Boxes: 2-degree rotation or 1/4 inch (6 mm) maximum over the full dimension of unit.
   o. Position of Sleeve: Plus or minus 1/2 inch (13 mm).
   p. Location of Window Washer Track or Buttons: Plus or minus 1/8 inch (3 mm).

3. Brick-Faced Architectural Precast Concrete Units: Restrict the following misalignments to 2 percent of number of bricks in a unit.
   a. Alignment of Mortar Joints:
      1) Jog in Alignment: 1/8 inch (3 mm).
      2) Alignment with Panel Centerline: Plus or minus 1/8 inch (3 mm).
   b. Variation in Width of Exposed Mortar Joints: Plus or minus 1/8 inch (3 mm).
   c. Tipping of Individual Bricks from the Panel Plane of Exposed Brick Surface: Plus 1/16 inch (1.5 mm); minus 1/4 inch (6 mm) less than or equal to depth of form liner joint.
   d. Exposed Brick Surface Parallel to Primary Control Surface of Panel: Plus 1/4 inch (6 mm); minus 1/8 inch (3 mm).
   e. Individual Brick Step in Face from Panel Plane of Exposed Brick Surface: Plus 1/16 inch (1.5 mm); minus 1/4 inch (6 mm) less than or equal to depth of form liner joint.
4. Stone Veneer-Faced Architectural Precast Concrete Units (for smooth-finished stone):
   a. Variation in Cross-Sectional Dimensions: For thickness of walls from dimensions indicated: Plus or minus 1/4 inch (6 mm).
   b. Variation in Joint Width: 1/8 inch in 36 inches (3 mm in 900 mm) or a quarter of nominal joint width, whichever is less.
   c. Variation in Plane between Adjacent Stone Units (Lipping): 1/16 inch (1.5 mm) difference between planes of adjacent units.

T. Finishes
1. Panel faces shall be free of joint marks, grain, and other obvious defects. Corners, including false joints shall be uniform, straight, and sharp. Finish exposed-face surfaces of architectural precast concrete units to match approved design reference sample **OR** sample panels, **as directed**, and as follows:
   a. PCI's "Architectural Precast Concrete - Color and Texture Selection Guide," of plate numbers indicated.
   b. As-Cast Surface Finish: Provide surfaces free of pockets, sand streaks, and honeycombs.
   c. Textured-Surface Finish: Impart by form liners or inserts to provide surfaces free of pockets, streaks, and honeycombs, with uniform color and texture.
   d. Bushhammer Finish: Use power or hand tools to remove matrix and fracture coarse aggregates.
   e. Exposed-Aggregate Finish: Use chemical retarding agents applied to concrete forms and washing and brushing procedures to expose aggregate and surrounding matrix surfaces after form removal.
   f. Abrasive-Blast Finish: Use abrasive grit, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces.
   g. Acid-Etched Finish: Use acid and hot-water solution, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces. Protect hardware, connections, and insulation from acid attach.
   h. Honed Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.
   i. Polished Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.
   j. Sand-Embedment Finish: Use selected stones placed in a sand bed in bottom of mold, with sand removed after curing.
2. Finish exposed top **OR** bottom, **as directed**, and back, **as directed**, surfaces of architectural precast concrete units to match face-surface finish.
   OR
   Finish exposed top **OR** bottom, **as directed**, and back, **as directed**, surfaces of architectural precast concrete units by smooth, steel-trowel finish.
3. Finish unexposed surfaces of architectural precast concrete units by float finish.

U. Source Quality Control
1. Quality-Control Testing: Test and inspect precast concrete according to PCI MNL 117 requirements. If using self-consolidating concrete, also test and inspect according to PCI TR-6,

"Interim Guidelines for the Use of Self-Consolidating Concrete in Precast/Prestressed Concrete Institute Member Plants."

2. Strength of precast concrete units will be considered deficient if units fail to comply with ACI 318 (ACI 318M) requirements for concrete strength.
3. Testing: If there is evidence that strength of precast concrete units may be deficient or may not comply with ACI 318 (ACI 318M) requirements, precaster will employ an independent testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C 42/C 42M.
   a. A minimum of three representative cores will be taken from units of suspect strength, from locations directed by the Owner.
   b. Cores will be tested in an air-dry condition.
   c. Strength of concrete for each series of 3 cores will be considered satisfactory if average compressive strength is equal to at least 85 percent of 28-day design compressive strength and no single core is less than 75 percent of 28-day design compressive strength.
   d. Test results will be made in writing on same day that tests are performed, with copies to the Owner, Contractor, and precast concrete fabricator. Test reports will include the following:
      1) Project identification name and number.
      2) Date when tests were performed.
      3) Name of precast concrete fabricator.
      4) Name of concrete testing agency.
      5) Identification letter, name, and type of precast concrete unit(s) represented by core tests; design compressive strength; type of break; compressive strength at breaks, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed.
4. Patching: If core test results are satisfactory and precast concrete units comply with requirements, clean and dampen core holes and solidly fill with precast concrete mixture that has no coarse aggregate, and finish to match adjacent precast concrete surfaces.

1.3 EXECUTION

A. Installation
   1. Install clips, hangers, bearing pads, and other accessories required for connecting architectural precast concrete units to supporting members and backup materials.
   2. Erect architectural precast concrete level, plumb, and square within specified allowable tolerances. Provide temporary supports and bracing as required to maintain position, stability, and alignment as units are being permanently connected.
      a. Install temporary steel or plastic spacing shims or bearing pads as precast concrete units are being erected. Tack weld steel shims to each other to prevent shims from separating.
      b. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
      c. Remove projecting lifting devices and grout fill voids within recessed lifting devices flush with surface of adjacent precast surfaces when recess is exposed.
      d. Unless otherwise indicated, maintain uniform joint widths of 3/4 inch (19 mm).
   3. Connect architectural precast concrete units in position by bolting, welding, grouting, or as otherwise indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and grouting are completed.
      a. Do not permit connections to disrupt continuity of roof flashing.
   4. Welding: Comply with applicable AWS D1.1/D1.1M and AWS D1.4 for welding, welding electrodes, appearance, quality of welds, and methods used in correcting welding work.
      a. Protect architectural precast concrete units and bearing pads from damage by field welding or cutting operations, and provide noncombustible shields as required.
      b. Welds not specified shall be continuous fillet welds, using no less than the minimum fillet as specified by AWS.

c. Clean weld-affected metal surfaces with chipping hammer followed by brushing, and apply a minimum 4.0-mil- (0.1-mm-) thick coat of galvanized repair paint to galvanized surfaces according to ASTM A 780.
OR
Clean weld-affected metal surfaces with chipping hammer followed by brushing, and reprime damaged painted surfaces.

d. Remove, reweld, or repair incomplete and defective welds.

5. At bolted connections, use lock washers, tack welding, or other approved means to prevent loosening of nuts after final adjustment.
   a. Where slotted connections are used, verify bolt position and tightness. For sliding connections, properly secure bolt but allow bolt to move within connection slot. For friction connections, apply specified bolt torque and check 25 percent of bolts at random by calibrated torque wrench.
6. Grouting Connections: Grout connections where required or indicated. Retain grout in place until hard enough to support itself. Pack spaces with stiff grout material, tamping until voids are completely filled. Place grout to finish smooth, level, and plumb with adjacent concrete surfaces. Keep grouted joints damp for not less than 24 hours after initial set. Promptly remove grout material from exposed surfaces before it affects finishes or hardens.

B. Erection Tolerances
1. Erect architectural precast concrete units level, plumb, square, true, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 117, Appendix I.

C. Field Quality Control
1. Special Inspections: Engage a qualified special inspector to perform the following special inspections and prepare reports:
   a. Erection of precast concrete members.
2. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
3. Field welds will be subject to visual inspections and nondestructive testing according to ASTM E 165 or ASTM E 709. High-strength bolted connections will be subject to inspections.
4. Testing agency will report test results promptly and in writing to Contractor and the Owner.
5. Repair or remove and replace work where tests and inspections indicate that it does not comply with specified requirements.
6. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

D. Repairs
1. Repair architectural precast concrete units if permitted by the Owner. the Owner reserves the right to reject repaired units that do not comply with requirements.
2. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 20 feet (6 m).
3. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A 780.
4. Wire brush, clean, and paint damaged prime-painted components with same type of shop primer.
5. Remove and replace damaged architectural precast concrete units when repairs do not comply with requirements.

E. Cleaning
1. Clean surfaces of precast concrete units exposed to view.
2. Clean mortar, plaster, fireproofing, weld slag, and other deleterious material from concrete surfaces and adjacent materials immediately.
3. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.

a. Perform cleaning procedures, if necessary, according to precast concrete fabricator's recommendations. Clean soiled precast concrete surfaces with detergent and water, using stiff fiber brushes and sponges, and rinse with clean water. Protect other work from staining or damage due to cleaning operations.
b. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION 04222

Task	Specification	Specification Description
04222	03620	Plant-Precast Structural Concrete
04222	04110	Unit Masonry Assemblies
04240	04110	Unit Masonry Assemblies
04251	04110	Unit Masonry Assemblies

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SECTION 04270 - GLASS UNIT MASONRY ASSEMBLIES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for glass unit masonry assemblies. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes glass block set in mortar and glass block set in glass-block grid systems.

C. Performance Requirements
1. Structural Performance: Provide glass-block grid systems capable of withstanding the effects of gravity loads and the loads and stresses within limits and under conditions indicated.

D. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:
   a. Product Data for Credit EQ 4.1: For sealants used inside the weatherproofing system, including printed statement of VOC content.
3. Samples: Glass-block units, glass-block grid material, and joint materials involving color selection.

E. Quality Assurance
1. Fire-Rated Glass Unit Masonry Assemblies: Assemblies listed by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 **OR** UBC Standard 7-4, **as directed**.
   a. Test Pressure: Test at atmospheric pressure **OR** After 10 minutes into the test, neutral pressure level in furnace shall be located so that at least two-thirds of test specimen is above the neutral pressure plane, **as directed**.

F. Delivery, Storage, And Handling
1. Store glass block in unopened cartons on elevated platforms, under cover, and in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.
2. Store glass-block grid materials in unopened cartons in an enclosed, dry location.
3. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
4. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
5. Store accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

G. Project Conditions
1. Weather Limitations: Proceed with installation of glass unit masonry assemblies only when ambient and material temperatures are 40 deg F (5 deg C) or higher.
   a. Maintain temperature in installation areas at 40 deg F (5 deg C) or above for 48 hours after installing.

1.2 PRODUCTS

A. Glass Block

1. Hollow Glass Block: Hollow units made from transparent glass, with manufacturer's standard edge coating.
   a. Glass Color: As selected from manufacturer's full range.
   b. Pattern:
      1) Smooth, undistorted inner and outer faces.
      2) Wavy, light-diffusive design on inner faces, and smooth outer faces.
      3) Fluted, light-diffusive design, horizontal on one inner face, vertical on other; and smooth outer faces.
      4) Linear prismatic design, horizontal on one inner face, vertical on other; and smooth outer faces.
      5) Prismatic pyramid, light-diffusive design on inner faces, and smooth outer faces.
      6) As indicated by manufacturer's designation.
      7) Manufacturer's standard decorative pattern to match sample.
      8) As selected from manufacturer's full range.
      9) Custom decorative pattern to match design.
   c. Edge-Coating Color: As selected from manufacturer's full range.
   d. Unit Sizes: Manufacturer's standard sizes corresponding to nominal sizes indicated on Drawings.
   e. Thick-Faced Units: Units with faces at least 3/4 inch (19 mm) thick.
2. Solid Glass Block: Colorless, transparent, solid glass blocks with smooth **OR** stippled, **as directed**, faces and manufacturer's standard edge coating.
3. Glass Paver Block: Transparent, colorless, pressed glass units, with a smooth top surface and a decorative, light-diffusing, patterned bottom surface.

B. Glass-Block Grid Systems
1. General: Aluminum extrusions complying with ASTM B 221 (ASTM B 221M), Alloy 6063-T6 or Alloy 6463-T6, forming a grid system and frame designed for application indicated.
2. Window and Wall System: Aluminum T-bar grid with tubular frame and vinyl glass-block boots.
   a. Finish: As selected from manufacturer's full range.
   b. Glass-Block Size: 7-3/4 inches (197 mm) square by 3-1/8 inches (79 mm) thick.
   c. Provide self-flashing, **as directed**, aluminum exterior frame covers with vinyl thermal break.
   d. Provide extruded-aluminum frame receivers (corner starters) at heads, jambs, and sills.
   e. Provide extruded-aluminum mullions where indicated.
   f. Provide aluminum trim and closures as indicated.
3. Skylight System: Aluminum T-bar grid with tubular frame; vinyl thermal break; extruded-aluminum, curb-mounting frame and counterflashing; and vinyl glass-block boots.
   a. Finish: As selected from manufacturer's full range.
   b. Glass-Block Size: 7-3/4 inches (197 mm) square by 3-1/8 inches (79 mm) thick.
4. Floor System: Aluminum tubular grid and frame with glass-block boots made from UV- and oil-resistant EPDM.
   a. Finish: Class II, clear-anodized finish; complying with AAMA 611.
   b. Glass-Paver-Block Size: 6 inches (152 mm) square by 1 inch (25 mm) thick.
5. Sealant: Product recommended by glass-block grid system manufacturer.
   a. Provide sealants for use inside the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Mortar Materials
1. Portland Cement: ASTM C 150, Type I or Type II, natural color, white, or a blend to produce mortar color indicated.
   a. Where joints are indicated to be raked out and pointed, gray cement may be used for setting mortar.
2. Hydrated Lime: ASTM C 207, Type S.
3. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or Type III, and hydrated lime complying with ASTM C 207, Type S.

4. Masonry Cement: ASTM C 91.
5. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortar.
6. Colored Cement Product: Packaged blend made from portland cement and lime **OR** masonry cement, **as directed**, and mortar pigments, all complying with specified requirements, and containing no other ingredients.
   a. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
   b. Pigments shall not exceed 10 percent of portland cement **OR** 5 percent of masonry cement, **as directed**, by weight.
7. Aggregate: ASTM C 144, with 100 percent passing No. 8 (2.36-mm) sieve.
   a. For pointing mortar and joints narrower than 1/4 inch (6 mm), use aggregate graded with 100 percent passing No. 16 (1.18-mm) sieve.
   b. White Aggregates: Natural white sand or crushed white stone.
   c. Colored Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
8. Water-Repellent Admixture: Manufacturer's standard dry mixture of stearates, water-reducing agents, and fine aggregates intended to reduce capillarity in mortar.
9. Water-Repellent Admixture: Liquid polymeric water-repellent mortar admixture that does not reduce flexural bond strength of mortar.
10. Water: Potable.

D. Glass Unit Masonry Accessories
1. Panel Reinforcement: Ladder-type units, butt welded, not lapped and welded; complying with ASTM A 951 in straight lengths of not less than 10 feet (3 m), and as follows:
   a. Interior Walls: Hot-dip galvanized, carbon-steel wire.
   b. Exterior Walls: Hot-dip galvanized, carbon-steel **OR** Stainless-steel, **as directed**, wire.
   c. Wire Size: W1.7 or 0.148-inch (3.8-mm) diameter.
   d. Width: 2 inches (50 mm) **OR** 1-5/8 inches (40 mm), **as directed**.
   e. Spacing of Cross Rods: Not more than 16 inches (407 mm) apart.
2. Panel Anchors: Glass-block manufacturer's standard perforated steel strips, 0.0359 inch (0.9 mm) by 1-3/4 inches (44 mm) wide by 24 inches (600 mm) long, hot-dip galvanized after fabrication to comply with ASTM A 153/A 153M.
3. Fasteners, General: Unless otherwise indicated, provide Type 304 or Type 316 stainless-steel fasteners at exterior walls and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, at interior walls. Select fasteners for type, grade, and class required.
4. Carbon-Steel Bolts: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6) with hex nuts, ASTM A 563 (ASTM A 563M), if applicable.
5. Stainless-Steel Bolts: ASTM F 593 (ASTM F 738M), Alloy Group 1 or 2 (A1 or A4) with hex nuts, ASTM F 594 (ASTM F 836M), if applicable.
6. Postinstalled Anchors: Provide powder-actuated fasteners **OR** metal expansion sleeve anchors **OR** metal impact expansion anchors, **as directed**, of type and size necessary for installation indicated, as recommended by manufacturer, unless otherwise indicated.
7. Asphalt Emulsion: Cold-applied asphalt emulsion complying with ASTM D 1187 or ASTM D 1227.
8. Mineral-Fiber Expansion Strips: Mineral-fiber strips, complying with requirements of fire-rated assembly listing and glass-block manufacturer.
   a. Use for fire-rated assemblies.
9. Plastic-Foam Expansion Strips: Polyethylene foam complying with requirements of glass-block manufacturer; 3/8 inch (9 mm) thick
   a. Use plastic-foam expansion strips for non-fire-rated assemblies **OR** fire-rated and non-fire-rated assemblies, **as directed**.
10. Sealants: Manufacturer's standard chemically curing, elastomeric sealants of base polymer and characteristics indicated below that comply with applicable requirements in Division 07 Section "Joint Sealants".
    a. Single-component, neutral-curing **OR** acid-curing, **as directed**, silicone sealant.

b. Single-component, nonsag urethane sealant.
c. Multicomponent, nonsag polysulfide sealant.
d. Provide sealants for use inside the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
e. Sealant Accessories: Provide sealant accessories, including primers, bond-breaker tape, and cylindrical sealant backing, that comply with applicable requirements in Division 07 Section "Joint Sealants".

E. Mortar Mixes
1. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, or antifreeze compounds, unless otherwise indicated.
a. Do not use calcium chloride in mortar.
b. For mortar in exterior panels, use water-repellent admixture according to admixture manufacturer's written instructions.
c. For pointing mortar in exterior panels, use water-repellent admixture according to admixture manufacturer's written instructions.
d. Limit cementitious materials in mortar to portland cement and lime.
2. Mortar for Glass Unit Masonry Assemblies: Provide mortar, mixed according to glass-block manufacturer's listing with testing and inspecting agency, for fire-resistance rating indicated.
OR
Mortar for Glass Unit Masonry Assemblies: Comply with ASTM C 270, Proportion Specification for Type S mortar.
a. Combine and thoroughly mix cementitious materials, water, and aggregates in a mechanical batch mixer, unless otherwise indicated. Mix mortar to produce a stiff but workable consistency that is drier than mortar for brick or concrete masonry. Discard mortar when it has reached initial set.
3. Pigmented Mortar: Use colored cement product **OR** Select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products, **as directed**.
4. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.

1.3 EXECUTION

A. Installing Glass Block With Mortar
1. Apply a heavy coat of asphalt emulsion to sill and adhere expansion strips to jambs and heads with asphalt emulsion. Allow asphalt emulsion to dry before placing mortar. Trim expansion strips to width required to fit glass block and to full lengths of heads and jambs.
2. Set glass block with completely filled bed and head joints, with no furrowing, accurately spaced and coordinated with other construction. Maintain 1/4-inch (6-mm) **OR** 3/8-inch (10-mm), **as directed**, exposed joint widths, unless otherwise indicated.
3. Install panel reinforcement in horizontal joints at spacing indicated and continuously from end to end of panels; comply with the following requirements:
a. Vertical Spacing of Panel Reinforcement for Exterior Panels: Every other course but not more than 16 inches (407 mm) o.c., starting with first course above sill **OR** As indicated on Drawings, **as directed**.
b. Vertical Spacing of Panel Reinforcement for Interior Panels: Not more than 16 inches (407 mm) o.c. **OR** As indicated on Drawings, **as directed**.
c. Do not bridge expansion joints with panel reinforcement.
d. Place panel reinforcement in joints immediately above and below all openings within glass unit masonry assemblies.
e. Lap panel reinforcement not less than 6 inches (150 mm) if more than 1 length is necessary.

f. Embed panel reinforcement in mortar bed by placing lower half of mortar bed first, pressing panel reinforcement into place and covering with upper half of mortar bed.

4. Install panel anchors at locations indicated and in same horizontal joints where panel reinforcement occurs. Extend panel anchors at least 12 inches (300 mm) into joints, and bend within expansion joints at edges of panels and across the head. Attach panel anchors as follows:
   a. For in-place unit masonry assemblies and concrete, attach panel anchors with 1/4-inch- (6-mm-) diameter bolt-size, postinstalled anchors, 2 per panel anchor.
   b. For new unit masonry assemblies, embed other ends of panel anchors, after bending portions crossing expansion joint, in horizontal mortar joints closest in elevation to joints in glass unit masonry assemblies containing panel anchors.
   c. For steel members, attach panel anchors with 1/4-inch- (6-mm-) diameter through bolts and nuts or bolts in tapped holes in steel members.
5. Use rubber mallet to tap units into position. Do not use steel tools, and do not allow units to come into contact with metal accessories and frames.
6. Use plastic spacers **OR** temporary wedges, **as directed**, in mortar joints to produce uniform joint widths and to prevent mortar from being squeezed out of joints.
   a. If temporary wedges are used, remove them after mortar has set and fill voids with mortar.
7. Keep expansion joints free of mortar.
8. Rake out joints indicated to be pointed to a uniform depth sufficient to accommodate pointing material, but not less than joint width.
   a. If temporary wedges are used, remove them before raking out and pointing joints.
   b. Point joints at exterior face **OR** both faces, **as directed**, of exterior panels with mortar.
   c. Point joints at exterior face **OR** both faces, **as directed**, of exterior panels with sealant.
   d. Point joints at both faces of exterior and interior panels with sealant.
9. Point joints with mortar by filling raked joints and voids. Place and compact pointing mortar in layers not more than 3/8 inch (10 mm) thick. Compact each layer thoroughly and allow to become thumbprint hard before applying next layer.
   a. Tool exposed joints slightly concave when pointing mortar is thumbprint hard. Use a smooth plastic jointer larger than joint width.
10. Point joints by filling with sealant to comply with requirements in Division 07 Section "Joint Sealants".
11. Clean glass unit masonry assemblies as work progresses. Remove mortar fins and smears immediately, using a clean, wet sponge or a scrub brush with stiff fiber bristles. Do not use harsh cleaners, acids, abrasives, steel wool, or wire brushes when removing mortar or cleaning glass unit masonry assemblies.
12. Install sealant at jambs, heads, mullions and other locations indicated. Prepare joints, including installation of primer and bond-breaker tape or cylindrical sealant backing, and apply elastomeric sealants to comply with requirements in Division 07 Section "Joint Sealants".
13. Construction Tolerances: Set glass block to comply with the following tolerances:
   a. Variation from Plumb: For lines and surfaces of vertical elements and arris, do not exceed 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2 inch in 40 feet (12 mm in 12 m) or more.
   b. Variation from Level: For bed joints, and other conspicuous lines, do not exceed 1/4 inch in 20 feet (6 mm in 6 m) or 1/2 inch in 40 feet (12 mm in 12 m) or more.
   c. Variation of Linear Building Line: For positions shown in plan and related portions of walls and partitions, do not exceed 1/2 inch in 20 feet (12 mm in 6 m) or 3/4 inch in 40 feet (19 mm in 12 m) or more.
   d. Variation in Mortar-Joint Thickness: Do not vary from joint thickness indicated by more than plus or minus 1/16 inch (1.5 mm).

B. Glass-Block Grid System Installation
   1. General: Install glass-block grid systems according to manufacturer's written instructions.
   2. Window and Wall System Installation: Assemble grid system, apply continuous sealant bead to back of window Z-bar, place in position, adjust as needed to make grid level and plumb, and fasten to substrate.

a. Insert glass blocks into vinyl glass-block boots and carefully insert into grid from exterior side. Install blocks firmly against T-bars without deforming boots.
b. Apply sealant to completely fill channel around each glass block, and tool flush with exterior surface. Remove excess sealant and smears.

3. Skylight System Installation: Assemble grid system, apply continuous sealant bead to top of supporting curb, place in position, adjust as needed to bring grid true to line, and fasten to substrate.
   a. Insert glass blocks into vinyl glass-block boots and carefully insert into grid from exterior side. Install blocks firmly against T-bars without deforming boots.
   b. Apply sealant to completely fill channel around each glass block, and tool flush with exterior surface. Remove excess sealant and smears.
4. Floor System Installation: Assemble grid system in position, adjusting supports as needed to level grid as system is assembled, and fasten to substrate.
   a. Insert glass blocks into glass-block boots and install in grid. Install blocks flush with adjoining floor surfaces and aluminum grid.
   b. Apply sealant to completely fill channel around each glass block and joints of aluminum grid. Tool sealant flush with exterior surface and remove excess sealant and smears.

C. Cleaning
1. On surfaces adjacent to glass unit masonry assemblies, remove mortar, sealants, and other residue resulting from glass-block installation, in a manner approved by manufacturers of materials involved.
2. Remove excess sealants with commercial solvents of type recommended by sealant manufacturer. Exercise care not to damage sealant in joints.
3. Perform final cleaning of glass unit masonry assemblies when surface is not exposed to direct sunlight. Start at top of panel using generous amounts of clean water. Remove water with clean, dry, soft cloths; change cloths frequently to eliminate dried mortar particles and aggregate.

END OF SECTION 04270

Task	Specification	Specification Description
04270	04110	Unit Masonry Assemblies
04285	04110	Unit Masonry Assemblies
04286	04110	Unit Masonry Assemblies

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SECTION 04410 - DIMENSION STONE CLADDING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for dimension stone cladding. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following types of dimension stone:
   a. Panels set with individual anchors.
   b. Panels mechanically anchored on prefabricated steel trusses.
   c. Panels mechanically anchored on prefabricated steel strongback frames.
   d. Panels mechanically anchored on prefabricated steel stud frames.
   e. Panels mechanically anchored (field installed) on a metal-grid system.
   f. Panels set in architectural precast concrete.
   g. Panels glazed into aluminum curtain-wall framing system.
   h. Trim units, including bands, copings, sills, jambs and soffits.
   i. Units with carving or inscriptions.

C. Definitions
1. Definitions contained in ASTM C 119 apply to this Section.
2. Dimension Stone Cladding System: An exterior wall covering system consisting of dimension stone panels and trim together with anchors, backup structure, secondary weather barrier (sheathing), mortar, adhesives, fasteners, and sealants used to secure the stone to building structure and to produce a weather-resistant covering.
   a. Backup structure includes prefabricated steel trusses **OR** prefabricated steel strongback frames **OR** prefabricated steel stud frames **OR** metal-grid system **OR** miscellaneous steel framing required to secure stone to building structure, **as directed**.

D. Performance Requirements
1. General: Design stone anchors and anchoring systems according to ASTM C 1242.
2. Structural Performance: Provide dimension stone cladding system capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
   a. Wind Loads: Determine loads based on the following minimum design wind pressures:
      1) Uniform pressure of 20 lbf/sq. ft. (957 Pa) **OR** 30 lbf/sq. ft. (1436 Pa), **as directed**, acting inward or outward.
   b. Equipment Loads: Allow for loads due to window cleaning and maintenance equipment.
3. Seismic Performance: Provide dimension stone cladding system capable of withstanding the effects of earthquake motions determined according to ASCE 7.
4. Safety Factors for Stone: Design dimension stone cladding system to withstand loads indicated without exceeding allowable working stress of stone determined by dividing stone's average ultimate strength, as established by testing, by the following safety factors:
   a. Safety Factor for Granite: 3, **as directed**.
   b. Safety Factor for Oolitic Limestone: 8, **as directed**.
   c. Safety Factor for Dolomitic Limestone: 6, **as directed**.
   d. Safety Factor for Marble: 5, **as directed**.
   e. Safety Factor for Quartz-Based Stone: 6, **as directed**.
   f. Safety Factor for Serpentine: 6, **as directed**.
   g. Safety Factor for Slate: 5, **as directed**.
   h. Safety Factor for Travertine: 8, **as directed**.

i. Safety Factor for Concentrated Stresses: 4 for granite and 10 for stone varieties other than granite.

E. Submittals
1. Product Data: For each variety of stone, stone accessory, and other manufactured products indicated.
2. Shop Drawings: Show fabrication and installation details for dimension stone cladding system, including dimensions and profiles of stone units.
   a. Show locations and details of joints both within dimension stone cladding system and between dimension stone cladding system and other construction.
   b. Show locations and details of anchors and backup structure.
   c. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
3. Stone Samples: Sets for each color, grade, finish, and variety of stone required; not less than 12 inches (300 mm) square.
4. Colored Pointing Mortar Samples: For each color required.
5. Sealant Samples for Verification: For each type and color of joint sealant required.
6. Material Test Reports: From a qualified independent testing agency, as follows:
   a. Stone Test Reports: For each stone variety proposed for use on Project, provide test data indicating compliance with required physical properties, other than abrasion resistance, according to referenced ASTM standards. Base reports on testing done within previous five **OR** three, **as directed**, years.
7. Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold-weather requirements.

F. Quality Assurance
1. Testing Agency Qualifications: An independent agency qualified according to ASTM E 329 for testing indicated.
2. Source Limitations for Stone: Obtain each variety of stone, regardless of finish, from a single quarry.
3. Preconstruction Stone Testing: Engage a qualified independent testing agency to perform preconstruction testing indicated below.
   a. Furnish test specimens that are representative of materials proposed for incorporation into the Work.
   b. Physical Property Tests: For each stone variety proposed for use on Project, tested for compliance with physical property requirements, other than abrasion resistance, according to referenced ASTM standards.
   c. Flexural Strength Tests: For each combination of stone variety, thickness, orientation of cut, and finish, proposed for use on Project, tested according to ASTM C 880, in both wet and dry conditions.
   d. Anchorage Tests: For each combination of stone variety, orientation of cut, finish, and anchor type proposed for use on Project, tested according to ASTM C 1354.
4. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   a. Build mockups of typical exterior wall with dimension stone cladding, approximately 72 inches (1800 mm) long by 48 inches (1200 mm) high **OR** 15 feet (4.5 m) long by 10 feet (3 m) high, **as directed**.

G. Delivery, Storage, And Handling
1. Store and handle stone and related materials to prevent deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breaking, chipping, and other causes.
   a. Lift stone with wide-belt slings; do not use wire rope or ropes that might cause staining. Move stone, if required, using dollies with cushioned wood supports.

b. Store stone on wood skids or pallets with nonstaining, waterproof covers. Arrange to distribute weight evenly and to prevent damage to stone. Ventilate under covers to prevent condensation.

2. Mark stone units, on surface that will be concealed after installation, with designations used on Shop Drawings to identify individual stone units. Orient markings on vertical panels so that they are right side up when units are installed.
3. Deliver sealants to Project site in original unopened containers labeled with manufacturer's name, product name and designation, color, expiration period, pot life, curing time, and mixing instructions for multicomponent materials.
4. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
5. Store aggregates in locations where grading and other required characteristics can be maintained and where contamination can be avoided.

H. Project Conditions
1. Environmental Limitations for Mortar: Do not use frozen materials or materials mixed or coated with ice or frost. Remove and replace dimension stone cladding damaged by frost or freezing conditions. Comply with cold- and hot-weather construction and protection requirements for masonry contained in ACI 530.1/ASCE 6/TMS 602.
2. Environmental Limitations for Sealants: Do not install sealants when ambient and substrate temperatures are outside limits permitted by sealant manufacturer or below 40 deg F (5 deg C) or when joint substrates are wet.

1.2 PRODUCTS

A. Granite
1. Granite: Comply with ASTM C 615.
2. Finish: Polished **OR** Honed **OR** Thermal **OR** As indicated **OR** Match sample, **as directed**.
3. Match samples for color, finish, and other stone characteristics relating to aesthetic effects.

B. Limestone
1. Limestone: Comply with ASTM C 568.
a. Classification: I Low-Density **OR** II Medium-Density **OR** II Medium-Density, except change requirements per ASTM C 568 for absorption by weight, density, compressive strength, and modulus of rupture to, respectively, 5 percent maximum, 150 lb/cu. ft. (2400 kg/cu. m) minimum, 8000 psi (55 MPa), and 800 psi (5.5 MPa) minimum **OR** III High-Density, **as directed**.
b. Description: Dolomitic **OR** Oolitic **OR** Shell, **as directed**, limestone.
2. Indiana Oolitic Limestone Grade and Color: Select, buff **OR** Select, gray **OR** Standard, buff **OR** Standard, gray **OR** Rustic, buff **OR** Rustic, gray **OR** Variegated, **as directed**, according to grade and color classification established by ILI.
3. Finish: Smooth **OR** Sand rubbed **OR** Machine tooled, 4 bats per 1 inch (25 mm) **OR** Machine tooled, 6 bats per 1 inch (25 mm) **OR** Machine tooled, 8 bats per 1 inch (25 mm) **OR** As indicated **OR** Match sample, **as directed**.
4. Match samples for color, finish, and other stone characteristics relating to aesthetic effects.

C. Marble
1. Marble: Comply with ASTM C 503, Classification I Calcite **OR** II Dolomite, **as directed**.
2. Finish: Polished **OR** Honed **OR** As indicated **OR** Match sample, **as directed**.
3. Match samples for color, finish, and other stone characteristics relating to aesthetic effects.

D. Quartz-Based Stone
1. Quartz-Based Stone: Comply with ASTM C 616, Classification I Sandstone **OR** II Quartzitic Sandstone **OR** III Quartzite, **as directed**.

2. Finish: Sand rubbed **OR** Natural cleft **OR** Thermal **OR** As indicated **OR** Match sample, **as directed**.
3. Match samples for color, finish, and other stone characteristics relating to aesthetic effects.

E. Serpentine
1. Serpentine: Comply with ASTM C 1526, Classification I Exterior **OR** II Interior, **as directed**.
2. Finish: Polished **OR** Honed **OR** As indicated **OR** Match sample, **as directed**.
3. Match samples for color, finish, and other stone characteristics relating to aesthetic effects.

F. Slate
1. Slate: Comply with ASTM C 629, Classification I Exterior **OR** II Interior, **as directed**, with a fine, even grain and unfading color, **as directed**, from clear, sound stock.
2. Finish: Honed **OR** Sand rubbed **OR** Natural cleft **OR** As indicated **OR** Match sample, **as directed**.
3. Match samples for color, finish, and other stone characteristics relating to aesthetic effects.

G. Travertine
1. Travertine: Comply with ASTM C 1527, Classification I Exterior **OR** II Interior, **as directed**.
2. Finish: Polished **OR** Honed **OR** As indicated **OR** Match sample, **as directed**.
3. Match samples for color, finish, and other stone characteristics relating to aesthetic effects.
4. Mortar Materials
5. Portland Cement: ASTM C 150, Type I or Type II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
   a. Low-Alkali Cement: Portland cement for use with limestone shall contain not more than 0.60 percent total alkali when tested according to ASTM C 114.
6. Hydrated Lime: ASTM C 207.
7. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or Type III, and hydrated lime complying with ASTM C 207.
8. Colored Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or Type III; hydrated lime complying with ASTM C 207; and mortar pigments. Use a mix of formulation required to produce color indicated or, if not indicated, as selected from manufacturer's standard formulations. Pigments shall not exceed 10 percent of portland cement by weight.
9. Aggregate: ASTM C 144; except for joints narrower than 1/4 inch (6 mm) and pointing mortar, use aggregate graded with 100 percent passing No. 16 (1.18-mm) sieve.
   a. White Aggregates: Natural white sand or ground white stone.
   b. Colored Aggregates: Natural-colored sand or ground marble, granite, or other durable stone; of color necessary to produce required mortar color.
10. Mortar Pigments: Natural and synthetic iron oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in mortar and containing no carbon black.
11. Water: Potable.

H. Anchors And Fasteners
1. Fabricate anchors, including shelf angles, **as directed**, from stainless steel, ASTM A 666, Type 304 **OR** 316, **as directed**. Fabricate dowels and pins from stainless steel, ASTM A 276, Type 304 **OR** 316, **as directed**.
2. Fabricate shelf angles for limestone from hot-dip galvanized steel, ASTM A 36/A 36M for materials and ASTM A 123/A 123M for galvanizing.
3. Cast-in-Place Concrete Inserts: Steel, cast iron, or malleable iron adjustable inserts, with bolts, nuts, washers, and shims; all hot-dip galvanized or mechanically zinc coated, with capability to sustain, without failure, a load equal to 4 times the loads imposed as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
4. Postinstalled Anchor Bolts for Concrete and Masonry: Chemical anchors **OR** torque-controlled expansion anchors **OR** undercut anchors, **as directed**, made from stainless-steel components complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and

ASTM F 836M, Alloy Group A1 or A4) for bolts and nuts; ASTM A 666 or ASTM A 276, Type 304 or 316, for anchors, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

5. Threaded Fasteners: Heavy hexagon structural bolts, heavy hexagon nuts, and hardened washers.
   a. For stainless steel, use stainless-steel bolts, nuts, and washers; ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Alloy Group A1 or A4).
   b. For galvanized steel shelf angles and backup structure, use carbon steel bolts, nuts, and washers; ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), for bolts; ASTM A 563 (ASTM A 563M), Grade A, for nuts; and ASTM F 436 (ASTM F 436M) for washers; all hot-dip or mechanically zinc coated.
6. Weld Plates for Installation in Concrete: Comply with Division 05 Section "Metal Fabrications".

I. Framing For Backup Structure
   1. Steel Trusses **OR** Strongback Frames **OR** Miscellaneous Steel Framing, **as directed**: For framing members in contact with stone fabricate from same material and finish specified for anchors. For framing members not in contact with stone, comply with requirements indicated below:
      a. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M, minimum thickness of 3/16 inch (5 mm).
      b. Steel Tubing: ASTM A 500 (cold formed), or ASTM A 513, Type 5 (mandrel drawn), minimum thickness of 3/16 inch (5 mm).
      c. Slotted Channel Framing: Cold-formed metal channels with continuous slot complying with MFMA-3, made from galvanized steel complying with ASTM A 653/A 653M, structural steel, Grade 33 (Grade 230), with G90 (Z275) coating, and not less than 0.108-inch (2.74-mm) nominal thickness **OR** steel sheet complying with ASTM A 1008/A 1008M, structural steel, Grade 33 (Grade 230), not less than 0.105-inch (2.66-mm) nominal thickness, hot-dip galvanized after fabrication to comply with ASTM A 123/A 123M, **as directed**.
   2. Prefabricated Steel Stud Frames: Galvanized steel wall framing complying with Division 05 Section "Cold-formed Metal Framing".
      a. Secondary Weather Barrier (Sheathing): Galvanized steel sheet complying with ASTM A 653/A 653M, commercial steel, coating designation G90 (Z275).
   3. Metal-Grid Systems: Provide manufacturer's standard integrated system that combines metal struts, fittings, fasteners, and stone anchors and that is engineered expressly for mechanically installing dimension stone cladding and that complies with the following requirements:
      a. Struts: Cold-formed metal channels with continuous slot complying with MFMA-3, of size and shape required for application indicated, made from galvanized steel complying with ASTM A 653/A 653M, with G90 (Z275) coating, and not less than 0.108-inch (2.74-mm) nominal thickness **OR** steel sheet complying with ASTM A 1008/A 1008M, not less than 0.105-inch (2.66-mm) nominal thickness, hot-dip galvanized after fabrication to comply with ASTM A 123/A 123M, **as directed**.
      b. Fittings and Fasteners: System manufacturer's standard components of design, size, and material required to securely attach struts to building structure, by method indicated or selected, and stone anchors to struts, as well as to prevent galvanic corrosion. Fabricate components in contact with stone from same material specified for anchors.
      c. Stone Anchors: Shapes and sizes standard with system manufacturer, complying with "Anchors and Fasteners" Article.

J. Stone Accessories
   1. Setting Shims: Strips of resilient plastic or vulcanized neoprene, Type A Shore durometer hardness of 50 to 70, nonstaining to stone, of thickness needed to prevent point loading of stone on anchors and of depths to suit anchors without intruding into required depths of pointing materials.

2. Setting Buttons: Resilient plastic buttons, nonstaining to stone, sized to suit joint thicknesses and bed depths of stone units without intruding into required depths of pointing materials.
3. Concealed Sheet Metal Flashing: Fabricate from zinc-tin alloy-coated, **as directed**, stainless steel in thicknesses indicated, but not less than 0.0156 inch (0.4 mm) thick. Comply with requirements specified in Division 07 Section "Sheet Metal Flashing And Trim".
4. Cementitious Dampproofing for Limestone: Provide cementitious formulations that are recommended by ILI and that are nonstaining to stone, compatible with joint sealants, and noncorrosive to anchors and attachments.
5. Weep and Vent Tubes: Medium-density polyethylene tubing, 1/4-inch (6-mm) OD **OR** Rectangular, cellular, polypropylene or clear butyrate extrusion, 3/8 by 1-1/2 inches (9 by 38 mm), **as directed**, and of length required to extend from exterior face of stone to cavity behind.
6. Plastic Weep Hole/Vents: One-piece, flexible extrusion manufactured from UV-resistant polypropylene copolymer, designed to weep moisture in masonry cavity to exterior, in color selected from manufacturer's standard.
7. Wicking Material: Absorbent rope, made from cotton or UV-resistant synthetic fiber, 1/4 to 3/8 inch (6 to 10 mm) in diameter, in length required to produce 2-inch (50-mm) exposure on exterior and 18 inches (450 mm) in cavity between wythes.
8. Sealants for Joints in Dimension Stone Cladding: Manufacturer's standard chemically curing, elastomeric sealants of base polymer and characteristics indicated below that comply with applicable requirements in Division 07 Section "Joint Sealants" and do not stain stone.
    a. Multicomponent **OR** Single-component, **as directed**, nonsag, polysulfide sealant.
    b. Multicomponent **OR** Single-component, **as directed**, nonsag, urethane sealant.
    c. Single-component, neutral-curing silicone sealant.
    d. Colors: Provide colors of exposed sealants to comply with the following requirement:
        1) Match color of sample **OR** Match color of stone **OR** Provide color as indicated by manufacturer's designations **OR** Provide color as selected from manufacturer's full range, **as directed**.
9. Sealant for Filling Kerfs: Same sealant used for joints in dimension stone **OR** Manufacturer's standard chemically curing, elastomeric sealants of base polymer and characteristics indicated below that comply with applicable requirements in Division 07 Section "Joint Sealants" and that do not stain stone, **as directed**.
    a. Single-component, nonsag, urethane sealant; Class 25, Use T (traffic), and Use M (masonry).
    b. Single-component, nonsag, neutral-curing, medium to high modulus, silicone sealant; Class 25, Use NT (nontraffic), and Use M (masonry).

K. Stone Fabrication
1. General: Fabricate stone units in sizes and shapes required to comply with requirements indicated, including details on Drawings and Shop Drawings.
    a. For granite, comply with recommendations in NBGQA's "Specifications for Architectural Granite."
    b. For limestone, comply with recommendations in ILI's "Indiana Limestone Handbook."
    c. For marble, comply with recommendations in MIA's "Dimensional Stone--Design Manual IV."
2. Control depth of stone and back check to maintain minimum clearance of 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed,** between backs of stone units and surfaces or projections of structural members, fireproofing (if any), backup walls, and other work behind stone.
3. Dress joints (bed and vertical) straight and at right angle to face, unless otherwise indicated. Shape beds to fit supports.
4. Cut and drill sinkages and holes in stone for anchors, fasteners, supports, and lifting devices as indicated or needed to set stone securely in place.
5. Finish exposed faces and edges of stone, except sawed reveals, to comply with requirements indicated for finish and to match approved samples and mockups.
6. Cut stone to produce uniform joints 3/8 inch (10 mm) **OR** 1/2 inch (13 mm), **as directed,** wide and in locations indicated.

7. Contiguous Work: Provide chases, reveals, reglets, openings, and similar features as required to accommodate contiguous work.
8. Fabricate molded work, including washes and drips, to produce stone shapes with a uniform profile throughout entire unit length, with precisely formed arris slightly eased to prevent snipping, and with matching profile at joints between units.

L. Fabrication Of Backup Structure
1. Fabrication of Steel Trusses **OR** Strongback Frames **OR** Miscellaneous Steel Framing, **as directed**: Fabricate in shop to comply with AISC's "Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design," to accommodate construction tolerances specified, and as indicated on Shop Drawings.
   a. Weld shop connections to comply with applicable provisions of AWS D1.1/D1.1M.
   b. Fabricate joints to exclude water or to permit its escape to building exterior, at locations where water could accumulate because of condensation or other causes.
   c. Hot-dip galvanize backup structure after fabrication to comply with ASTM A 123/A 123M.
2. Fabrication of Prefabricated Steel Stud Frames: Fabricate and assemble by welding to comply with requirements in Division 05 Section "Cold-formed Metal Framing".
   a. Weld secondary weather barrier (sheathing) to outside face of steel stud frames. Use continuous welds at all four edges of sheets to provide continuous weather seal.
   b. For assemblies made from galvanized steel, clean welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

M. Shop-Painted Steel Finishes
1. General: Paint uncoated steel backup structure before delivering to Project site to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel."
2. Surface Preparation: After completing fabrication of steel items, prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
3. Apply two-coat high-performance coating system consisting of organic zinc-rich primer, complying with SSPC-Paint 20 or SSPC-Paint 29 and topcoat of high-build urethane or epoxy coating recommended by manufacturer for application over specified zinc-rich primer.

N. Mortar Mixes
1. General: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures needed to produce mortar of uniform quality and with optimum performance characteristics.
   a. Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated. Do not use calcium chloride.
   b. Combine and thoroughly mix cementitious materials, water, and aggregates in a mechanical batch mixer, unless otherwise indicated. Discard mortar when it has reached initial set.
2. Portland Cement-Lime Setting Mortar: Comply with ASTM C 270, Proportion Specification, for types of mortar indicated below:
   a. Set granite with Type S mortar.
   b. Set limestone with Type N mortar.
   c. Set marble with Type S mortar.
   d. Set quartz-based stone with Type S **OR** N, **as directed**, mortar.
   e. Set serpentine with Type S mortar.
   f. Set slate with Type S mortar.
   g. Set travertine with Type N mortar.
   h. Backparge travertine with Type O mortar.
3. Pointing Mortar: Comply with ASTM C 270, Proportion Specification, for types of mortar indicated. Provide pointing mortar mixed to match sample and complying with the following:

a. Pigmented Pointing Mortar: Select and proportion pigments with other ingredients to produce color required. Do not exceed pigment-to-cement ratio of 1:10, by weight.
b. Packaged Portland Cement-Lime Mix Mortar: Use portland cement-lime mix of selected color.
c. Colored-Aggregate Pointing Mortar: Produce color required by combining colored aggregates with portland cement of selected color.
d. Point granite with Type S **OR** N, **as directed**, mortar.
e. Point limestone with Type N **OR** O, **as directed**, mortar.
f. Point marble with Type N **OR** O, **as directed**, mortar.
g. Point quartz-based stone with Type N **OR** O, **as directed**, mortar.
h. Point serpentine with Type N **OR** O, **as directed**, mortar.
i. Point slate with Type N mortar.
j. Point travertine with Type N **OR** O, **as directed**, mortar.

1.3 EXECUTION

A. Installing Backup Structure
1. Installing Steel Trusses **OR** Strongback Frames **OR** Miscellaneous Steel Framing, **as directed**: Comply with AISC's "Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design," and install to accommodate construction tolerances specified and as indicated on Shop Drawings.
a. Maintain erection tolerances of backup structure within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
b. For prefabricated units to which stone has been installed before erection, maintain tolerances of stone faces and edges as specified in "Installation Tolerances" Article.
2. Installing Prefabricated Steel Stud Frames: Install by welding to steel weld-plates anchored in concrete **OR** by welding to structural-steel frame **OR** by bolting to structural-steel frame, **as directed**, to comply with requirements in Division 05 Section "Cold-formed Metal Framing".
a. Install prefabricated steel stud frames level, plumb, and true to line with no variation in plane or alignment exceeding 1/16 inch (1.5 mm) and no variation in position exceeding 1/8 inch (3 mm).
b. For prefabricated frames to which stone has been installed before erection, maintain tolerances of stone faces and edges as specified in "Installation Tolerances" Article.
3. Installing Metal-Grid Systems: Comply with manufacturer's written instructions to provide integrated system that combines metal struts, fittings, fasteners, and stone anchors.
a. Fasten struts by bolting to inserts in concrete or steel angle clips bolted to steel framing.
b. Fasten stone supports and anchors by bolting to struts.
c. Shim and adjust struts and stone supports and anchors to provide grid that is level, plumb, and true to line with no variation in plane or alignment exceeding 1/16 inch (1.5 mm) and no variation in position exceeding 1/8 inch (3 mm).

B. Setting Dimension Stone Cladding, General
1. Before setting stone clean surfaces that are dirty or stained by removing soil, stains, and foreign materials. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.
2. Coat limestone with dampproofing to extent indicated below:
a. Stone at Grade: Beds, joints, and back surfaces to at least 12 inches (300 mm) above finish-grade elevations.
b. Stone Extending below Grade: Beds, joints, back surfaces, and face surfaces below grade.
c. Allow cementitious dampproofing formulations to cure before setting dampproofed stone. Do not damage or remove dampproofing while handling and setting stone.
3. Parge back side of travertine panels with mortar not less than 3/8 inch (10 mm) thick.

4. Execute dimension stone cladding installation by skilled mechanics and employ skilled stone fitters at Project site to do necessary field cutting as stone is set.
   a. Use power saws with diamond blades to cut stone. Produce lines cut straight and true, with edges eased slightly to prevent snipping.
5. Contiguous Work: Provide reveals, reglets, and openings as required to accommodate contiguous work.
6. Set stone to comply with requirements indicated on Drawings and Shop Drawings. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure dimension stone cladding in place. Shim and adjust anchors, supports, and accessories to set stone accurately in locations indicated with uniform joints of widths indicated and with edges and faces aligned according to established relationships and indicated tolerances.
7. Provide expansion, control, and pressure-relieving joints of widths and at locations indicated.
   a. Sealing expansion and other joints is specified in Division 07 Section "Joint Sealants".
   b. Keep expansion joints free of mortar and other rigid materials.
8. Install concealed flashing at continuous shelf angles, lintels, ledges, and similar obstructions to downward flow of water to divert water to building exterior.
9. Keep cavities open where unfilled space is indicated between back of stone units and backup wall; do not fill cavities with mortar or grout.
   a. Place weep holes in joints where moisture may accumulate, including base of cavity walls, above shelf angles, and flashing. Locate weep holes at intervals not exceeding 24 inches (600 mm). Use weep and vent tubes **OR** plastic weep hole/vents **OR** wicking material, **as directed**.
   b. Place vents in cavity walls at tops of cavities, below shelf angles and flashing, and at intervals not exceeding 20 feet (6 m) vertically. Locate vents in joints at intervals not exceeding 60 inches (1500 mm) horizontally. Use weep and vent tubes **OR** plastic weep hole/vents, **as directed**.

C. Setting Mechanically Anchored Dimension Stone Cladding
1. Attach anchors securely to stone and to backup surfaces. Comply with recommendations in ASTM C 1242.
2. Provide compressible filler in ends of dowel holes and bottoms of kerfs to prevent end bearing of dowels and anchor tabs on stone. Fill remainder of anchor holes and kerfs with sealant indicated for filling kerfs.
3. Set stone supported on clips or continuous angles on resilient setting shims. Use material of thickness required to maintain uniform joint widths and to prevent point loading of stone on anchors. Hold shims back from face of stone a distance at least equal to width of joint.

D. Setting Dimension Stone Cladding With Mortar
1. Set stone in full bed of mortar with head joints filled, unless otherwise indicated.
   a. Use setting buttons of adequate size, in sufficient quantity, and of thickness required to maintain uniform joint width and to prevent mortar from extruding. Hold buttons back from face of stone a distance at least equal to width of joint, but not less than depth of pointing materials.
   b. Do not set heavy units or projecting courses until mortar in courses below has hardened enough to resist being squeezed out of joint.
   c. Support and brace projecting stones until wall above is in place and mortar has set.
   d. Provide compressible filler in ends of dowel holes and bottoms of kerfs to prevent end bearing of dowels and anchor tabs on stone. Fill remainder of anchor holes and kerfs with mortar.
2. Embed ends of sills in mortar; leave remainder of joint open until final pointing.
3. Rake out joints for pointing with mortar to depths of not less than 1/2 inch (12 mm). Rake joints to uniform depths with square bottoms and clean sides.
4. Prepare stone-joint surfaces for pointing with mortar by removing dust and mortar particles. Where setting mortar was removed to depths greater than surrounding areas, apply first layer of pointing mortar in layers not more than 3/8 inch (10 mm) until a uniform depth is formed.

5. Point stone joints by placing pointing mortar in layers not more than 3/8 inch (10 mm). Compact each layer thoroughly and allow to become thumbprint hard before applying next layer.
6. Tool joints with a round jointer having a diameter 1/8 inch (3 mm) larger than width of joint, when pointing mortar is thumbprint hard.
7. Rake out mortar from sealant-pointed joints to depths of not less than 1/2 inch (12 mm) nor less than that required for sealant and sealant backing. Rake joints to uniform depths with square bottoms and clean sides.
8. Set the following dimension stone cladding with unfilled head joints for installing joint sealants:
   a. Cornices.
   b. Copings.
   c. Belt and other projecting courses.

E. Joint-Sealant Installation
1. Prepare joints and apply sealants of type and at locations indicated to comply with applicable requirements in Division 07 Section "Joint Sealants".

F. Installation Tolerances
1. Variation from Plumb: For vertical lines and surfaces of walls, do not exceed 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (10 mm in 6 m), or 1/2 inch in 40 feet (12 mm in 12 m) or more. For external corners, corners and jambs within 20 feet (6 m) of an entrance, expansion joints, and other conspicuous lines, do not exceed 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 3/8 inch in 40 feet (10 mm in 12 m) or more.
2. Variation from Level: For lintels, sills, water tables, parapets, horizontal bands, horizontal grooves, and other conspicuous lines, do not exceed 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 3/8 inch (10 mm) maximum.
3. Variation of Linear Building Line: For positions shown in plan and related portions of walls and partitions, do not exceed 1/4 inch in 20 feet (6 mm in 6 m) or 1/2 inch in 40 feet (12 mm in 12 m) or more.
4. Variation in Cross-Sectional Dimensions: For thickness of walls from dimensions indicated, do not exceed plus or minus 1/4 inch (6 mm).
5. Variation in Joint Width: Do not vary from average joint width more than plus or minus 1/8 inch (3 mm) or a quarter of nominal joint width, whichever is less. For joints within 60 inches (1500 mm) of each other, do not vary more than 1/8 inch (3 mm) or a quarter of nominal joint width, whichever is less from one to the other.
6. Variation in Plane between Adjacent Stone Units (Lipping): Do not exceed 1/16-inch (1.5-mm) difference between planes of adjacent units.

G. Adjusting And Cleaning
1. Remove and replace broken, chipped, stained, or otherwise damaged stone, defective joints, and dimension stone cladding that does not match approved samples and mockups. Damaged stone may be repaired if the Owner approves methods and results.
2. Replace in a manner that results in dimension stone cladding's matching approved samples and mockups, complying with other requirements, and showing no evidence of replacement.
3. In-Progress Cleaning: Clean dimension stone cladding as work progresses. Remove mortar fins and smears before tooling joints. Remove excess sealant and smears as sealant is installed.
4. Final Cleaning: Clean dimension stone cladding no fewer than six days after completion of pointing and sealing, using clean water and stiff-bristle fiber brushes. Do not use wire brushes, acid-type cleaning agents, cleaning agents containing caustic compounds or abrasives, or other materials or methods that could damage stone.

END OF SECTION 04410

SECTION 04410a - INTERIOR STONE FACING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for interior stone facing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following interior applications of dimension stone:
   a. Wall paneling.
   b. Wainscot paneling.
   c. Column facing.
   d. Window stools.
   e. Base.
   f. Trim.
   g. Benches.

C. Performance Requirements
1. General: Design stone anchors and anchoring systems according to ASTM C 1242.
2. Seismic Performance: Provide interior stone facing system capable of withstanding the effects of earthquake motions determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures."

D. Submittals
1. Product Data: For each variety of stone, installation materials, and other manufactured products.
2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   a. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
3. Samples:
   a. For Each Stone Type: Include two **OR** three **OR** four **OR** five, **as directed**, or more Samples in each set and show the full range of variations in appearance characteristics expected in completed Work.
   b. For each color of grout and pointing mortar required.
4. LEED Submittal:
   a. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
5. Sealant Compatibility Test Report: From sealant manufacturer, complying with requirements in Division 07 Section "Joint Sealants" and indicating that sealants will not stain or damage stone.
6. Maintenance data.

E. Quality Assurance
1. Installer Qualifications: An installer who employs experienced stone setters who are skilled in installing interior stone facing similar in material, design, and extent to that indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.
   a. Installer's responsibilities include fabricating and installing interior stone facing, including anchoring system, and providing professional engineering services needed to assume engineering responsibility.
   b. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

2. Source Limitations for Stone: Obtain each variety of stone, regardless of finish, from a single quarry, whether specified in this Section or in another Section, with resources to provide materials of consistent quality in appearance and physical properties.

F. Delivery, Storage, And Handling
1. Lift stone with wide-belt slings; do not use wire rope or ropes that might cause staining. Move stone, if required, using dollies with cushioned wood supports.
2. Store stone on wood A-frames or pallets with nonstaining separators and nonstaining, waterproof covers. Ventilate under covers to prevent condensation.
3. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

1.2 PRODUCTS

A. Granite
1. Granite: Comply with ASTM C 615.
2. Description: Uniform, fine-grained **OR** medium-grained, **as directed**, white **OR** pink **OR** gray **OR** black, **as directed**, stone with **OR** without, **as directed**, veining.
3. Cut: Vein **OR** Fleuri, **as directed**, cut.
   a. Orientation of Veining: Horizontal **OR** Vertical **OR** As indicated, **as directed**.
4. Cut stone from one block or contiguous, matched blocks in which natural markings occur.
5. Finish: polished **OR** Honed **OR** Thermal **OR** As indicated **OR** Match sample, **as directed**.

B. Limestone
1. Limestone: Comply with ASTM C 568.
   a. Classification: I Low-Density **OR** II Medium-Density **OR** III High-Density, **as directed**.
   b. Description: Dolomitic **OR** Oolitic **OR** Shell, **as directed**, limestone.
2. Cut: Vein **OR** Fleuri, **as directed**, cut.
   a. Orientation of Veining: Horizontal **OR** Vertical **OR** As indicated, **as directed**.
3. Cut stone from one block or contiguous, matched blocks in which natural markings occur.
4. Finish: Smooth **OR** Sand rubbed **OR** Machine tooled, 4 bats per 1 inch (25 mm) **OR** Machine tooled, 6 bats per 1 inch (25 mm) **OR** Machine tooled, 8 bats per 1 inch (25 mm) **OR** As indicated **OR** Match sample, **as directed**.

C. Marble
1. Marble: Comply with ASTM C 503.
2. Description: Uniform, fine- to medium-grained, white stone with only slight veining.
3. Cut: Vein **OR** Fleuri, **as directed**, cut.
   a. Orientation of Veining: Horizontal **OR** Vertical **OR** As indicated, **as directed**.
4. Cut stone from one block or contiguous, matched blocks in which natural markings occur.
5. Finish: Polished **OR** Honed **OR** As indicated **OR** Match sample, **as directed**.

D. Quartz-Based Stone
1. Quartz-Based Stone: Comply with ASTM C 616, Classification I Sandstone **OR** II Quartzitic Sandstone **OR** III Quartzite, **as directed**.
2. Finish: Sand rubbed **OR** Natural cleft **OR** Thermal **OR** As indicated **OR** Match sample, **as directed**.

E. Serpentine
1. Serpentine: Comply with ASTM C 1526, Classification I Exterior **OR** II Interior, **as directed**.
2. Cut stone from one block or contiguous, matched blocks in which natural markings occur.
3. Finish: Polished **OR** Honed **OR** As indicated **OR** Match sample, **as directed**.

F. Slate

1. Slate: Comply with ASTM C 629, Classification I Exterior **OR** II Interior, **as directed**, with a fine, even grain and unfading color, from clear, sound stock.
   a. Color: Black **OR** Blue-black **OR** Gray **OR** Blue-gray **OR** Green **OR** Purple **OR** Mottled purple and green **OR** Red, **as directed**.
2. Finish: Honed **OR** Sand rubbed **OR** Natural cleft **OR** As indicated **OR** Match sample, **as directed**.

G. Travertine
1. Travertine: Comply with ASTM C 1527, Classification I Exterior **OR** II Interior, **as directed**.
2. Cut: Vein **OR** Fleuri, **as directed**, cut.
   a. Orientation of Veining: Horizontal **OR** Vertical **OR** As indicated, **as directed**.
3. Cut stone from one block or contiguous, matched blocks in which natural markings occur.
4. Filling: Fill pores on faces of stone with cementitious filler of color selected **OR** matching sample, **as directed**.
5. Finish: Polished **OR** Honed **OR** As indicated **OR** Match sample, **as directed**.

H. Setting Materials
1. Molding Plaster: ASTM C 59/C 59M.
2. Portland Cement: ASTM C 150, Type I or II.
   a. Low-Alkali Cement: Not more than 0.60 percent total alkali when tested according to ASTM C 114.
3. Hydrated Lime: ASTM C 207, Type S.
4. Aggregate: ASTM C 144.
5. Water: Potable.
6. Adhesives, General: Use only adhesives formulated for stone and ceramic tile and recommended by their manufacturer for the application indicated.
7. Organic Adhesive: ANSI A136.1, Type I, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
8. Water-Cleanable Epoxy Adhesive: ANSI A118.3, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. Stone Adhesive: 2-part, epoxy-resin or polyester-resin stone adhesive with an initial set time of not more than 2 hours at 70 deg F (21 deg C), and with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   a. Color: Clear **OR** Match stone, **as directed**.

I. Grout
1. Grout Colors: Match stone **OR** As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
2. Sand-Portland Cement Grout: ANSI A108.10, composed of white or gray cement and white or colored aggregate as required to produce required color.
3. Standard Sanded Cement Grout: ANSI A118.6.
4. Standard Unsanded Cement Grout: ANSI A118.6.
5. Polymer-Modified Tile Grout: ANSI A118.7.
   a. Polymer Type: Ethylene vinyl acetate, in dry, redispersible form, prepackaged with other dry ingredients.
   b. Polymer Type: Acrylic resin or styrene-butadiene rubber in liquid-latex form for addition to prepackaged dry-grout mix.
   c. Polymer Type: Either ethylene vinyl acetate, in dry, redispersible form, prepackaged with other dry ingredients, or acrylic resin or styrene-butadiene rubber in liquid-latex form for addition to prepackaged dry-grout mix.
   d. Grout Type: Sanded **OR** Unsanded, **as directed**.
6. Water-Cleanable Epoxy Grout: ANSI A118.3, chemical-resistant, water-cleanable, tile-setting and -grouting epoxy.

J. Pointing Mortar Materials

1. Portland Cement: ASTM C 150, Type I or II. Provide natural color or white cement as required to produce mortar color indicated.
   a. Low-Alkali Cement: Not more than 0.60 percent total alkali when tested according to ASTM C 114.
2. Hydrated Lime: ASTM C 207, Type S.
3. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or III, and hydrated lime complying with ASTM C 207, Type S.
4. Colored Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or Type III; hydrated lime complying with ASTM C 207, Type S; and mortar pigments. Use a mix of formulation required to produce color indicated or, if not indicated, as selected from manufacturer's standard formulations. Pigments shall not exceed 10 percent of portland cement by weight.
5. Aggregate: ASTM C 144, except with 100 percent passing No. 16 (1.18-mm) sieve.
   a. White Aggregates: Natural white sand or ground white stone.
   b. Colored Aggregates: Natural-colored sand or ground marble, granite, or other durable stone; of color necessary to produce required mortar color.
6. Mortar Pigments: Natural and synthetic iron oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in mortar and containing no carbon black.
7. Water: Potable.

K. Sealants
1. Joint Sealants: Manufacturer's standard sealants of characteristics indicated below that comply with applicable requirements in Division 07 Section "Joint Sealants" and will not stain the stone they are applied to.
   a. Single-component, mildew-resistant, neutral-curing **OR** acid-curing, **as directed**, silicone sealant.
   b. Single-component, nonsag urethane sealant.
   c. Latex Sealant.
   d. VOC Content: 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   e. Colors: Provide colors of exposed sealants to match colors of grout in stone adjoining sealed joints, unless otherwise indicated.
2. Sealant for Filling Kerfs: Same sealant used for joints in dimension stone **OR** Manufacturer's standard chemically curing, elastomeric sealants of base polymer and characteristics indicated below that comply with applicable requirements in Division 07 Section "Joint Sealants" and that do not stain stone, **as directed**.
   a. Single-component, nonsag, urethane sealant; Class 25, Use T (traffic), and Use M (masonry).
   b. Single-component, nonsag, neutral-curing, medium to high modulus, silicone sealant; Class 25, Use NT (nontraffic), and Use M (masonry).
   c. VOC Content: 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

L. Stone Anchors And Attachments
1. Fabricate anchors from stainless steel, ASTM A 240/A 240M, Type 304.
   a. Fasteners for Stainless-Steel Anchors: Annealed stainless-steel bolts, nuts, and washers; ASTM F 593 (ASTM F 738M) for bolts and ASTM F 594 (ASTM F 836M) for nuts, Alloy Group 1 (A1).
2. Fabricate dowels from stainless steel, ASTM A 276, Type 304.
3. Fabricate anchors from extruded aluminum, ASTM B 221 (ASTM B 221M), alloy and temper as required to support loads imposed without exceeding allowable design stresses, but not less than strength and durability properties of Alloy 6063-T6.
   a. Fasteners for Extruded-Aluminum Anchors: Annealed stainless-steel bolts, nuts, and washers; ASTM F 593 (ASTM F 738M) for bolts and ASTM F 594 (ASTM F 836M) for nuts, Alloy Group 1 (A1).

4. Anchor Support Grids: Roll-formed steel channels, of size and shape required for application indicated, formed from galvanized steel sheet not less than 0.108 inch (2.8 mm) thick and complying with ASTM A 653/A 653M, G90 (Z275).
   a. Fittings and Fasteners: System manufacturer's standard components of design, size, and material required to securely attach grids to building structure and stone anchors to grids. Fabricate components in contact with stone from same material specified for anchors.
5. Wire Tiebacks: No. 9 AWG copper or copper-alloy or 0.120-inch- (3.0-mm-) diameter, stainless-steel wire.
6. Dovetail Slots: Furnish dovetail slots with filler strips of slot size required to receive anchors provided, fabricated from 0.0336-inch- (0.85-mm-) thick, galvanized steel sheet complying with ASTM A 653/A 653M, G90 (Z275).
7. Direct-Mount Anchoring Systems: Stainless-steel or aluminum stone anchors designed to be applied directly to wall surfaces or to metal grids. System is secured to wall framing, furring, or sheet-metal reinforcing strips built into wall with stainless-steel self-drilling screws. Anchors fit into kerfs or holes in edges of interior stone facing panels and do not need setting spots.

M. Stone Accessories
1. Temporary Setting Shims: Rigid plastic shims, nonstaining to stone, sized to suit joint thickness.
2. Setting Shims for Direct-Mount Anchoring Systems: Strips of resilient plastic or neoprene, nonstaining to stone, of thickness needed to prevent point loading of stone on anchors and of depths to suit anchors without intruding into required depths of pointing materials.
3. Cleaner: Stone cleaner specifically formulated for stone types, finishes, and applications indicated, as recommended by stone producer. Do not use cleaning compounds containing acids, caustics, harsh fillers, or abrasives.
4. Stone Sealer: Colorless, stain-resistant sealer that does not affect color or physical properties of stone surfaces, as recommended by stone producer for application indicated.

N. Stone Fabrication, General
1. Select stone for intended use to prevent fabricated units from containing cracks, seams, and starts that could impair structural integrity or function.
   a. Repairs that are characteristic of the varieties specified are acceptable provided they do not impair structural integrity or function and are not aesthetically unpleasing, as judged by the Owner.
2. Fabricate interior stone facing in sizes and shapes required to comply with requirements indicated, including details on Drawings and Shop Drawings.
   a. For granite, comply with recommendations in NBGQA's "Specifications for Architectural Granite."
   b. For marble, comply with recommendations in MIA's "Dimension Stone--Design Manual."
   c. For limestone, comply with recommendations in ILI's "Indiana Limestone Handbook."
3. Cut stone to produce pieces of thickness, size, and shape indicated and to comply with fabrication and construction tolerances recommended by applicable stone association.
   a. Where items are installed with adhesive or where edges of stone is visible in the finished work, make items uniform in thickness and of identical thickness for each type of item; gage back of stone if necessary.
   b. Clean sawed backs of stones to remove rust stains and iron particles.
   c. Dress joints straight and at right angle to face, unless otherwise indicated.
   d. Cut and drill sinkages and holes in stone for anchors, supports, and lifting devices as indicated or needed to set stone securely in place; shape beds to fit supports.
   e. Provide openings, reveals, and similar features as needed to accommodate adjacent work.
4. Fabricate molded work to produce stone shapes with a uniform profile throughout entire unit length and with precisely formed arris slightly eased to prevent snipping, and matched at joints between units.
   a. Produce moldings with machines having abrasive shaping wheels made to reverse contour of molding shape; do not sculpt moldings.
   b. Miter moldings at corners, unless otherwise indicated, with edges of miters slightly eased at outside corners.

5. Finish exposed faces and edges of stone to comply with requirements indicated for finish of each type of stone required and to match approved Samples.
6. Carefully inspect finished stone units at fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units.
   a. Grade and mark stone for overall uniform appearance when assembled in place. Natural variations in appearance are acceptable if installed stone units match range of colors and other appearance characteristics represented in approved Samples.

O. Stone Paneling And Column Facing
1. Arrange panels in shop or other suitable space in proposed orientation and sequence for examination by the Owner. Mark units with temporary sequence numbers to indicate position in proposed layout.
   a. Lay out one elevation at a time if approved by the Owner.
   b. Notify the Owner seven days in advance of date and time when layout will be available for viewing.
   c. Provide lighting of similar type and level as that of final installation for viewing layout, unless otherwise approved by the Owner.
   d. Rearrange panels as directed by the Owner until layout is approved.
   e. Do not trim nonmodular-size units to less than modular size until after the Owner's approval of layout, unless otherwise approved by the Owner.
   f. Mark backs of units and Shop Drawings with sequence numbers based on approved layout. Mark backs of units to indicate orientation of units in completed Work.
2. Nominal Thickness: 3/4 inch (20 mm) **OR** 7/8 inch (21 mm) **OR** 1 inch (25 mm) **OR** 1-1/4 inches (32 mm) **OR** 2 inches (50 mm), **as directed**, unless otherwise indicated.
3. Maintain minimum clearances of 3/4 inch (20 mm) **OR** 1 inch (25 mm), **as directed**, between backs of panels and structural members, fireproofing if any, backup walls, and other work behind stone. Do not back check stone less than 1 inch (25 mm) thick.
4. Joints: 1/16-inch- (1.5-mm-) wide grouted **OR** 1/8-inch- (3-mm-) wide grouted **OR** 1/8-inch- (3-mm-) wide, sealant-filled **OR** 1/4-inch- (6-mm-) wide, mortar-pointed **OR** 1/4-inch- (6-mm-) wide, sealant-filled **OR** 3/8-inch- (10-mm-) wide, mortar-pointed **OR** 3/8-inch- (10-mm-) wide, sealant-filled, **as directed**, joints.
5. Quirk-miter corners, unless otherwise indicated. Install anchorage in top and bottom bed joints of corner units.
6. Carve and cut inscriptions and decorative surfaces according to Shop Drawings. Use skilled stone carvers experienced in the successful performance of work similar to that indicated.
7. Abrasively etch inscriptions and decorative surfaces according to Shop Drawings.
8. Laser etch inscriptions and decorative surfaces according to Shop Drawings.
9. Pattern Arrangement: Fabricate and arrange panels with veining and other natural markings to comply with the following requirements:
   a. Arrange panels with veining horizontal.
   b. Arrange panels with veining vertical.
   c. Arrange panels with veining as indicated on Drawings.
   d. Arrange panels in blend pattern.
   e. Book match units, single-course height.
   f. Book match units, both vertically and horizontally.
   g. Book match units in each course. No matching is required between successive courses.
   h. Slip match units, single-course height.
   i. Slip match units, both vertically and horizontally.
   j. Slip match units in each course. No matching is required between successive courses.

P. Stone Window Stools, Base, And Trim
1. Window Stools:
   a. Nominal Thickness: 3/4 inch (20 mm) **OR** 7/8 inch (22 mm) **OR** 1-1/4 inches (32 mm), **as directed**, unless otherwise indicated.

b. Edge Detail: Straight, slightly eased at corners **OR** 3/8-inch (10-mm) bevel at top edge, bottom corner slightly eased **OR** 3/8-inch (10-mm) radius at top edge, bottom corner slightly eased **OR** 3/4-inch (20-mm) bullnose **OR** 1-1/2-inch (40-mm) laminated bullnose **OR** As indicated, **as directed**.

c. Ends: Extend stools beyond opening same distance as stool overhang and finish ends to match exposed edge.

d. Joints: 1/16-inch- (1.5-mm-) wide grouted joints **OR** 1/8-inch- (3-mm-) wide grouted joints **OR** 1/8-inch- (3-mm-) wide, sealant-filled joints **OR** Bonded joints, 1/32 inch (0.8 mm) or less in width, **as directed**.

e. Assemble window stools by bonding joints with stone adhesive. Mask areas adjacent to joints to prevent adhesive smears. Clamp units to temporary bracing to ensure that window stools are properly aligned and joints are minimum width.

2. Base:

a. Nominal Thickness: 3/4 inch (20 mm) **OR** 7/8 inch (22 mm) **OR** 1-1/4 inches (32 mm), **as directed**, unless otherwise indicated.

b. Top-Edge Detail: Straight, slightly eased at corner **OR** 3/8-inch (10-mm) bevel **OR** 3/4-inch (20-mm) radius **OR** 3/8-inch (10-mm) radius **OR** As indicated, **as directed**.

c. Ends: Butt ends into casings **OR** Butt ends into opening frames **OR** Return ends to depth of adjacent finish with edge detail same as top edge, **as directed**, unless otherwise indicated.

d. Joints: 1/16-inch- (1.5-mm-) wide grouted joints **OR** 1/8-inch- (3-mm-) wide grouted joints **OR** 1/8-inch- (3-mm-) wide, sealant-filled joints **OR** Bonded joints, 1/32 inch (0.8 mm) or less in width, **as directed**.

1) Locate joints at midpoints between adjacent paneling joints, unless otherwise indicated.

3. Flat Trim:

a. Nominal Thickness: 3/4 inch (20 mm) **OR** 7/8 inch (22 mm) **OR** 1-1/4 inches (32 mm) **OR** 1-1/2 inches (40 mm), **as directed**, unless otherwise indicated.

b. Edge Detail: Straight, slightly eased at corners **OR** 3/8-inch (10-mm) bevels **OR** 3/4-inch (20-mm) radii **OR** 3/8-inch (10-mm) radii **OR** As indicated, **as directed**.

c. Joints: 1/16-inch- (1.5-mm-) wide grouted joints **OR** 1/8-inch- (3-mm-) wide grouted joints **OR** 1/8-inch- (3-mm-) wide, sealant-filled joints **OR** Bonded joints, 1/32 inch (0.8 mm) or less in width, **as directed**.

4. Molded Trim:

a. Profile: Match profiles indicated on Drawings **OR** existing, **as directed**.

b. Joints: 1/16-inch- (1.5-mm-) wide grouted joints **OR** 1/8-inch- (3-mm-) wide grouted joints **OR** 1/8-inch- (3-mm-) wide, sealant-filled joints **OR** Bonded joints, 1/32 inch (0.8 mm) or less in width, **as directed**.

Q. Stone Benches

1. Tops:

a. Nominal Thickness: 3/4 inch (20 mm) **OR** 7/8 inch (22 mm) **OR** 1-1/4 inches (32 mm) **OR** 1-1/2 inches (40 mm) **OR** 2 inches (50 mm), **as directed**, unless otherwise indicated.

b. Edge Detail: Straight, slightly eased at corners **OR** 3/8-inch (10-mm) bevel at top edge, bottom corner slightly eased **OR** 3/8-inch (10-mm) radius at top edge, bottom corner slightly eased **OR** 3/8-inch (10-mm) bevel at top and bottom edges **OR** full bullnose **OR** As indicated, **as directed**.

c. Corner Detail: Match top edge **OR** Square, slightly eased **OR** As indicated, **as directed**.

d. Bottom Surface Finish: Smooth.

2. Pedestals:

a. Nominal Thickness: 4 inches (100 mm), unless otherwise indicated.

b. Edge Detail: Straight, slightly eased at corners **OR** 3/8-inch (10-mm) bevel at corners **OR** 3/8-inch (10-mm) radius at corners **OR** full bullnose **OR** As indicated, **as directed**.

3. Base: Stone facing applied to concrete **OR** masonry, **as directed**.

a. Nominal Stone Thickness: 3/4 inch (20 mm) **OR** 7/8 inch (22 mm) **OR** 1-1/4 inches (32 mm), **as directed**, unless otherwise indicated.

b. Joints: 1/16-inch- (1.5-mm-) wide grouted **OR** 1/8-inch- (3-mm-) wide grouted **OR** 1/4-inch- (6-mm-) wide, mortar-pointed **OR** 3/8-inch- (10-mm-) wide, mortar-pointed, **as directed**, joints.

R. Mixes
1. Spotting Plaster: Stiff mix of molding plaster and water.
2. Mortar: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures needed to produce mortar of uniform quality and with optimum performance characteristics.
   a. Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated. Do not use calcium chloride.
   b. Combine and thoroughly mix cementitious materials, water, and aggregates in a mechanical batch mixer, unless otherwise indicated. Discard mortar when it has reached initial set.
3. Setting Mortar: Comply with ASTM C 270, Proportion Specification.
   a. Type: N **OR** O, **as directed**.
   b. Mix Proportions: 1 part portland cement and 2-1/2 to 4 parts lime with aggregate ratio of 2-1/4 to 3 times volume of cement and lime.
4. Pointing Mortar: Comply with ASTM C 270, Proportion Specification, for types of mortar indicated. Provide pointing mortar mixed to match the Owner's sample and complying with the following:
   a. Pigmented Pointing Mortar: Select and proportion pigments with other ingredients to produce color required. Do not exceed pigment-to-cement ratio of 1:10, by weight.
   b. Packaged Portland Cement-Lime Mix Mortar: Use portland cement-lime mix of selected color.
   c. Colored-Aggregate Pointing Mortar: Produce color required by combining colored aggregates with portland cement of selected color.
   d. Type: N **OR** O, **as directed**.
   e. Mix Proportions: 1 part portland cement and 2-1/2 to 4 parts lime with aggregate ratio of 2-1/4 to 3 times volume of cement and lime.
5. Grout: Comply with mixing requirements of referenced ANSI standards and with manufacturer's written instructions.

1.3 EXECUTION

A. Preparation
1. Clean dirty or stained stone surfaces by removing soil, stains, and foreign materials before setting. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

B. Setting Of Stone, General
1. Do necessary field cutting as stone is set. Use power saws with diamond blades to cut stone. Cut lines straight and true, with edges eased slightly to prevent snipping.
2. Contiguous Work: Provide reveals and openings as required to accommodate contiguous work.
3. Set stone to comply with requirements indicated on Drawings and Shop Drawings. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure stone in place. Shim and adjust anchors, supports, and accessories to set stone accurately in locations indicated, with edges and faces aligned according to established relationships and indicated tolerances.
4. Erect stone units level, plumb, and true with uniform joint widths. Use temporary shims to maintain joint width.

5. Provide expansion, control, and pressure-relieving joints of widths and at locations indicated.
   a. Sealing of expansion, control, and pressure-relieving joints is specified in Division 07 Section "Joint Sealants".
   b. Keep expansion, control, and pressure-relieving joints free of plaster, mortar, grout, and other rigid materials.

C. Construction Tolerances
1. Variation from Plumb: For vertical lines and surfaces, do not exceed 1/8 inch in 96 inches (3 mm in 2400 mm), 1/4 inch (6 mm) maximum.
2. Variation from Level: For lintels, sills, chair rails, horizontal bands, horizontal grooves, and other conspicuous lines, do not exceed 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), 3/8 inch (10 mm) maximum.
3. Variation of Linear Building Line: For position shown in plan and related portion of walls and partitions, do not exceed 1/8 inch in 96 inches (3 mm in 2400 mm), 1/4 inch in 20 feet (6 mm in 6 m), 3/8 inch (10 mm) maximum.
4. Variation in Cross-Sectional Dimensions: For thickness of walls from dimensions indicated, do not exceed plus or minus 1/8 inch (3 mm).
5. Variation in Joint Width: Do not vary joint thickness more than 1/16 inch (1.5 mm) or 1/4 of nominal joint width, whichever is less.
6. Variation in Plane between Adjacent Stone Units (Lipping): Do not exceed 1/32-inch (0.8-mm) difference between planes of adjacent units.

D. Installation Of Stone Paneling And Column Facing
1. Set units firmly against setting spots. Locate setting spots at anchors and spaced not more than 18 inches (450 mm) apart across back of unit, but provide no fewer than 1 setting spot per 2 sq. ft. (0.18 sq. m), unless otherwise indicated.
   a. Moisture Exposure: Use portland cement mortar for setting spots where stone is applied to inside face of exterior walls and at other locations where stone or cavity will be exposed to moisture.
2. Set units on direct-mount anchoring system with anchors securely attached to stone and to backup surfaces. Comply with recommendations in ASTM C 1242.
   a. Provide compressible filler in ends of dowel holes and bottoms of kerfs to prevent end bearing of dowels and anchor tabs on stone. Fill remainder of anchor holes and kerfs with sealant indicated for filling kerfs.
   b. Set stone supported on clips or continuous angles on resilient setting shims. Use material of thickness required to maintain uniform joint widths and to prevent point loading of stone on anchors. Hold shims back from face of stone a distance at least equal to width of joint.
3. Minimum Anchors: Provide anchors at a maximum of 24 inches (600 mm) o.c. around perimeter of interior stone facing panels with a minimum of 4 anchors per panel.
4. Minimum Anchors: Provide a minimum of 4 anchors per panel up to 12 sq. ft. (1.1 sq. m) in face area, plus a minimum of 2 additional anchors for each additional 8 sq. ft. (0.7 sq. m).
5. Grout **OR** Point, **as directed**, joints after setting.

E. Installation Of Stone Window Stools, Base, And Trim
1. Stone Window Stools: Set stone window stools on masonry in a full bed of mortar.
   OR
   Stone Window Stools: Set stone window stools on wood or metal framing or wood blocking in a full bed of organic **OR** water-cleanable epoxy, **as directed**, adhesive. Hold adhesive back from exposed edges of joints to allow for grouting **OR** pointing with sealant, **as directed**.
2. Where window stools are too long to be installed in one piece, assemble by bonding joints with stone adhesive as units are set. Mask areas adjacent to joints to prevent adhesive smears. Clamp units in place to ensure that window stools are properly aligned and joints are minimum width.
3. Where joints are indicated in window stools maintain alignment across joints. Use temporary shims as necessary to maintain joint width.

4. Stone Base and Trim at Walls with Stone Paneling: Set units by adhering to interior stone facing with water-cleanable epoxy adhesive. Hold adhesive back from exposed edges of joints to allow for grouting.
   OR
   Stone Base and Trim at Walls with Stone Paneling: Set units firmly against setting spots. Located setting spots at anchors and spaced not more than 18 inches (450 mm) apart, unless otherwise indicated. Provide no fewer than 2 anchors per piece for stone trim up to 48 inches (1200 mm) in length, plus 1 additional anchor for each additional 24 inches (600 mm) of length.
5. Stone Base and Trim at Walls without Stone Paneling: Adhere units to plywood backing with full spread of water-cleanable epoxy adhesive. Hold adhesive back from exposed edges of joints to allow for grouting.
   OR
   Stone Base and Trim at Walls without Stone Paneling: Adhere units to gypsum board with full spread of organic **OR** water-cleanable epoxy, **as directed**, adhesive. Hold adhesive back from exposed edges of joints to allow for grouting.
6. Assemble stone base and trim by bonding joints with stone adhesive as units are set. Mask areas adjacent to joints to prevent adhesive smears. Clamp units in place to ensure that surfaces are properly aligned and joints are minimum width.
7. Grout **OR** Point, **as directed**, joints after setting.

F. Installation Of Stone Benches
1. Stone Pedestals: Set pedestals on concrete subfloor **OR** stone flooring, **as directed**, in a full bed of mortar. Anchor pedestals with no fewer than two 1/4-inch (6-mm) **OR** 3/8-inch (10-mm), **as directed**, dowels, extending not les than 2 inches (50 mm) into pedestals and 2 inches (50 mm) **OR** 4 inches (100 mm), **as directed**, into floor construction. Solidly fill space around dowels with mortar.
   OR
   Stone Pedestals: Set pedestals on stone flooring in a full bed of water-cleanable epoxy adhesive. Anchor pedestals with no fewer than two 1/4-inch (6-mm) **OR** 3/8-inch (10-mm), **as directed**, dowels, extending not les than 2 inches (50 mm) into pedestals and 2 inches (50 mm) into floor construction. Solidly fill space around dowels with adhesive. Hold adhesive back from exposed edges to allow for grouting.
2. Stone Bench Tops: Set tops on pedestals **OR** concrete or masonry bases, **as directed**, in a full bed of mortar. Anchor tops with no fewer than two 1/4-inch (6-mm) **OR** 3/8-inch (10-mm), **as directed**, dowels, extending not les than 2 inches (50 mm) into pedestals **OR** bases, **as directed**, and half of thickness into the tops. Solidly fill space around dowels with mortar.
   OR
   Stone Bench Tops: Set stone bench tops on pedestals **OR** concrete or masonry bases, **as directed**, in a full bed of water-cleanable epoxy adhesive. Anchor tops with no fewer than two 1/4-inch (6-mm) **OR** 3/8-inch (10-mm), **as directed**, dowels, extending not less than 2 inches (50 mm) into pedestals **OR** bases, **as directed**, and half of thickness into the tops. Solidly fill space around dowels with adhesive. Hold adhesive back from exposed edges of joints to allow for grouting.
3. Stone Base: Apply stone facing to concrete or masonry bases by setting in a full spread of mortar **OR** water-cleanable epoxy adhesive, **as directed**.
   a. Provide no fewer than 2 anchors per piece for stone base up to 48 inches (1200 mm) in length, plus 1 additional anchor for each additional 24 inches (600 mm) of length.
   b. Hold adhesive back from exposed edges of joints to allow for grouting.

G. Grouting Joints
1. Grout stone to comply with ANSI A108.10.
   a. Use sanded grout mixture for joints wider than 1/8 inch (3 mm).
   b. Use unsanded grout mixture for joints 1/8 inch (3 mm) and narrower.
2. Remove temporary shims before grouting.
3. Tool joints uniformly and smoothly with plastic tool.

H. Pointing Joints With Mortar
1. Prepare stone-joint surfaces for pointing with mortar by removing temporary shims, dust, and mortar particles. Where setting spots occur at joints, rake out excess setting mortar or plaster to a depth of not less than 1/2 inch (13 mm).
2. Point stone joints by placing pointing mortar in layers not more than 3/8 inch (10 mm). Compact each layer thoroughly and allow to become thumbprint hard before applying next layer. Apply mortar first to areas where depths are greater than surrounding areas until a uniform depth is formed.
3. Tool joints when pointing mortar is thumbprint hard. Use a round jointer having a diameter 1/8 inch (3 mm) larger than width of joint.

I. Joint-Sealant Installation
1. Prepare joints and apply sealants of type and at locations indicated to comply with applicable requirements in Division 07 Section "Joint Sealants". Remove temporary shims before applying sealants.

J. Adjusting And Cleaning
1. In-Progress Cleaning: Clean interior stone facing as work progresses. Remove adhesive, grout, mortar, and sealant smears immediately.
2. Remove and replace interior stone facing of the following description:
   a. Broken, chipped, stained, or otherwise damaged stone. Stone may be repaired if methods and results are approved by the Owner.
   b. Defective stone facing.
   c. Defective joints, including misaligned joints.
   d. Interior stone facing and joints not matching approved Samples.
   e. Interior stone facing not complying with other requirements indicated.
3. Replace in a manner that results in interior stone facing's matching approved Samples, complying with other requirements, and showing no evidence of replacement.
4. Clean interior stone facing no fewer than six days after completion of grouting and pointing, using clean water and soft rags or stiff-bristle fiber brushes. Do not use wire brushes, acid-type cleaning agents, cleaning compounds with caustic or harsh fillers, or other materials or methods that could damage stone.
5. Sealer Application: Apply stone sealer to comply with stone producer's and sealer manufacturer's written instructions and recommendations.

K. Protection
1. Protect stone surfaces, edges, and corners from construction damage. Use securely fastened untreated wood, plywood, or heavy cardboard to prevent damage.
2. Before inspection for Substantial Completion, remove protective coverings and clean surfaces.

END OF SECTION 04410a

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SECTION 04422 - STONE MASONRY

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for stone masonry. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes the following applications of stone masonry:
   a. Anchored or Adhered to concrete backup.
   b. Anchored or Adhered to unit masonry backup.
   c. Anchored or Adhered to wood framing and sheathing.
   d. Anchored or Adhered to cold-formed metal framing and sheathing.

C. Submittals
1. Product Data: For each type of product indicated.
   a. For stone varieties proposed for use on Project, include test data indicating compliance with physical properties specified or required by referenced ASTM standards.
2. Samples:
   a. For each stone type indicated.
   b. For each color of mortar required.

D. Delivery, Storage, And Handling
1. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
2. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
3. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.
4. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

E. Project Conditions
1. Protection of Stone Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed stone masonry when construction is not in progress.
   a. Extend cover a minimum of 24 inches (600 mm) down both sides and hold cover securely in place.
2. Stain Prevention: Immediately remove mortar and soil to prevent them from staining the face of stone masonry.
   a. Protect base of walls from rain-splashed mud and mortar splatter by coverings spread on the ground and over the wall surface.
   b. Protect sills, ledges, and projections from mortar droppings.
   c. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
   d. Turn scaffold boards near the wall on edge at end of each day to prevent rain from splashing mortar and dirt on completed stone masonry.
3. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace stone masonry damaged by

frost or freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

a. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and above and will remain so until masonry has dried, but not less than 7 days after completing cleaning.

4. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

1.2 PRODUCTS

A. Granite
1. Granite: Comply with ASTM C 615.

B. Limestone
1. Limestone: Comply with ASTM C 568.

C. Quartz-Based Stone
1. Quartz-Based Stone: Comply with ASTM C 616, Classification I Sandstone **OR** II Quartzitic Sandstone **OR** III Quartzite, **as directed**.

D. Mortar Materials
1. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
   a. Low-Alkali Cement: Not more than 0.60 percent total alkali when tested according to ASTM C 114.
2. Hydrated Lime: ASTM C 207, Type S.
3. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or III, and hydrated lime complying with ASTM C 207.
4. Mortar Cement: ASTM C 1329.
5. Masonry Cement: ASTM C 91.
6. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in stone masonry mortar.
7. Colored Cement Product: Packaged blend made from portland cement and lime **OR** masonry cement **OR** mortar cement, **as directed**, and mortar pigments, all complying with specified requirements, and containing no other ingredients.
   a. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
8. Aggregate: ASTM C 144 and as follows:
   a. For pointing mortar, use aggregate graded with 100 percent passing No. 16 (1.18-mm) sieve.
   b. White Aggregates: Natural white sand or ground white stone.
   c. Colored Aggregates: Natural-colored sand or ground marble, granite, or other sound stone; of color necessary to produce required mortar color.
9. Latex Additive: Manufacturer's standard **OR** acrylic-resin **OR** styrene-butadiene-rubber, **as directed**, water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement mortar bed, and not containing a retarder.
10. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
11. Water: Potable.

E. Veneer Anchors

1. Materials:
   a. Hot-Dip Galvanized-Steel Wire: ASTM A 82, with ASTM A 153/A 153M, Class B-2.
   b. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304 **OR** Type 316, **as directed**.
   c. Hot-Dip Galvanized-Steel Sheet: ASTM A 1008/A 1008M, cold-rolled, carbon-steel sheet hot-dip galvanized after fabrication to comply with ASTM A 153/A 153M, Class B-2.
   d. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304 **OR** Type 316, **as directed**.
2. Size: Sufficient to extend at least halfway, but not less than 1-1/2 inches (38 mm), through stone masonry and with at least 5/8-inch (16-mm) cover on outside face.
3. Wire Veneer Anchors: Wire ties formed from W1.7 or 0.148-inch- (3.8-mm-) diameter, hot-dip galvanized **OR** stainless, **as directed**,-steel wire.
4. Corrugated-Metal Veneer Anchors: Not less than 0.030-inch- (0.76-mm-) thick by 7/8-inch- (22-mm-) wide hot-dip galvanized **OR** stainless, **as directed**,-steel sheet with corrugations having a wavelength of 0.3 to 0.5 inch (7.6 to 13 mm) and an amplitude of 0.06 to 0.10 inch (1.5 to 2.5 mm).
5. Adjustable, Screw-Attached Veneer Anchors: Units consisting of a wire tie section and a metal anchor section that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, and as follows:
   a. Structural Performance Characteristics: Capable of withstanding a 100-lbf (445-N) load in both tension and compression without deforming or developing play in excess of 0.05 inch (1.3 mm).
   b. Anchor Section: Rib-stiffened, sheet metal plate with screw holes top and bottom, 2-3/4 inches (70 mm) wide by 3 inches (75 mm) high; with projecting tabs having slotted holes for inserting vertical legs of wire tie specially formed to fit veneer anchor section.
   c. Anchor Section: Sheet metal plate, 1-1/4 inches (32 mm) wide by 6 inches (150 mm) **OR** 9 inches (225 mm), **as directed**, long, with screw holes top and bottom and with raised rib-stiffened strap, 5/8 inch (16 mm) wide by 3-5/8 inches (92 mm) **OR** 5-1/2 inches (140 mm), **as directed**, long, stamped into center to provide a slot between strap and plate for inserting wire tie.
   d. Anchor Section: Gasketed sheet metal plate, 1-1/4 inches (32 mm) wide by 6 inches (150 mm) long, with screw holes top and bottom; top and bottom ends bent to form pronged legs of length to match thickness of insulation or sheathing; and raised rib-stiffened strap, 5/8 inch (16 mm) wide by 6 inches (150 mm) long, stamped into center to provide a slot between strap and plate for inserting wire tie. Provide anchor manufacturer's standard, self-adhering, modified bituminous gaskets manufactured to fit behind anchor plate and extend beyond pronged legs.
   e. Anchor Section: Zinc-alloy barrel section with flanged head with eye and corrosion-resistant, self-drilling screw. Eye designed to receive wire tie and to serve as head for drilling fastener into framing. Barrel length to suit sheathing thickness, allowing screw to seat directly against framing with flanged head covering hole in sheathing.
   f. Fabricate sheet metal anchor sections and other sheet metal parts from 0.067-inch- (1.7-mm-) thick, steel sheet, galvanized after fabrication **OR** 0.097-inch- (2.5-mm-) thick, steel sheet, galvanized after fabrication **OR** 0.078-inch- (2.0-mm-) thick, stainless-steel sheet **OR** 0.109-inch- (2.8-mm-) thick, stainless-steel sheet, **as directed**.
   g. Wire Ties: Triangular-, rectangular-, or T-shaped wire ties fabricated from 0.188-inch- (4.8-mm-) **OR** 0.25-inch- (6.4-mm-), **as directed,** diameter, hot-dip galvanized **OR** stainless, **as directed**,-steel wire.
6. Seismic Veneer Anchors: Units consisting of a metal anchor section and a connector section designed to engage a continuous wire embedded in stone masonry mortar joint.
   a. Structural Performance Characteristics: Capable of withstanding a 100-lbf (445-N) load in both tension and compression without deforming or developing play in excess of 0.05 inch (1.3 mm).
   b. Anchor Section: Rib-stiffened, sheet metal plate with screw holes top and bottom, 2-3/4 inches (70 mm) wide by 3 inches (75 mm) high; with projecting tabs having slotted holes for inserting vertical leg of connector section.

c. Connector Section: Rib-stiffened, sheet metal bent plate with down-turned leg designed to fit in anchor section slot and with integral tabs designed to engage continuous wire. Size connector to extend at least halfway through stone masonry but with at least 5/8-inch (16-mm) cover on outside face.
d. Anchor Section: Rib-stiffened, sheet metal plate with screw holes top and bottom, 2-3/4 inches (70 mm) wide by 3 inches (75 mm) high; with projecting tabs having slotted holes for inserting vertical legs of wire tie specially formed to fit anchor section. Size wire tie to extend at least 1-1/2 inches (38 mm) into stone masonry but with at least 5/8-inch (16-mm) cover on outside face.
e. Connector Section: Sheet metal clip welded to wire tie with integral tabs designed to engage continuous wire.
f. Anchor Section: Gasketed sheet metal plate, 1-1/4 inches (32 mm) wide by 6 inches (150 mm) long, with screw holes top and bottom; top and bottom ends bent to form pronged legs to bridge insulation or sheathing and contact studs; and raised rib-stiffened strap, 5/8 inch (16 mm) wide by 6 inches (150 mm) long, stamped into center to provide a slot between strap and plate for inserting wire tie. Provide anchor manufacturer's standard, self-adhering, modified bituminous gaskets manufactured to fit behind anchor plate and extend beyond pronged legs.
g. Connector Section: Triangular wire tie and rigid PVC extrusion with snap-in grooves for inserting continuous wire.
h. Fabricate sheet metal anchor sections and other sheet metal parts from 0.067-inch- (1.7-mm-) thick, steel sheet, galvanized after fabrication **OR** 0.097-inch- (2.5-mm-) thick, steel sheet, galvanized after fabrication **OR** 0.078-inch- (2.0-mm-) thick, stainless-steel sheet **OR** 0.109-inch- (2.8-mm-) thick, stainless-steel sheet, **as directed**.
i. Fabricate wire connector sections from 0.188-inch- (4.8-mm-) **OR** 0.25-inch- (6.4-mm-), **as directed,** diameter, hot-dip galvanized, carbon **OR** stainless, **as directed**,-steel wire.
j. Continuous Wire: 0.188-inch- (4.8-mm-) diameter, hot-dip galvanized **OR** stainless, **as directed**,-steel wire.

7. Polymer-Coated, Steel Drill Screws for Steel Studs: ASTM C 954 except manufactured with hex washer head and neoprene washer, No. 10 (4.8-mm diameter) by length required to penetrate steel stud flange with not less than 3 exposed threads, and with organic polymer coating with salt-spray resistance to red rust of more than 800 hours per ASTM B 117.
8. Stainless-Steel Drill Screws for Steel Studs: Proprietary fastener consisting of carbon-steel drill point and 300 Series stainless-steel shank, complying with ASTM C 954 except manufactured with hex washer head and neoprene washer, No. 10 (4.8-mm diameter) by length required to penetrate steel stud flange with not less than three exposed threads.
9. Polymer-Coated, Steel Drill Screws for Wood Studs: Self-drilling, bugle-head or wafer-head wood screws recommended by veneer anchor manufacturer for fastening to wood studs; not less than No. 10 (4.8-mm diameter), 1-1/2 inches (38 mm) long, and with organic polymer coating with salt-spray resistance to red rust of more than 500 hours per ASTM B 117.
10. Polymer-Coated, Steel Tapping Screws for Concrete Masonry: Self-tapping screws with specially designed threads for tapping and wedging into masonry, with hex washer head and neoprene washer, 3/16-inch (4.8-mm) diameter by 1-1/2-inch (38-mm) length, and with organic polymer coating with salt-spray resistance to red rust of more than 800 hours per ASTM B 117.

F. Stone Trim Anchors
1. Stone Trim Anchors: Units fabricated with tabs or dowels designed to engage kerfs or holes in stone trim units and holes for fasteners or postinstalled anchor bolts for fastening to substrates or framing as indicated.
2. Materials: Fabricate anchors from stainless steel, ASTM A 240/A 240M, Type 304. Fabricate dowels from stainless steel, ASTM A 276, Type 304.
3. Fasteners for Stone Trim Anchors: Annealed stainless-steel bolts, nuts, and washers; ASTM F 593 (ASTM F 738M) for bolts and ASTM F 594 (ASTM F 836M) for nuts, Alloy Group 1 (A1).

4. Postinstalled Anchor Bolts for Fastening Stone Trim Anchors: Chemical anchors **OR** torque-controlled expansion anchors **OR** undercut anchors, **as directed**, made from stainless-steel components complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Alloy Group A1 or A4) for bolts and nuts; ASTM A 666 or ASTM A 276, Type 304 or 316, for anchors.

G. Embedded Flashing Materials
1. Metal Flashing: Provide metal flashing, where flashing is exposed or partly exposed and where indicated, complying with SMACNA's "Architectural Sheet Metal Manual **OR** Division 07 Section "Sheet Metal Flashing And Trim", **as directed,** and as follows:
   a. Stainless Steel: ASTM A 240/A 240M, Type 304, 0.016 inch (0.4 mm) thick.
   b. Copper: ASTM B 370, Temper H00 or H01, cold-rolled copper sheet, 10-oz./sq. ft. (3-kg/sq. m) weight or 0.0135 inch (0.34 mm) thick for fully concealed flashing; 16-oz./sq. ft. (5-kg/sq. m) weight or 0.0216 inch (0.55 mm) thick elsewhere.
   c. Fabricate continuous flashings in sections 96 inches (2400 mm) long minimum, but not exceeding 12 feet (3.6 m). Provide splice plates at joints of formed, smooth metal flashing.
   d. Fabricate through-wall metal flashing embedded in masonry from stainless steel **OR** copper, **as directed**, with ribs at 3-inch (75-mm) intervals along length of flashing to provide an integral mortar bond.
   e. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.
   f. Fabricate through-wall flashing with drip edge where **OR** unless otherwise, **as directed**, indicated. Fabricate by extending flashing 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees and hemmed, **as directed**.
   g. Fabricate through-wall flashing with sealant stop where **OR** unless otherwise, **as directed**, indicated. Fabricate by bending metal back on itself 3/4 inch (19 mm) at exterior face of wall and down into joint 3/8 inch (10 mm) to form a stop for retaining sealant backer rod.
   h. Fabricate metal drip edges and sealant stops for ribbed metal flashing from plain metal flashing of same metal as ribbed flashing and extending at least 3 inches (75 mm) into wall with hemmed inner edge to receive ribbed flashing and form a hooked seam. Form hem on upper surface of metal so that completed seam will shed water.
   i. Metal Drip Edges: Fabricate from stainless steel. Extend at least 3 inches (75 mm) into wall and 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees and hemmed, **as directed**.
   j. Metal Flashing Terminations: Fabricate from stainless steel. Extend at least 3 inches (75 mm) into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch (19 mm) and down into joint 3/8 inch (10 mm) to form a stop for retaining sealant backer rod.
   k. Metal Expansion-Joint Strips: Fabricate from stainless steel **OR** copper, **as directed**, to shapes indicated.
2. Flexible Flashing: For flashing not exposed to the exterior, use one of the following unless otherwise indicated:
   a. Copper-Laminated Flashing: 5-oz./sq. ft. (1.5-kg/sq. m) **OR** 7-oz./sq. ft. (2-kg/sq. m), **as directed**, copper sheet bonded with asphalt between 2 layers of glass-fiber cloth. Use only where flashing is fully concealed in masonry.
   b. Asphalt-Coated Copper Flashing: 5-oz./sq. ft. (1.5-kg/sq. m) **OR** 7-oz./sq. ft. (2-kg/sq. m), **as directed**, copper sheet coated with flexible asphalt. Use only where flashing is fully concealed in masonry.
   c. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.030 inch (0.8 mm) **OR** 0.040 inch (1.0 mm), **as directed**.
   d. Elastomeric Thermoplastic Flashing: Composite flashing product consisting of a polyester-reinforced ethylene interpolymer alloy as follows:
      1) Monolithic Sheet: Elastomeric thermoplastic flashing, 0.040 inch (1.0 mm) thick.

2) Self-Adhesive Sheet: Elastomeric thermoplastic flashing, 0.025 inch (0.6 mm) thick, with a 0.015-inch- (0.4-mm-) thick coating of rubberized-asphalt adhesive.
3) Self-Adhesive Sheet with Drip Edge: Elastomeric thermoplastic flashing, 0.025 inch (0.6 mm) thick, with a 0.015-inch- (0.4-mm-) thick coating of rubberized-asphalt adhesive. Where flashing extends to face of masonry, rubberized-asphalt coating is held back approximately 1-1/2 inches (38 mm) from edge.
a) Color: Gray **OR** White **OR** Tan/buff **OR** Black, **as directed**.
4) Accessories: Provide preformed corners, end dams, other special shapes, and seaming materials produced by flashing manufacturer.

e. EPDM Flashing: Sheet flashing product made from ethylene-propylene-diene terpolymer, complying with ASTM D 4637, 0.040 inch (1.0 mm) thick.

3. Solder and Sealants for Sheet Metal Flashings
a. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.
b. Solder for Copper: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead.
c. Elastomeric Sealant: ASTM C 920, chemically curing urethane **OR** polysulfide **OR** silicone, **as directed**, sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
4. Adhesives, Primers, and Seam Tapes for Flexible Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

H. Miscellaneous Masonry Accessories
1. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene **OR** urethane **OR** PVC, **as directed**.
2. Cementitious Dampproofing: Cementitious formulations that are recommended by ILI and that are nonstaining to stone, compatible with joint sealants, and noncorrosive to veneer anchors and attachments.
3. Asphalt Dampproofing: Cut-back asphalt complying with ASTM D 4479, Type I **OR** asphalt emulsion complying with ASTM D 1227, Type III or IV, **as directed**.
4. Weep Hole/Vent Products: Use one of the following unless otherwise indicated:
a. Wicking Material: Absorbent rope, made from cotton **OR** UV-resistant synthetic fiber, **as directed**, 1/4 to 3/8 inch (6 to 10 mm) in diameter, in length required to produce 2-inch (50-mm) exposure on exterior and 18 inches (450 mm) in cavity behind stone masonry. Use only for weep holes.
b. Round Plastic Tubing: Medium-density polyethylene, 3/8-inch (10-mm) OD by thickness of stone masonry.
c. Rectangular Plastic Tubing: Clear butyrate, 3/8 by 1-1/2 inches (10 by 38 mm) by thickness of stone masonry.
d. Mesh Weep Holes/Vents: Free-draining mesh; made from polyethylene strands, full width of head joint and 2 inches (50 mm) high by thickness of stone masonry; in color selected from manufacturer's standard.
e. Aluminum Weep Holes/Vents: One-piece, L-shaped units made from sheet aluminum, designed to fit into head joint and consisting of vertical channel with louvers stamped in web and with top flap to keep mortar out of head joint; painted to comply with Division 07, before installation, in color approved to match that of mortar.
f. Vinyl Weep Holes/Vents: One-piece, offset, T-shaped units made from flexible, injection-molded PVC, designed to fit into head joint and consisting of louvered vertical leg, flexible wings to seal against ends of stone units, and top flap to keep mortar out of head joint; in color approved to match that of mortar.
5. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
a. Provide one of the following configurations:

1) Strips, full-depth of cavity and 10 inches (250 mm) wide, with dovetail shaped notches 7 inches (175 mm) deep that prevent mesh from being clogged with mortar droppings.
2) Strips, not less than 3/4 inch (19 mm) **OR** 1-1/2 inches (38 mm), **as directed**, thick and 10 inches (250 mm) wide, with dimpled surface designed to catch mortar droppings and prevent weep holes from being clogged with mortar.
3) Sheets or strips full depth of cavity and installed to full height of cavity.
4) Sheets or strips not less than 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed,** thick and installed to full height of cavity with additional strips 4 inches (100 mm) high at weep holes and thick enough to fill entire depth of cavity and prevent weep holes from being clogged with mortar.

6. Expanded Metal Lath: 3.4 lb/sq. yd. (1.8 kg/sq. m), self-furring, diamond-mesh lath complying with ASTM C 847. Fabricate from structural-quality, zinc-coated (galvanized) steel sheet complying with ASTM A 653/A 653M, G60 (Z180).
7. Woven-Wire Lath: ASTM C 1032, fabricated into 1-1/2-inch (38-mm) hexagonal-shaped mesh with minimum 0.0510-inch- (1.3-mm-) diameter, galvanized-steel wire.
8. Welded-Wire Lath: ASTM C 933, fabricated into 2-by-2-inch (50-by-50-mm) mesh with minimum 0.0625-inch- (1.6-mm-) diameter, galvanized-steel wire.
9. Lath Attachment Devices: Material and type required by ASTM C 1063 for installations indicated.

I. Cavity-Wall Insulation
1. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV **OR** Type X, **as directed**, closed-cell product extruded with an integral skin.
2. Extruded-Polystyrene Board Insulation with Increased R-Value: ASTM C 578, Type IV, but with an aged thermal resistance (R-value) for 1-inch (25-mm) thickness of 5.6 deg F x h x sq. ft./Btu at 75 deg F (1.0 K x sq. m/W at 24 deg C) at 5 years; closed-cell product with a carbon-black filler and extruded with an integral skin.
3. Molded-Polystyrene Board Insulation: ASTM C 578, Type I.
4. Polyisocyanurate Board Insulation: ASTM C 1289, Type I (aluminum-foil faced), Class 2 (glass-fiber reinforced).
5. Adhesive: Type recommended by insulation board manufacturer for application indicated.

J. Masonry Cleaners
1. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar and grout stains, efflorescence, and other new construction stains from stone masonry surfaces without discoloring or damaging masonry surfaces; expressly approved for intended use by cleaner manufacturer and stone producer.

K. Mortar Mixes
1. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
   a. Do not use calcium chloride.
   b. Limit cementitious materials in mortar to portland cement **OR** mortar cement, **as directed**, and lime.
   c. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
   d. Mixing Pointing Mortar: Thoroughly mix cementitious and aggregate materials together before adding water. Then mix again, adding only enough water to produce a damp, unworkable mix that will retain its form when pressed into a ball. Maintain mortar in this dampened condition for one to two hours. Add remaining water in small portions until mortar reaches desired consistency. Use mortar within 30 minutes of final mixing; do not retemper or use partially hardened material.
2. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in the form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

3. Mortar for Stone Masonry: Comply with ASTM C 270, Proportion **OR** Property, **as directed**, Specification.
   a. Mortar for Setting Stone: Type S **OR** Type N, **as directed**.
   b. Mortar for Pointing Stone: Type N **OR** Type O, **as directed**.
4. Latex-Modified Portland Cement Setting Mortar: Proportion and mix portland cement, aggregate, and latex additive to comply with latex-additive manufacturer's written instructions.
5. Cement-Paste Bond Coat: Mix either neat cement and water or cement, sand, and water to a consistency similar to that of thick cream.
   a. For latex-modified portland cement setting-bed mortar, substitute latex admixture for part or all of water, according to latex-additive manufacturer's written instructions.
6. Mortar for Scratch Coat over Metal Lath: 1 part portland cement, 1/2 part lime, 5 parts loose damp sand, and enough water to produce a workable consistency.
7. Mortar for Scratch Coat over Unit Masonry: 1 part portland cement, 1 part lime, 7 parts loose damp sand, and enough water to produce a workable consistency.
8. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.
   a. Pigments shall not exceed 10 percent of portland cement by weight.
   b. Pigments shall not exceed 5 percent of masonry cement **OR** mortar cement, **as directed**, by weight.
   c. Mix to match sample.
9. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.
   a. Mix to match sample.

L. Fabrication
1. Fabricate stone to comply with sizes, shapes, and tolerances recommended by applicable stone association or, if none, by stone source, for faces, edges, beds, and backs.
   a. For granite, comply with recommendations in NBGQA's "Specifications for Architectural Granite."
   b. For limestone, comply with recommendations in ILI's "Indiana Limestone Handbook."
2. Cut **OR** Select, **as directed**, stone to produce pieces of thickness, size, and shape indicated, including details on Drawings. Dress joints (bed and vertical) straight and at right angle to face unless otherwise indicated.
3. Cut and drill sinkages and holes in stone for anchors and supports.
4. Carefully inspect stone at quarry or fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units before shipment.
   a. Clean sawed backs of stone to remove rust stains and iron particles.
5. Gage backs of stones for adhered veneer if more than 81 sq. in. (522 sq. cm) in area.
6. Thickness of Stone: Provide thickness indicated, but not less than the following:
   a. Thickness for anchored veneer: 4 inches (100 mm) plus or minus 1/4 inch (6 mm) **OR** 1/2 inch (13 mm), **as directed**. Thickness does not include projection of pitched faces.
   b. Thickness for adhered veneer: 1 inch (25 mm) plus or minus 1/8 inch (3 mm) **OR** 1/4 inch (6 mm), **as directed**.
7. Shape stone for type of masonry (pattern) as follows:
   a. Sawed-bed, range ashlar with uniform course heights and uniform lengths as indicated on Drawings.
   b. Sawed-bed, range ashlar with uniform course heights as indicated on Drawings and with random lengths.
   c. Sawed-bed, broken-range ashlar with uniform course heights as indicated on Drawings and with random lengths.
   d. Sawed **OR** Split, **as directed**,-bed, random-range ashlar with random course heights and random lengths (interrupted coursed).
   e. Coursed rubble.
   f. Uncoursed rubble (fieldstone).
   g. Polygonal or mosaic.

8. Finish exposed faces and edges of stone to comply with requirements indicated for finish and to match approved samples and mockups.
   a. Finish: Split face **OR** Rock face (pitched face) **OR** Natural cleft **OR** Mixed split face and seam face **OR** Mixed split face, seam face, and rock face (pitched face) **OR** Smooth **OR** Sand rubbed **OR** As indicated, **as directed**.
   b. Finish for Sills: Smooth **OR** Sand rubbed **OR** Split face with sand-rubbed washes **OR** Rock face (pitched face) with sand-rubbed washes **OR** Rock face (pitched face) with tooled (boasted) washes, **as directed**
   c. Finish for Lintels: Smooth **OR** Sand rubbed **OR** Split face **OR** Rock face (pitched face), **as directed**.
   d. Finish for Copings: Smooth **OR** Sand rubbed **OR** Split faces **OR** Rock face (pitched face), front and back; sand-rubbed top **OR** Rock face (pitched face), front and back; tooled (boasted) top, **as directed**.
      1) Finish exposed ends of copings same as front and back faces.

1.3 EXECUTION

A. Preparation
1. Accurately mark stud centerlines on face of weather-resistant sheathing paper before beginning stone installation.
2. Coat concrete and unit masonry backup with asphalt dampproofing.
3. Clean dirty or stained stone surfaces by removing soil, stains, and foreign materials before setting. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

B. Setting Of Stone Masonry, General
1. Perform necessary field cutting and trimming as stone is set.
   a. Use power saws to cut stone that is fabricated with saw-cut surfaces. Cut lines straight and true, with edges eased slightly to prevent snipping.
   b. Use hammer and chisel to split stone that is fabricated with split surfaces. Make edges straight and true, matching similar surfaces that were shop or quarry fabricated.
   c. Pitch face at field-split edges as needed to match stones that are not field split.
2. Sort stone before it is placed in wall to remove stone that does not comply with requirements relating to aesthetic effects, physical properties, or fabrication, or that is otherwise unsuitable for intended use.
3. Arrange stones in range ashlar pattern with course heights as indicated, uniform **OR** random, **as directed** lengths, and uniform joint widths, with offset between vertical joints as indicated.
4. Arrange stones in broken-range ashlar pattern with uniform course heights, random lengths, and uniform joint widths.
5. Arrange stones in three-course, random-range ashlar pattern with random course heights, random lengths (interrupted coursed), and uniform joint widths.
6. Arrange stones in coursed **OR** uncoursed, **as directed**, rubble pattern with joint widths within tolerances indicated. Insert small stones into spaces between larger stones as needed to produce joints as uniform in width as practical, **as directed**.
7. Arrange stones in polygonal (mosaic) pattern with uniform joint widths.
8. Arrange stones with color and size variations uniformly dispersed for an evenly blended appearance.
9. Set stone to comply with requirements indicated on Drawings. Install supports, fasteners, and other attachments indicated or necessary to secure stone masonry in place. Set stone accurately in locations indicated with edges and faces aligned according to established relationships and indicated tolerances.
10. Maintain uniform joint widths except for variations due to different stone sizes and where minor variations are required to maintain bond alignment if any. Lay walls with joints not less than 1/4 inch (6 mm) **OR** 3/8 inch (10 mm), **as directed**, at narrowest points or more than 3/8 inch (10

mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm) **OR** 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, at widest points.

11. Provide sealant joints of widths and at locations indicated.
    a. Keep sealant joints free of mortar and other rigid materials.
    b. Sealing joints is specified in Division 07 Section "Joint Sealants".
12. Install metal expansion strips in sealant joints at locations indicated. Build flanges of expansion strips into masonry by embedding in mortar between stone masonry and backup wythe. Lap each joint 4 inches (100 mm) in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
13. Install embedded flashing and weep holes, **as directed**, at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.
    a. At stud-framed walls, extend flashing through stone masonry, up the face of sheathing at least 8 inches (200 mm) **OR** 12 inches (300 mm) **OR** 16 inches (400 mm), **as directed**, and behind weather-resistant sheathing paper.
    b. At multiwythe masonry walls, including cavity walls, extend flashing through stone masonry, turned up a minimum of 4 inches (100 mm) **OR** 8 inches (200 mm) **OR** 12 inches (300 mm) **OR** 16 inches (400 mm), **as directed**, and extend into or through inner wythe to comply with requirements in Division 04 Section "Unit Masonry Assemblies".
    c. At concrete backing, extend flashing through stone masonry, turned up a minimum of 4 inches (100 mm) **OR** 6 inches (150 mm) **OR** 8 inches (200 mm) **OR** 12 inches (300 mm), **as directed**, and insert in reglet. Reglets are specified Division 07 Section "Sheet Metal Flashing And Trim".
    d. At lintels and shelf angles, extend flashing full length of angles but not less than 6 inches (150 mm) into masonry at each end.
    e. At sills, extend flashing not less than 4 inches (100 mm) at ends.
    f. At ends of head and sill flashing turn up not less than 2 inches (50 mm) to form end dams.
    g. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches (38 mm) or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Division 07 Section "Joint Sealants" for application indicated.
    h. Install metal drip edges and sealant stops with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Division 07 Section "Joint Sealants" for application indicated.
    i. Extend sheet metal flashing 1/2 inch (13 mm) beyond face of masonry at exterior and turn flashing down to form a drip.
    j. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (13 mm) back from outside face of wall and adhere flexible flashing to top of metal drip edge.
    k. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (13 mm) back from outside face of wall and adhere flexible flashing to top of metal flashing termination.
    l. Cut flexible flashing flush with face of wall after masonry wall construction is completed.
14. Coat limestone with cementitious dampproofing as follows:
    a. Stone at Grade: Beds, joints, and back surfaces to at least 12 inches (300 mm) above finish-grade elevations.
    b. Stone Extending below Grade: Beds, joints, back surfaces, and face surfaces below grade.
    c. Allow cementitious dampproofing formulations to cure before setting dampproofed stone. Do not damage or remove dampproofing in the course of handling and setting stone.
15. Place weep holes and vents in joints where moisture may accumulate, including at base of cavity walls, above shelf angles, and at flashing.
    a. Use wicking material **OR** round plastic tubing **OR** rectangular plastic tubing **OR** mesh weep holes/vents **OR** aluminum weep holes/vents **OR** vinyl weep holes/vents **OR** open head joints, **as directed**, to form weep holes.

b. Use wicking material to form weep holes above flashing in stone sills. Turn wicking down at lip of sill to be as inconspicuous as possible.
c. Space weep holes 16 inches (400 mm) **OR** 24 inches (600 mm), **as directed**, o.c.
d. Space weep holes formed from plastic tubing **OR** wicking material, **as directed**, 16 inches (400 mm) o.c.
e. Trim wicking material used in weep holes flush with outside face of wall after mortar has set.
f. Place pea gravel in cavities as soon as practical to a height of not less than 2 inches (50 mm) above top of flashing, to maintain drainage.
g. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.

16. Install vents in vertical head joints at the top of each continuous cavity at spacing indicated. Use round plastic tubing **OR** rectangular plastic tubing **OR** mesh weep holes/vents **OR** aluminum weep holes/vents **OR** vinyl weep holes/vents **OR** open head joints, **as directed**, to form vents.
    a. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

C. Construction Tolerances
1. Variation from Plumb: For vertical lines and surfaces, do not exceed 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (10 mm in 6 m), or 1/2 inch in 40 feet (13 mm in 12 m) or more. For external corners, expansion joints, control joints, and other conspicuous lines, do not exceed 1/4 inch in 20 feet (6 mm in 6 m) or 1/2 inch in 40 feet (13 mm in 12 m) or more.
2. Variation from Level: For bed joints and lines of exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines, do not exceed 1/4 inch in 20 feet (6 mm in 6 m) or 1/2 inch in 40 feet (13 mm in 12 m) or more.
3. Variation of Linear Building Line: For position shown in plan, do not exceed 1/2 inch in 20 feet (13 mm in 6 m) or 3/4 inch in 40 feet (19 mm in 12 m) or more.
4. For rough stone, measure variation from level, plumb, and position shown in plan as variation of the average plane of the face of each stone from level, plumb, or dimensioned plane.
5. Variation in Mortar-Joint Thickness: Do not vary from joint size range indicated.
6. Variation in Plane between Adjacent Stones for Rough Stone: Do not exceed one-half of tolerance specified for thickness of stone.

D. Installation Of Anchored Stone Masonry
1. Anchor stone masonry to concrete with corrugated-metal veneer anchors unless otherwise indicated. Secure anchors by inserting dovetailed ends into dovetail slots in concrete.
2. Anchor stone masonry to unit masonry with corrugated-metal **OR** individual wire, **as directed**, veneer anchors unless otherwise indicated. Embed anchors in unit masonry mortar joints or grouted cells for distance at least one-half of unit masonry thickness.
3. Anchor stone masonry to unit masonry with wire anchors unless otherwise indicated. Connect anchors to masonry joint reinforcement by inserting pintles into eyes of masonry joint reinforcement projecting from unit masonry.
4. Anchor stone masonry to unit masonry with wire anchors unless otherwise indicated. Connect anchors to masonry joint reinforcement with vertical rods inserted through anchors and through eyes of masonry joint reinforcement projecting from unit masonry.
5. Anchor stone masonry to unit masonry with adjustable, screw-attached **OR** seismic, **as directed**, veneer anchors unless otherwise indicated. Fasten anchors to unit masonry with two screws.
6. Anchor stone masonry to stud framing with adjustable, screw-attached **OR** seismic, **as directed**, veneer anchors unless otherwise indicated. Fasten anchors through sheathing to framing with two screws.
7. Anchor stone masonry to stud framing with screw-attached veneer anchors unless otherwise indicated.
8. Anchor stone masonry to wood stud framing with corrugated-metal veneer anchors unless otherwise indicated. Fasten anchors through sheathing to studs with corrosion-resistant roofing nails.

9. Anchor stone masonry to wood stud framing with wire anchors unless otherwise indicated. Fasten anchors through sheathing to wood studs with corrosion-resistant roofing nails.
10. Anchor stone masonry to metal stud framing with wire anchors unless otherwise indicated. Tie anchors to studs.
11. Embed veneer anchors in mortar joints of stone masonry at least halfway, but not less than 1-1/2 inches (38 mm), through stone masonry and with at least 5/8-inch (16-mm) cover on outside face.
    a. Install continuous wire reinforcement in horizontal joints and attach to seismic veneer anchors as stone is set.
12. Space anchors to provide not less than 1 anchor per 2 sq. ft. (0.2 sq. m) of wall area. Install additional anchors within 12 inches (300 mm) of openings, sealant joints, and perimeter at intervals not exceeding 12 inches (300 mm).
13. Space anchors not more than 16 inches (400 mm) o.c. vertically and 24 inches (600 mm) o.c. horizontally. Install additional anchors within 12 inches (300 mm) of openings, sealant joints, and perimeter at intervals not exceeding 12 inches (300 mm).
14. Anchor stone trim with stone trim anchors where indicated. Install anchors by fastening to substrate and inserting tabs and dowels into kerfs and holes in stone units. Provide compressible filler in ends of dowel holes and bottoms of kerfs to prevent end bearing of dowels and anchor tabs on stone. Fill remainder of anchor holes and kerfs with mortar.
15. Set stone in full bed of mortar with full head joints unless otherwise indicated. Build anchors into mortar joints as stone is set.
16. Fill collar joint **OR** space between back of stone masonry and weather-resistant sheathing paper, **as directed**, with mortar as stone is set.
17. Provide 1-inch (25-mm) **OR** 2-inch (50-mm), **as directed**, cavity between stone masonry and backup construction unless otherwise indicated. Keep cavity free of mortar droppings and debris.
    a. Place mortar spots in cavity at veneer anchors to maintain spacing.
    b. Slope beds toward cavity to minimize mortar protrusions into cavity.
    c. Do not attempt to trowel or remove mortar fins protruding into cavity.
18. Rake out joints for pointing with mortar to depth of not less than 1/2 inch (13 mm) **OR** 3/4 inch (19 mm), **as directed**, before setting mortar has hardened. Rake joints to uniform depths with square bottoms and clean sides.

E. Installation Of Adhered Stone Masonry Veneer
1. Install flashing over sheathing and behind weather-resistant sheathing paper by fastening through sheathing into framing.
2. Install lath over weather-resistant sheathing paper by fastening through sheathing into framing to comply with ASTM C 1063.
3. Install lath over unit masonry and concrete to comply with ASTM C 1063.
4. Install scratch coat over metal lath 3/8 inch (10 mm) thick to comply with ASTM C 926.
5. Coat backs of stone units and face of scratch coat **OR** masonry backup, **as directed**, with cement-paste bond coat, then butter both surfaces with setting mortar. Use sufficient setting mortar so a slight excess will be forced out the edges of stone units as they are set. Tap units into place, completely filling space between units and scratch coat **OR** masonry backup, **as directed**.
6. Rake out joints for pointing with mortar to depth of not less than 1/2 inch (13 mm) **OR** 3/4 inch (19 mm), **as directed**, before setting mortar has hardened. Rake joints to uniform depths with square bottoms and clean sides.

F. Pointing
1. Prepare stone-joint surfaces for pointing with mortar by removing dust and mortar particles. Where setting mortar was removed to depths greater than surrounding areas, apply pointing mortar in layers not more than 3/8 inch (10 mm) deep until a uniform depth is formed.
2. Point stone joints by placing and compacting pointing mortar in layers not more than 3/8 inch (10 mm) deep. Compact each layer thoroughly and allow to become thumbprint hard before applying next layer.

3. Tool joints, when pointing mortar is thumbprint hard, with a smooth jointing tool to produce the following joint profile:
    a. Joint Profile: Concave **OR** Smooth, flat face slightly below edges of stone **OR** Smooth, flat face recessed 1/4 inch (6 mm) below edges of stone (raked joint) **OR** Flush, with a 3/8-inch (10-mm) half-round raised bead in middle of joint **OR** As indicated, **as directed**.

G. Adjusting And Cleaning
1. Remove and replace stone masonry of the following description:
    a. Broken, chipped, stained, or otherwise damaged stone. Stone may be repaired if methods and results are approved.
    b. Defective joints.
    c. Stone masonry not matching approved samples and mockups.
    d. Stone masonry not complying with other requirements indicated.
2. Replace in a manner that results in stone masonry matching approved samples and mockups, complying with other requirements, and showing no evidence of replacement.
3. In-Progress Cleaning: Clean stone masonry as work progresses. Remove mortar fins and smears before tooling joints.
4. Final Cleaning: After mortar is thoroughly set and cured, clean stone masonry as follows:
    a. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
    b. Test cleaning methods on mockup; leave one-half of panel uncleaned for comparison purposes. Obtain approval of sample cleaning before cleaning stone masonry.
    c. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent, polyethylene film, or waterproof masking tape.
    d. Wet wall surfaces with water before applying cleaner; remove cleaner promptly by rinsing thoroughly with clear water.
    e. Clean stone masonry by bucket and brush hand-cleaning method described in BIA Technical Note No. 20 Revised II, using job-mixed detergent solution.
    f. Clean stone masonry with proprietary acidic cleaner applied according to manufacturer's written instructions.
    g. Clean limestone masonry to comply with recommendations in ILI's "Indiana Limestone Handbook."

H. Excess Materials And Waste
1. Disposal as Fill Material: Dispose of clean masonry waste, including mortar and excess or soil-contaminated sand, by crushing and mixing with fill material as fill is placed.
    a. Crush masonry waste to less than 4 inches (100 mm) in greatest dimension.
    b. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Division 02 Section "Earthwork".
    c. Do not dispose of masonry waste as fill within 18 inches (450 mm) of finished grade.
2. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other waste, and legally dispose of off Owner's property.

END OF SECTION 04422

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Task	Specification	Specification Description
04422	04410	Dimension Stone Cladding
04422	04410a	Interior Stone Facing
04423	04410	Dimension Stone Cladding
04423	04422	Stone Masonry
04423	04410a	Interior Stone Facing
04424	01352	No Specification Required
04424	04410	Dimension Stone Cladding
04424	04422	Stone Masonry
04424	04410a	Interior Stone Facing
04426	01352	No Specification Required
04426	04410	Dimension Stone Cladding
04426	04422	Stone Masonry
04426	04410a	Interior Stone Facing
04428	01352	No Specification Required
04428	04410	Dimension Stone Cladding
04428	04422	Stone Masonry
04550	04110	Unit Masonry Assemblies

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SECTION 04910 - CLAY MASONRY RESTORATION AND CLEANING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for clay masonry restoration and cleaning. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes maintenance of unit masonry consisting of brick and terra cotta clay masonry restoration and cleaning as follows:
   a. Unused anchor removal.
   b. Repairing unit masonry, including replacing units.
   c. Painting steel uncovered during the work.
   d. Reanchoring veneers.
   e. Repointing joints.
   f. Preliminary cleaning, including removing plant growth.
   g. Cleaning exposed unit masonry surfaces.
2. Owner-Furnished Material: Salvaged brick (if salvaged brick is available from Owner for reuse).

C. Definitions
1. Very Low-Pressure Spray: Under 100 psi (690 kPa).
2. Low-Pressure Spray: 100 to 400 psi (690 to 2750 kPa); 4 to 6 gpm (0.25 to 0.4 L/s).
3. Medium-Pressure Spray: 400 to 800 psi (2750 to 5510 kPa); 4 to 6 gpm (0.25 to 0.4 L/s).
4. High-Pressure Spray: 800 to 1200 psi (5510 to 8250 kPa); 4 to 6 gpm (0.25 to 0.4 L/s).
5. Saturation Coefficient: Ratio of the weight of water absorbed during immersion in cold water to weight absorbed during immersion in boiling water; used as an indication of resistance of masonry units to freezing and thawing.

D. Preconstruction Testing
1. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on masonry units as follows.
   a. Existing Brick and Terra Cotta: Test each type of existing masonry unit indicated for replacement, according to testing methods in ASTM C 67 for compressive strength, 24-hour cold-water absorption, 5-hour boil absorption, saturation coefficient, and initial rate of absorption (suction). Carefully remove five existing units from locations designated by the Owner. Take testing samples from these units.
   b. Existing Mortar: Test according to ASTM C 295, modified as agreed by testing service and the Owner for Project requirements, to determine proportional composition of original ingredients, sizes and colors of aggregates, and approximate strength. Use X-ray diffraction, infrared spectroscopy, and differential thermal analysis as necessary to supplement microscopical methods. Carefully remove existing mortar from within joints at five locations designated by the Owner or testing service.
   c. Temporary Patch: as directed by the Owner, provide temporary materials at locations from which existing samples were taken.
   d. Replacement Brick and Terra Cotta: Test each proposed type of replacement masonry unit, according to sampling and testing methods in ASTM C 67 for compressive strength, 24-hour cold-water absorption, 5-hour boil absorption, saturation coefficient, and initial rate of absorption (suction).

E. Submittals
1. Product Data: For each type of product indicated.

2. Shop Drawings: For the following:
   a. Full-size patterns with complete dimensions for new terra cotta units, specially molded brick shapes, and brick arches and their jointing, showing relation of existing to new units.
   b. Setting number of each new terra cotta unit and its location on the structure in annotated plans and elevations.
   c. Provisions for expansion joints or other sealant joints.
   d. Provisions for flashing, lighting fixtures, conduits, and weep holes as required.
   e. Replacement and repair anchors. Include details of anchors within individual masonry units, with locations of anchors and dimensions of holes and recesses in units required for anchors.
3. Samples: For each exposed product and for each color and texture specified.
4. Preconstruction Test Reports.

F. Quality Assurance
1. Restoration Specialist Qualifications: Engage an experienced, preapproved masonry restoration and cleaning firm to perform work of this Section. Firm shall have completed work similar in material, design, and extent to that indicated for this Project with a record of successful in-service performance. Experience installing standard unit masonry is not sufficient experience for masonry restoration work.
   a. At Contractor's option, work may be divided between two specialist firms: one for cleaning work and one for repair work.
   b. Field Supervision: Restoration specialist firms shall maintain experienced full-time supervisors on Project site during times that clay masonry restoration and cleaning work is in progress. Supervisors shall not be changed during Project except for causes beyond the control of restoration specialist firm.
   c. Restoration Worker Qualifications: Persons who are experienced and specialize in restoration work of types they will be performing. When masonry units are being patched, assign at least one worker among those performing patching work who is trained and certified by manufacturer of patching compound to apply its products.
2. Terra Cotta Manufacturer Qualifications: A firm regularly engaged in manufacturing custom architectural terra cotta units for building restoration purposes, of same type and of similar size, complexity, and tolerances as those required for the Work.
3. Mockups: Prepare mockups of restoration and cleaning to demonstrate aesthetic effects and set quality standards for materials and execution and for fabrication and installation.
   a. Masonry Repair: Prepare sample areas for each type of masonry material indicated to have repair work performed. If not otherwise indicated, size each mockup not smaller than 2 adjacent whole units or approximately 48 inches (1200 mm) in least dimension. Erect sample areas in existing walls unless otherwise indicated, to demonstrate quality of materials, workmanship, and blending with existing work. Include the following as a minimum:
      1) Replacement:
         a) Four brick units replaced.
         b) Four terra cotta units replaced.
      2) Reanchoring Veneers: Install three masonry repair anchors in mockup wall assembly of each anchor type required.
      3) Patching: Three small holes at least 1 inch (25 mm) in diameter **OR** as directed, **as directed**, for each type of masonry material indicated to be patched, so as to leave no evidence of repair.
      4) Widening Joints: Widen a joint in 2 separate locations, each approximately 12 inches (300 mm) long **OR** as directed, **as directed**.
   b. Repointing: Rake out joints in 2 separate areas, each approximately 36 inches (900 mm) high by 48 inches (1200 mm) wide **OR** as indicated, **as directed**, for each type of repointing required and repoint one of the areas.
   c. Cleaning: Clean an area approximately 25 sq. ft. (2.3 sq. m) **OR** as indicated, **as directed**, for each type of masonry and surface condition.

4. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver masonry units to Project site strapped together in suitable packs or pallets or in heavy-duty cartons.
2. Deliver each piece of terra cotta with code mark or setting number on unexposed face, corresponding to Shop Drawings, using nonstaining paint.
3. Deliver other materials to Project site in manufacturer's original and unopened containers, labeled with manufacturer's name and type of products.
4. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
5. Store hydrated lime in manufacturer's original and unopened containers. Discard lime if containers have been damaged or have been opened for more than two days.
6. Store lime putty covered with water in sealed containers.
7. Store sand where grading and other required characteristics can be maintained and contamination avoided.

H. Project Conditions
1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit masonry restoration and cleaning work to be performed according to manufacturers' written instructions and specified requirements.
2. Repair masonry units and repoint mortar joints only when air temperature is between 40 and 90 deg F (4 and 32 deg C) and is predicted to remain so for at least 7 days after completion of the Work unless otherwise indicated.
3. Cold-Weather Requirements: Comply with the following procedures for masonry repair and mortar-joint pointing unless otherwise indicated:
   a. When air temperature is below 40 deg F (4 deg C), heat mortar ingredients, masonry repair materials, and existing masonry walls to produce temperatures between 40 and 120 deg F (4 and 49 deg C).
   b. When mean daily air temperature is below 40 deg F (4 deg C), provide enclosure and heat to maintain temperatures above 32 deg F (0 deg C) within the enclosure for 7 days after repair and pointing.
   c. Hot-Weather Requirements: Protect masonry repair and mortar-joint pointing when temperature and humidity conditions produce excessive evaporation of water from mortar and repair materials. Provide artificial shade and wind breaks and use cooled materials as required to minimize evaporation. Do not apply mortar to substrates with temperatures of 90 deg F (32 deg C) and above unless otherwise indicated.
4. For manufactured repair materials, perform work within the environmental limits set by each manufacturer.
5. Clean masonry surfaces only when air temperature is 40 deg F (4 deg C) and above and is predicted to remain so for at least 7 days after completion of cleaning.

1.2 PRODUCTS

A. Masonry Materials
1. Face Brick: Provide face brick, including specially molded, ground, cut, or sawed shapes where required to complete masonry restoration work.
   a. Provide units with physical properties, colors, color variation within units, surface texture, size, and shape to match existing brickwork.
      1) Physical Properties per ASTM C 67:
      2) For existing brickwork that exhibits a range of colors or color variation within units, provide brick that proportionally matches that range and variation rather than brick that matches an individual color within that range.
   b. Special Shapes:

1) Provide specially molded, 100 percent solid shapes for applications where core holes or "frogs" could be exposed to view or weather when in final position and where shapes produced by sawing would result in sawed surfaces being exposed to view.
2) Provide specially ground units, shaped to match patterns, for arches and where indicated.
3) Mechanical chopping or breaking brick, or bonding pieces of brick together by adhesive, are not acceptable procedures for fabricating special shapes.

c. Tolerances as Fabricated: Comply with tolerance requirements in ASTM C 216, Type FBX **OR** Comply with tolerance requirements in ASTM C 216, Type FBS, **as directed**.

2. Building Brick: Provide building brick complying with ASTM C 62, of same vertical dimension as face brick, for masonry work concealed from view.
   a. Grade SW where in contact with earth.
   b. Grade SW, MW, or NW for concealed backup.
3. Salvaged Brick: Obtain salvaged brick from Owner from location shown on Drawings. Clean off residual mortar.
4. Glazed Terra Cotta: Provide new terra cotta units to match existing terra cotta units in body composition, physical properties, color, gloss, surface texture, thickness, profile, dimensions, and composition of surface glaze.
   a. Physical Properties: Provide units with tested physical properties within 10 percent of those determined from preconstruction testing of selected existing units.
      1) Physical Properties per ASTM C 67:
   b. Tolerances as Fabricated: Comply with tolerance requirements in ASTM C 212, Type FTX.
5. Brownstone Terra Cotta: Provide new, unglazed, brownstone terra cotta units to match existing terra cotta units in body composition, physical properties, colors, color variation within units, surface texture, unit profile, and dimensions.
   a. Physical Properties: Provide units with tested physical properties within 10 percent of those determined from preconstruction testing of selected existing units.
   b. Physical Properties per ASTM C 67:
   c. Tolerances as Fabricated: Comply with tolerance requirements in ASTM C 212, Type FTX.
   d. For existing terra cotta that exhibits a range of colors or color variation within units, provide terra cotta that proportionally matches that range and variation rather than terra cotta that matches an individual color within that range.

B. Mortar Materials
1. Portland Cement: ASTM C 150, Type I or Type II, white or gray or both where required for color matching of exposed mortar.
   a. Provide cement containing not more than 0.60 percent total alkali when tested according to ASTM C 114.
2. Hydrated Lime: ASTM C 207, Type S.
3. Factory-Prepared Lime Putty: ASTM C 1489.
4. Quicklime: ASTM C 5, pulverized lime.
5. Mortar Sand: ASTM C 144 unless otherwise indicated.
   a. Color: Provide natural sand or ground marble, granite, or other sound stone of color necessary to produce required mortar color.
   b. For pointing mortar, provide sand with rounded edges.
   c. Match size, texture, and gradation of existing mortar sand as closely as possible. Blend several sands if necessary to achieve suitable match.
6. Mortar Pigments: Natural and synthetic iron oxides, compounded for mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortars.
7. Water: Potable.

C. Manufactured Repair Materials

1. Masonry Patching Compound: Factory-mixed cementitious product that is custom manufactured for patching masonry.
   a. Use formulation that is vapor- and water permeable (equal to or more than the masonry unit), exhibits low shrinkage, has lower modulus of elasticity than the masonry units being repaired, and develops high bond strength to all types of masonry.
   b. Use formulation having working qualities and retardation control to permit forming and sculpturing where necessary.
   c. Formulate patching compound used for patching brick and terra cotta in colors and textures to match each masonry unit being patched.
2. Terra Cotta Glaze Replacement: A high-solids, nonyellowing, fade-resistant, waterborne polyurethane or epoxy coating intended for exterior use as terra cotta glaze replacement. Product shall be custom mixed by manufacturer to match color and gloss of existing terra cotta glaze.

D. Paint Removers
1. Alkaline Paste Paint Remover: Manufacturer's standard alkaline paste formulation for removing paint coatings from masonry.
2. Covered or Skin-Forming Alkaline Paint Remover: Manufacturer's standard covered or skin-forming alkaline formulation for removing paint coatings from masonry.
3. Solvent-Type Paint Remover: Manufacturer's standard water-rinsable, solvent-type gel formulation for removing paint coatings from masonry.
4. Low-Odor, Solvent-Type Paint Remover: Manufacturer's standard low-odor, water-rinsable solvent-type gel formulation, containing no methanol or methylene chloride, for removing paint coatings from masonry.

E. Cleaning Materials
1. Water: Potable.
2. Hot Water: Water heated to a temperature of 140 to 160 deg F (60 to 71 deg C).
3. Job-Mixed Detergent Solution: Solution prepared by mixing 2 cups (0.5 L) of tetrasodium polyphosphate, 1/2 cup (125 mL) of laundry detergent, and 20 quarts (20 L) of hot water for every 5 gal. (20 L) of solution required.
4. Job-Mixed Mold, Mildew, and Algae Remover: Solution prepared by mixing 2 cups (0.5 L) of tetrasodium polyphosphate, 5 quarts (5 L) of 5 percent sodium hypochlorite (bleach), and 15 quarts (15 L) of hot water for every 5 gal. (20 L) of solution required.
5. Nonacidic Gel Cleaner: Manufacturer's standard gel formulation, with pH between 6 and 9, that contains detergents with chelating agents and is specifically formulated for cleaning masonry surfaces.
6. Nonacidic Liquid Cleaner: Manufacturer's standard mildly alkaline liquid cleaner formulated for removing mold, mildew, and other organic soiling from ordinary building materials, including polished stone, brick, aluminum, plastics, and wood.
7. Mild Acidic Cleaner: Manufacturer's standard mildly acidic cleaner containing no muriatic (hydrochloric), hydrofluoric, or sulfuric acid; or ammonium bifluoride or chlorine bleaches.
8. Acidic Cleaner: Manufacturer's standard acidic masonry cleaner composed of hydrofluoric acid or ammonium bifluoride blended with other acids, detergents, wetting agents, and inhibitors.
9. Two-Part Chemical Cleaner: Manufacturer's standard system consisting of potassium or sodium hydroxide based, alkaline prewash cleaner and acidic afterwash cleaner that does not contain hydrofluoric acid.

F. Accessory Materials
1. Liquid Strippable Masking Agent: Manufacturer's standard liquid, film-forming, strippable masking material for protecting glass, metal, and polished stone surfaces from damaging effects of acidic and alkaline masonry cleaners.
2. Terra Cotta Anchors: Type and size indicated or, if not indicated, to match existing anchors in size and type. Fabricate anchors from Type 304 **OR** Type 316, **as directed**, stainless steel.
3. Masonry Repair Anchors, Expansion Type: Mechanical fasteners designed for masonry veneer stabilization consisting of 1/4-inch- (6-mm-) diameter, Type 304 **OR** Type 316, **as directed**,

stainless-steel rod with brass expanding shells at each end and water-shedding washer in the middle. Expanding shells shall be designed to provide positive mechanical anchorage to veneer on one end and backup masonry on the other.

4. Masonry Repair Anchors, Spiral Type: Type 304 **OR** Type 316, **as directed**, stainless-steel spiral rods designed to anchor to backing and veneer. Anchors are flexible in plane of veneer but rigid perpendicular to it.
   a. Provide adhesive-installed anchors complete with manufacturer's standard epoxy adhesive and injection tubes, or other devices required for installation.
   b. Provide driven-in anchors designed to be installed in drilled holes and relying on screw effect rather than adhesive to secure them to backup and veneer.
5. Masonry Repair Anchors, Rod/Screen Tube Type: Stainless-steel screen tube with or without Type 304 **OR** Type 316, **as directed**, stainless-steel rod, adhesive installed by injection with manufacturer's standard epoxy adhesive, complete with other devices required for installation.
6. Sealant Materials:
   a. Provide manufacturer's standard chemically curing, elastomeric sealant(s) of base polymer and characteristics indicated below that comply with applicable requirements in Division 07 Section "Joint Sealants".
      1) Single-component, nonsag urethane sealant.
   b. Colors: Provide colors of exposed sealants to match colors of masonry adjoining installed sealant unless otherwise indicated.
   c. Ground-Mortar Aggregate: Custom crushed and ground pointing mortar sand or existing mortar retrieved from joints. Grind to a particle size that matches the adjacent mortar aggregate and color. Remove all fines passing the 100 sieve.
7. Joint-Sealant Backing:
   a. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin) or Type B (bicellular material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
   b. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where acceptable.
8. Setting Buttons: Resilient plastic buttons, nonstaining to masonry, sized to suit joint thicknesses and bed depths of masonry units without intruding into required depths of pointing materials.
9. Masking Tape: Nonstaining, nonabsorbent material, compatible with pointing mortar, joint primers, sealants, and surfaces adjacent to joints; that will easily come off entirely, including adhesive.
10. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with MPI #79, Alkyd Anticorrosive Metal Primer or SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating.
    a. Use coating requiring no better than SSPC-SP 2, "Hand Tool Cleaning" **OR** SSPC-SP 3, "Power Tool Cleaning" **OR** SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning", **as directed**, surface preparation according to manufacturer's literature or certified statement.
    b. Use coating with a VOC content of 420 g/L (3.5 lb/gal.) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
11. Miscellaneous Products: Select materials and methods of use based on the following, subject to approval of a mockup:
    a. Previous effectiveness in performing the work involved.
    b. Little possibility of damaging exposed surfaces.
    c. Consistency of each application.
    d. Uniformity of the resulting overall appearance.
    e. Do not use products or tools that could do the following:
       1) Remove, alter, or in any way harm the present condition or future preservation of existing surfaces, including surrounding surfaces not in contract.
       2) Leave a residue on surfaces.

G. Mortar Mixes
1. Preparing Lime Putty: Slake quicklime and prepare lime putty according to appendix to ASTM C 5 and manufacturer's written instructions.
2. Measurement and Mixing: Measure cementitious materials and sand in a dry condition by volume or equivalent weight. Do not measure by shovel; use known measure. Mix materials in a clean, mechanical batch mixer.
   a. Mixing Pointing Mortar: Thoroughly mix cementitious materials and sand together before adding any water. Then mix again adding only enough water to produce a damp, unworkable mix that will retain its form when pressed into a ball. Maintain mortar in this dampened condition for 15 to 30 minutes. Add remaining water in small portions until mortar reaches desired consistency. Use mortar within one hour of final mixing; do not retemper or use partially hardened material.
3. Colored Mortar: Produce mortar of color required by using specified ingredients. Do not alter specified proportions without the Owner's approval.
   a. Mortar Pigments: Where mortar pigments are indicated, do not exceed a pigment-to-cement ratio of 1:10 by weight.
4. Do not use admixtures in mortar unless otherwise indicated.
5. Mortar Proportions: Mix mortar materials in the following proportions:
   a. Pointing Mortar for Brick: 1 part portland cement, 2 parts lime, and 6 parts sand **OR** 1 part portland cement, 6 parts lime, and 12 parts sand, **as directed**.
      1) Add mortar pigments to produce mortar colors required.
   b. Pointing Mortar for Terra Cotta: 1 part white portland cement, 1 part lime, and 6 parts sand.
      1) Add mortar pigments to produce mortar colors required.
   c. Rebuilding (Setting) Mortar: Same as pointing mortar except mortar pigments are not required, **as directed**.
   d. Rebuilding (Setting) Mortar: 1 part portland cement, 2 parts lime, and 6 parts sand **OR** 1 part portland cement, 6 parts lime, and 12 parts sand, **as directed**.
   e. Rebuilding (Setting) Mortar: Comply with ASTM C 270, Proportion Specification, Type N unless otherwise indicated; with cementitious material limited to portland cement and lime.

H. Chemical Cleaning Solutions
1. Dilute chemical cleaners with water to produce solutions not exceeding concentration recommended by chemical-cleaner manufacturer.
2. Acidic Cleaner Solution for Brick and Brownstone Terra Cotta: Dilute with water to produce hydrofluoric acid content of 3 percent or less, but not greater than that recommended by chemical-cleaner manufacturer.
3. Acidic Cleaner Solution for Glazed Terra Cotta: Dilute with water to concentration demonstrated by testing that does not etch or otherwise damage terra cotta surface, but not greater than that recommended by chemical-cleaner manufacturer.

1.3 EXECUTION

A. Protection
1. Protect persons, motor vehicles, surrounding surfaces of building being restored, building site, plants, and surrounding buildings from harm resulting from masonry restoration work.
   a. Erect temporary protective covers over walkways and at points of pedestrian and vehicular entrance and exit that must remain in service during course of restoration and cleaning work.
2. Comply with chemical-cleaner manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products. Prevent chemical-cleaning solutions from coming into contact with people, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.
   a. Cover adjacent surfaces with materials that are proven to resist chemical cleaners used unless chemical cleaners being used will not damage adjacent surfaces. Use materials

that contain only waterproof, UV-resistant adhesives. Apply masking agents to comply with manufacturer's written instructions. Do not apply liquid masking agent to painted or porous surfaces. When no longer needed, promptly remove masking to prevent adhesive staining.

b. Keep wall wet below area being cleaned to prevent streaking from runoff.

c. Do not clean masonry during winds of sufficient force to spread cleaning solutions to unprotected surfaces.

d. Neutralize and collect alkaline and acid wastes for disposal off Owner's property.

e. Dispose of runoff from cleaning operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

3. Prevent mortar from staining face of surrounding masonry and other surfaces.
   a. Cover sills, ledges, and projections to protect from mortar droppings.
   b. Keep wall area wet below rebuilding and pointing work to discourage mortar from adhering.
   c. Immediately remove mortar in contact with exposed masonry and other surfaces.
   d. Clean mortar splatters from scaffolding at end of each day.
4. Remove gutters and downspouts adjacent to masonry and store where indicated during masonry restoration and cleaning. Reinstall when masonry restoration and cleaning are complete.
   a. Provide temporary rain drainage during work as indicated to direct water away from building.

B. Unused Anchor Removal
1. Remove masonry anchors, brackets, wood nailers, and other extraneous items no longer in use unless identified as historically significant or indicated to remain.
   a. Remove items carefully to avoid spalling or cracking masonry.
   b. Where directed, if an item cannot be removed without damaging surrounding masonry, do the following:
      1) Cut or grind off item approximately 3/4 inch (20 mm) beneath surface and core drill a recess of same depth in surrounding masonry as close around item as practical.
      2) Immediately paint exposed end of item with two coats of antirust coating, following coating manufacturer's written instructions and without exceeding manufacturer's recommended dry film thickness per coat. Keep paint off sides of recess.
   c. Patch the hole where each item was removed unless directed to remove and replace the masonry unit.

C. Brick Removal And Replacement
1. At locations indicated, remove bricks that are damaged, spalled, or deteriorated or are to be reused. Carefully demolish or remove entire units from joint to joint, without damaging surrounding masonry, in a manner that permits replacement with full-size units.
   a. When removing single bricks, remove material from center of brick and work toward outside edges.
2. Support and protect remaining masonry that surrounds removal area. Maintain flashing, reinforcement, lintels, and adjoining construction in an undamaged condition.
3. Notify the Owner of unforeseen detrimental conditions including voids, cracks, bulges, and loose units in existing masonry backup, rotted wood, rusted metal, and other deteriorated items.
4. Remove in an undamaged condition as many whole bricks as possible.
   a. Remove mortar, loose particles, and soil from brick by cleaning with hand chisels, brushes, and water.
   b. Remove sealants by cutting close to brick with utility knife and cleaning with solvents.
   c. Store brick for reuse. Store off ground, on skids, and protected from weather.
   d. Deliver cleaned brick not required for reuse to Owner unless otherwise indicated.
5. Clean bricks surrounding removal areas by removing mortar, dust, and loose particles in preparation for replacement.

6. Replace removed damaged brick with other removed brick and salvaged brick in good quality, where possible, or with new brick matching existing brick, including size. Do not use broken units unless they can be cut to usable size.
7. Install replacement brick into bonding and coursing pattern of existing brick. If cutting is required, use a motor-driven saw designed to cut masonry with clean, sharp, unchipped edges.
   a. Maintain joint width for replacement units to match existing joints.
   b. Use setting buttons or shims to set units accurately spaced with uniform joints.
8. Lay replacement brick with completely filled bed, head, and collar joints. Butter ends with sufficient mortar to fill head joints and shove into place. Wet both replacement and surrounding bricks that have ASTM C 67 initial rates of absorption (suction) of more than 30 g/30 sq. in. per min. (30 g/194 sq. cm per min.). Use wetting methods that ensure that units are nearly saturated but surface is dry when laid.
   a. Tool exposed mortar joints in repaired areas to match joints of surrounding existing brickwork.
   b. Rake out mortar used for laying brick before mortar sets and point new mortar joints in repaired area to comply with requirements for repointing existing masonry, and at same time as repointing of surrounding area.
   c. When mortar is sufficiently hard to support units, remove shims and other devices interfering with pointing of joints.

D. Terra Cotta Removal And Replacement
1. At locations indicated, remove terra cotta units that are damaged, spalled, or deteriorated. Carefully demolish or remove entire units from joint to joint, without damaging surrounding masonry, in a manner that permits replacement with full-size units.
2. Support and protect remaining masonry that was supported by removed units. Maintain flashing, reinforcement, lintels, and adjoining construction in an undamaged condition.
3. Notify the Owner of unforeseen detrimental conditions including voids, cracks, bulges, and loose units in existing masonry backup, rotted wood, rusted metal, and other deteriorated items.
4. Clean masonry surrounding removal areas by removing mortar, dust, and loose particles in preparation for replacement.
5. Install replacement units into bonding and coursing pattern of existing units.
   a. Do not cut or grind glazed terra cotta.
   b. If minor cutting of replacement brownstone terra cotta is required, use a motor-driven grinder or saw designed to cut masonry with clean, sharp, unchipped edges. Do not cut or grind more than 1/8 inch (3 mm) along any edge.
   c. Use setting buttons or shims to set units accurately spaced with uniform joints.
6. Set replacement units in a full bed of mortar. Replace existing anchors with new anchors of size and type indicated.
   a. Embed anchors in mortar and fill voids behind units with mortar.
   b. Tool exposed mortar joints in repaired areas to match joints of surrounding existing terra cotta.
   c. Rake out mortar used for laying terra cotta before mortar sets and point new mortar joints in repaired area to comply with requirements for repointing existing masonry, and at same time as repointing of surrounding area.
   d. When mortar is sufficiently hard to support units, remove shims and other devices interfering with pointing of joints.

E. Reanchoring Veneers
1. Install masonry repair anchors in horizontal mortar joints and according to manufacturer's written instructions. Install at not more than 16 inches (400 mm) o.c. vertically and 32 inches (800 mm) o.c. horizontally unless otherwise indicated. Install at locations to avoid penetrating flashing.
2. Recess anchors at least 5/8 inch (16 mm) from surface of mortar joint and fill recess with pointing mortar.

F. Painting Steel Uncovered During The Work

1. Inspect steel exposed during masonry removal. Where the Owner determines that it is structural, or for other reasons cannot be totally removed, prepare and paint it as follows:
   a. Remove paint, rust, and other contaminants according to SSPC-SP 2, "Hand Tool Cleaning" **OR** SSPC-SP 3, "Power Tool Cleaning" **OR** SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning", **as directed**, as applicable to meet paint manufacturer's recommended preparation.
   b. Immediately paint exposed steel with two coats of antirust coating, following coating manufacturer's written instructions and without exceeding manufacturer's recommended rate of application (dry film thickness per coat).
2. If on inspection and rust removal, the cross section of a steel member is found to be reduced from rust by more than 1/16 inch (1.6 mm), notify the Owner before proceeding.

G. Masonry Unit Patching
1. Patch the following masonry units unless another type of replacement or repair is indicated:
   a. Units indicated to be patched.
   b. Units with holes.
   c. Units with chipped edges or corners.
   d. Units with small areas of deep deterioration.
2. Remove and replace existing patches unless otherwise indicated or approved by the Owner.
3. Patching Bricks:
   a. Remove loose material from masonry surface. Carefully remove additional material so patch will not have feathered edges but will have square or slightly undercut edges on area to be patched and will be at least 1/4 inch (6 mm) thick, but not less than recommended by patching compound manufacturer.
   b. Mask adjacent mortar joint or rake out for repointing if patch will extend to edge of masonry unit.
   c. Mix patching compound in individual batches to match each unit being patched. Combine one or more colors of patching compound, as needed, to produce exact match.
   d. Rinse surface to be patched and leave damp, but without standing water.
   e. Brush-coat surfaces with slurry coat of patching compound according to manufacturer's written instructions.
   f. Place patching compound in layers as recommended by patching compound manufacturer, but not less than 1/4 inch (6 mm) or more than 2 inches (50 mm) thick. Roughen surface of each layer to provide a key for next layer.
   g. Trowel, scrape, or carve surface of patch to match texture and surrounding surface plane or contour of the masonry unit. Shape and finish surface before or after curing, as determined by testing, to best match existing masonry unit.
   h. Keep each layer damp for 72 hours or until patching compound has set.
4. Patching Terra Cotta:
   a. Remove deteriorated material as determined by sounding gently with a small hammer. Carefully remove additional material so patch will not have feathered edges but will have square or slightly undercut edges on area to be patched and will be at least 1/4 inch (6 mm) thick, but not less than recommended by patching compound manufacturer.
   b. Where mortar joints adjacent to patch are open, fill back of joints with pointing mortar and allow to cure before patching terra cotta. Leave space for pointing joints according to "Repointing Masonry" Article.
   c. Mask adjacent mortar joint or rake out for repointing if patch will extend to edge of unit.
   d. Rinse surface to be patched and leave damp, but without standing water.
   e. Brush-coat surfaces with slurry coat of patching compound according to manufacturer's written instructions.
   f. Place patching compound in layers as recommended by patching compound manufacturer, but not less than 1/4 inch (6 mm) or more than 2 inches (50 mm) thick. Roughen surface of each layer to provide a key for next layer.
   g. Do not apply patching compound over mortar joints. If patching compound bridges mortar joints, cut out joints after patching compound hardens.

h. Trowel, scrape, or carve surface of patch to match texture, details, and surrounding surface plane or contour of terra cotta. Shape and finish surface before or after curing, as determined by testing to best match existing terra cotta.
i. Keep each layer damp for 72 hours or until patching compound has set.
j. After final layer of patching compound has cured, apply glaze replacement according to manufacturer's written instructions. Apply two or more coats, as needed, to match glaze of adjacent terra cotta units.

H. Widening Joints
1. Do not widen a joint, except where indicated or approved by the Owner.
2. Location Guideline: Where an existing masonry unit abuts another or the joint is less than 1/8 inch (3 mm), widen the joint for length indicated and to depth required for repointing after obtaining the Owner 's approval.
3. Carefully perform widening by cutting, grinding, routing, or filing procedures demonstrated in an approved mockup.
4. Widen joint to width equal to or less than predominant width of other joints on building. Make sides of widened joint uniform and parallel. Ensure that edges of units along widened joint are in alignment with joint edges at unaltered joints.

I. Cleaning Masonry, General
1. Proceed with cleaning in an orderly manner; work from bottom to top **OR** top to bottom, **as directed**, of each scaffold width and from one end of each elevation to the other. Ensure that dirty residues and rinse water will not wash over cleaned, dry surfaces.
2. Use only those cleaning methods indicated for each masonry material and location.
a. Do not use wire brushes or brushes that are not resistant to chemical cleaner being used. Do not use plastic-bristle brushes if natural-fiber brushes will resist chemical cleaner being used.
b. Use spray equipment that provides controlled application at volume and pressure indicated, measured at spray tip. Adjust pressure and volume to ensure that cleaning methods do not damage masonry.
1) Equip units with pressure gages.
c. For chemical-cleaner spray application, use low-pressure tank or chemical pump suitable for chemical cleaner indicated, equipped with cone-shaped spray tip.
d. For water-spray application, use fan-shaped spray tip that disperses water at an angle of 25 to 50 degrees.
e. For high-pressure water-spray application, use fan-shaped spray tip that disperses water at an angle of at least 40 degrees.
f. For heated water-spray application, use equipment capable of maintaining temperature between 140 and 160 deg F (60 and 71 deg C) at flow rates indicated.
g. For steam application, use steam generator capable of delivering live steam at nozzle.
3. Perform each cleaning method indicated in a manner that results in uniform coverage of all surfaces, including corners, moldings, and interstices, and that produces an even effect without streaking or damaging masonry surfaces.
4. Water Application Methods:
a. Water-Soak Application: Soak masonry surfaces by applying water continuously and uniformly to limited area for time indicated. Apply water at low pressures and low volumes in multiple fine sprays using perforated hoses or multiple spray nozzles. Erect a protective enclosure constructed of polyethylene sheeting to cover area being sprayed.
b. Water-Spray Applications: Unless otherwise indicated, hold spray nozzle at least 6 inches (150 mm) from surface of masonry and apply water in horizontal back and forth sweeping motion, overlapping previous strokes to produce uniform coverage.
5. Steam Cleaning: Apply steam to masonry surfaces at the very low pressures indicated for each type of masonry material. Hold nozzle at least 6 inches (150 mm) from surface of masonry and apply steam in horizontal back and forth sweeping motion, overlapping previous strokes to produce uniform coverage.

6. Chemical-Cleaner Application Methods: Apply chemical cleaners to masonry surfaces to comply with chemical-cleaner manufacturer's written instructions; use brush or spray application. Do not spray apply at pressures exceeding 50 psi (345 kPa). Do not allow chemicals to remain on surface for periods longer than those indicated or recommended by manufacturer.
7. Rinse off chemical residue and soil by working upward from bottom to top of each treated area at each stage or scaffold setting. Periodically during each rinse, test pH of rinse water running off of cleaned area to determine that chemical cleaner is completely removed.
   a. Apply neutralizing agent and repeat rinse if necessary to produce tested pH of between 6.7 and 7.5.
8. After cleaning is complete, remove protection no longer required. Remove tape and adhesive marks.

J. Preliminary Cleaning
1. Removing Plant Growth: Completely remove visible plant, moss, and shrub growth from masonry surfaces. Carefully remove plants, creepers, and vegetation by cutting at roots and allowing to dry as long as possible before removal. Remove loose soil and debris from open masonry joints to whatever depth they occur.
2. Preliminary Cleaning: Before beginning general cleaning, remove extraneous substances that are resistant to cleaning methods being used. Extraneous substances include paint, calking, asphalt, and tar.
   a. Carefully remove heavy accumulations of material from surface of masonry with a sharp chisel. Do not scratch or chip masonry surface.
   b. Remove paint and calking with alkaline paint remover.
      1) Comply with requirements in "Paint Removal" Article.
      2) Repeat application up to two times if needed.
   c. Remove asphalt and tar with solvent-type paint remover.
      1) Comply with requirements in "Paint Removal" Article.
      2) Apply paint remover only to asphalt and tar by brush without prewetting.
      3) Allow paint remover to remain on surface for 10 to 30 minutes.
      4) Repeat application if needed.

K. Paint Removal
1. Paint Removal with Alkaline Paste Paint Remover:
   a. Remove loose and peeling paint using low **OR** medium **OR** high, **as directed**,-pressure spray, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
   b. Apply paint remover to dry, painted masonry with brushes.
   c. Allow paint remover to remain on surface for period recommended by manufacturer.
   d. Rinse with cold **OR** hot, **as directed**, water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove chemicals and paint residue.
   e. Repeat process if necessary to remove all paint.
   f. Apply acidic cleaner or manufacturer's recommended afterwash to masonry, while surface is still wet, using low-pressure spray equipment or soft-fiber brush. Let cleaner or afterwash remain on surface as a neutralizing agent for period recommended by chemical cleaner or afterwash manufacturer.
   g. Rinse with cold water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove chemicals and soil.
2. Paint Removal with Covered or Skin-Forming Alkaline Paint Remover:
   a. Remove loose and peeling paint using low **OR** medium **OR** high, **as directed**,-pressure spray, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
   b. Apply paint remover to dry, painted masonry with trowel, spatula, or as recommended by manufacturer.
   c. Apply cover, if required by manufacturer, per manufacturer's written instructions.
   d. Allow paint remover to remain on surface for period recommended by manufacturer or as determined in test panels.
   e. Scrape off paint and remover and collect for disposal.

f. Rinse with cold **OR** hot, **as directed**, water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove chemicals and paint residue.
g. Use alkaline paste paint remover, according to "Paint Removal with Alkaline Paste Paint Remover" Paragraph, if necessary to remove remaining paint.
h. Apply acidic cleaner or manufacturer's recommended afterwash to masonry, while surface is still wet, using low-pressure spray equipment or soft-fiber brush. Let cleaner or afterwash remain on surface as a neutralizing agent for period recommended by chemical-cleaner or afterwash manufacturer.
i. Rinse with cold water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove chemicals and soil.

3. Paint Removal with Solvent-Type Paint Remover:
   a. Remove loose and peeling paint using low **OR** medium **OR** high, **as directed**,-pressure spray, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
   b. Apply thick coating of paint remover to painted masonry with natural-fiber cleaning brush, deep-nap roller, or large paint brush.
   c. Allow paint remover to remain on surface for period recommended by manufacturer. Agitate periodically with stiff-fiber brush.
   d. Rinse with cold **OR** hot, **as directed**, water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove chemicals and paint residue.

L. Cleaning Brickwork
1. Cold-Water Soak:
   a. Apply cold water by intermittent spraying to keep surface moist.
   b. Use perforated hoses or other means that will apply a fine water mist to entire surface being cleaned.
   c. Apply water in cycles with at least 30 minutes between cycles.
   d. Continue spraying until surface encrustation has softened sufficiently to permit its removal by water wash, as indicated by cleaning tests.
   e. Continue spraying for 72 hours.
   f. Remove soil and softened surface encrustation from masonry with cold water applied by low-pressure spray.
2. Cold-Water Wash: Use cold water applied by low **OR** medium **OR** high, **as directed**,-pressure spray.
3. Hot-Water Wash: Use hot water applied by low **OR** medium **OR** high, **as directed**,-pressure spray.
4. Steam Cleaning: Apply steam at very low pressures not exceeding 30 psi (207 kPa) **OR** 80 psi (550 kPa), **as directed**. Remove dirt softened by steam with wood scrapers, stiff-nylon or -fiber brushes, or cold-water wash, as indicated by cleaning tests.
5. Detergent Cleaning:
   a. Wet masonry with cold **OR** hot, **as directed**, water applied by low-pressure spray.
   b. Scrub masonry with detergent solution using medium-soft brushes until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from mortar joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that masonry surface remains wet.
   c. Rinse with cold **OR** hot, **as directed**, water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove detergent solution and soil.
   d. Repeat cleaning procedure above where required to produce cleaning effect established by mockup.
6. Mold, Mildew, and Algae Removal:
   a. Wet masonry with cold **OR** hot, **as directed**, water applied by low-pressure spray.
   b. Apply mold, mildew, and algae remover by brush or low-pressure spray.
   c. Scrub masonry with medium-soft brushes until mold, mildew, and algae are thoroughly dislodged and can be removed by rinsing. Use small brushes for mortar joints and crevices. Dip brush in mold, mildew, and algae remover often to ensure that adequate fresh cleaner is used and that masonry surface remains wet.

d. Rinse with cold **OR** hot, **as directed**, water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove mold, mildew, and algae remover and soil.
e. Repeat cleaning procedure above where required to produce cleaning effect established by mockup.

7. Nonacidic Gel Chemical Cleaning:
   a. Wet masonry with cold **OR** hot, **as directed**, water applied by low-pressure spray.
   b. Apply nonacidic gel cleaner in 1/8-inch (3-mm) thickness by brush, working into joints and crevices. Apply quickly and do not brush out excessively so area will be uniformly covered with fresh cleaner and dwell time will be uniform throughout area being cleaned.
   c. Let cleaner remain on surface for period indicated below:
      1) As recommended by chemical-cleaner manufacturer.
      2) As established by mockup.
   d. Remove bulk of nonacidic gel cleaner by squeegeeing into containers for disposal.
   e. Rinse with cold **OR** hot, **as directed**, water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove chemicals and soil.
   f. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.
8. Nonacidic Liquid Chemical Cleaning:
   a. Wet masonry with cold **OR** hot, **as directed**, water applied by low-pressure spray.
   b. Apply cleaner to masonry in two applications, **as directed**, by brush or low-pressure spray. Let cleaner remain on surface for period indicated below:
      1) As recommended by chemical-cleaner manufacturer.
      2) As established by mockup.
      3) Two to three minutes.
   c. Rinse with cold **OR** hot, **as directed**, water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove chemicals and soil.
   d. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.
9. Mild Acidic **OR** Acidic, **as directed**, Chemical Cleaning:
   a. Wet masonry with cold water applied by low-pressure spray.
   b. Apply cleaner to masonry in two applications, **as directed**, by brush or low-pressure spray. Let cleaner remain on surface for period indicated below:
      1) As recommended by chemical-cleaner manufacturer.
      2) As established by mockup.
      3) Two to three minutes.
   c. Rinse with cold water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove chemicals and soil.
   d. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use a steam cleaning.

M. Cleaning Brownstone Terra Cotta
1. Cold-Water Soak:
   a. Apply cold water by intermittent spraying to keep surface moist.
   b. Use perforated hoses or other means that will apply a fine water mist to entire surface being cleaned.
   c. Apply water in cycles with at least 30 minutes between cycles.
   d. Continue spraying until surface encrustation has softened sufficiently to permit its removal by water wash, as indicated by cleaning tests.
   e. Continue spraying for 72 hours.
   f. Remove soil and softened surface encrustation from masonry with cold water applied by low-pressure spray.

2. Cold-Water Wash: Use cold water applied by low **OR** medium **OR** high, **as directed**,-pressure spray.
3. Hot-Water Wash: Use hot water applied by low **OR** medium **OR** high, **as directed**,-pressure spray.
4. Steam Cleaning: Apply steam at very low pressures not exceeding 30 psi (207 kPa) **OR** 80 psi (550 kPa), **as directed**. Remove dirt softened by steam with wood scrapers, stiff-nylon or -fiber brushes, or cold-water wash, as indicated by cleaning tests.
5. Detergent Cleaning:
   a. Wet masonry with cold **OR** hot, **as directed**, water applied by low-pressure spray.
   b. Scrub masonry with detergent solution using medium-soft brushes until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from mortar joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that masonry surface remains wet.
   c. Rinse with cold **OR** hot, **as directed**, water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove detergent solution and soil.
   d. Repeat cleaning procedure above where required to produce cleaning effect established by mockup.
6. Mold, Mildew, and Algae Removal:
   a. Wet masonry with cold **OR** hot, **as directed**, water applied by low-pressure spray.
   b. Apply mold, mildew, and algae remover by brush or low-pressure spray.
   c. Scrub masonry with medium-soft brushes until mold, mildew, and algae are thoroughly dislodged and can be removed by rinsing. Use small brushes for mortar joints and crevices. Dip brush in mold, mildew, and algae remover often to ensure that adequate fresh cleaner is used and that masonry surface remains wet.
   d. Rinse with cold **OR** hot, **as directed**, water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove mold, mildew, and algae remover and soil.
   e. Repeat cleaning procedure above where required to produce cleaning effect established by mockup.
7. Nonacidic Gel Chemical Cleaning:
   a. Wet masonry with cold **OR** hot, **as directed**, water applied by low-pressure spray.
   b. Apply nonacidic gel cleaner in 1/8-inch (3-mm) thickness by brush, working into joints and crevices. Apply quickly and do not brush out excessively so area will be uniformly covered with fresh cleaner and dwell time will be uniform throughout area being cleaned.
   c. Let cleaner remain on surface for period indicated below:
      1) As recommended by chemical-cleaner manufacturer.
      2) As established by mockup.
   d. Remove bulk of nonacidic gel cleaner by squeegeeing into containers for disposal.
   e. Rinse with cold **OR** hot, **as directed**, water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove chemicals and soil.
   f. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.
8. Nonacidic Liquid Chemical Cleaning:
   a. Wet masonry with cold **OR** hot, **as directed**, water applied by low-pressure spray.
   b. Apply cleaner to masonry in two applications, **as directed**, by brush or low-pressure spray. Let cleaner remain on surface for period indicated below:
      1) As recommended by chemical-cleaner manufacturer.
      2) As established by mockup.
      3) Two to three minutes.
   c. Rinse with cold **OR** hot, **as directed**, water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove chemicals and soil.
   d. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.
9. Mild Acidic **OR** Acidic, **as directed**, Chemical Cleaning:
   a. Wet masonry with cold water applied by low-pressure spray.

b. Apply cleaner to masonry in two applications, **as directed**, by brush or low-pressure spray. Let cleaner remain on surface for period indicated below:
   1) As recommended by chemical-cleaner manufacturer.
   2) As established by mockup.
   3) Two to three minutes.
c. Rinse with cold water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove chemicals and soil.
d. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use a steam cleaning.

N. Cleaning Glazed Terra Cotta
1. Hot-Water Wash: Use hot water applied by low **OR** medium **OR** high, **as directed**,-pressure spray.
2. Steam Cleaning: Apply steam at very low pressures not exceeding 30 psi (207 kPa) **OR** 80 psi (550 kPa), **as directed**. Remove dirt softened by steam with wood scrapers, stiff-nylon or -fiber brushes, or cold-water wash, as indicated by cleaning tests.
3. Nonacidic Gel Chemical Cleaning:
   a. Wet terra cotta with cold **OR** hot, **as directed**, water applied by low-pressure spray.
   b. Apply nonacidic gel cleaner in 1/8-inch (3-mm) thickness by brush, working into joints and crevices. Apply quickly and do not brush out excessively so area will be uniformly covered with fresh cleaner and dwell time will be uniform throughout area being cleaned.
   c. Let cleaner remain on surface for period indicated below:
      1) As recommended by chemical-cleaner manufacturer.
      2) As established by mockup.
   d. Remove bulk of nonacidic gel cleaner by squeegeeing into containers for disposal.
   e. Rinse with cold **OR** hot, **as directed**, water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove chemicals and soil.
   f. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.
4. Nonacidic Liquid Chemical Cleaning:
   a. Wet terra cotta with cold **OR** hot, **as directed**, water applied by low-pressure spray.
   b. Apply cleaner to terra cotta in two applications, **as directed**. Let cleaner remain on surface for period indicated below:
      1) As recommended by chemical-cleaner manufacturer.
      2) As established by mockup.
      3) Two to three minutes.
   c. Rinse with cold **OR** hot, **as directed**, water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove chemicals and soil.
   d. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.
5. Mild Acidic Chemical Cleaning:
   a. Wet terra cotta with cold water applied by low-pressure spray.
   b. Apply cleaner to terra cotta in two applications, **as directed**. Let cleaner remain on surface for period indicated below:
      1) As recommended by chemical-cleaner manufacturer.
      2) As established by mockup.
      3) Two to three minutes.
   c. Rinse with cold water applied by low **OR** medium **OR** high, **as directed**,-pressure spray to remove chemicals and soil.
   d. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.

6. Two-Part Chemical Cleaning:
   a. Wet terra cotta with cold **OR** hot, **as directed**, water applied by low-pressure spray.
   b. Apply alkaline prewash cleaner to terra cotta by brush or roller. Let cleaner remain on surface for period recommended by chemical-cleaner manufacturer unless otherwise indicated.
   c. Rinse with cold **OR** hot, **as directed**, water applied by medium-pressure spray to remove chemicals and soil.
   d. Apply acidic afterwash cleaner to terra cotta in two applications, **as directed**, while surface is still wet, using low-pressure spray equipment, deep-nap roller or soft-fiber brush. Let neutralizer remain on surface for period recommended by manufacturer unless otherwise indicated.
   e. Rinse with cold water applied by medium-pressure spray to remove chemicals and soil.
   f. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.

O. Repointing Masonry
1. Rake out and repoint joints to the following extent:
   a. All joints in areas indicated.
   b. Joints where mortar is missing or where they contain holes.
   c. Cracked joints where cracks can be penetrated at least 1/4 inch (6 mm) by a knife blade 0.027 inch (0.7 mm) thick.
   d. Cracked joints where cracks are 1/16 inch (1.6 mm) **OR** 1/8 inch (3 mm), **as directed**, or more in width and of any depth.
   e. Joints where they sound hollow when tapped by metal object.
   f. Joints where they are worn back 1/4 inch (6 mm) or more from surface.
   g. Joints where they are deteriorated to point that mortar can be easily removed by hand, without tools.
   h. Joints where they have been filled with substances other than mortar.
   i. Joints indicated as sealant-filled joints.
2. Do not rake out and repoint joints where not required.
3. Rake out joints as follows, according to procedures demonstrated in approved mockup:
   a. Remove mortar from joints to depth of joint width plus 1/8 inch (3 mm) **OR** 2 times joint width **OR** 2-1/2 times joint width, **as directed**,, but not less than 1/2 inch (13 mm) or not less than that required to expose sound, unweathered mortar.
   b. Remove mortar from masonry surfaces within raked-out joints to provide reveals with square backs and to expose masonry for contact with pointing mortar. Brush, vacuum, or flush joints to remove dirt and loose debris.
   c. Do not spall edges of masonry units or widen joints. Replace or patch damaged masonry units as directed by the Owner.
      1) Cut out mortar by hand with chisel and resilient mallet. Do not use power-operated grinders without the Owner's written approval based on approved quality-control program.
      2) Cut out center of mortar bed joints using angle grinders with diamond-impregnated metal blades. Remove remaining mortar by hand with chisel and resilient mallet. Strictly adhere to approved quality-control program.
4. Notify the Owner of unforeseen detrimental conditions including voids in mortar joints, cracks, loose masonry units, rotted wood, rusted metal, and other deteriorated items.
5. Pointing with Mortar:
   a. Rinse joint surfaces with water to remove dust and mortar particles. Time rinsing application so, at time of pointing, joint surfaces are damp but free of standing water. If rinse water dries, dampen joint surfaces before pointing.
   b. Apply pointing mortar first to areas where existing mortar was removed to depths greater than surrounding areas. Apply in layers not greater than 3/8 inch (9 mm) until a uniform depth is formed. Fully compact each layer thoroughly and allow it to become thumbprint hard before applying next layer.

c. After low areas have been filled to same depth as remaining joints, point all joints by placing mortar in layers not greater than 3/8 inch (9 mm). Fully compact each layer and allow to become thumbprint hard before applying next layer. Where existing masonry units have worn or rounded edges, slightly recess finished mortar surface below face of masonry to avoid widened joint faces. Take care not to spread mortar beyond joint edges onto exposed masonry surfaces or to featheredge the mortar.

d. When mortar is thumbprint hard, tool joints to match original appearance of joints as demonstrated in approved mockup. Remove excess mortar from edge of joint by brushing.

e. Cure mortar by maintaining in thoroughly damp condition for at least 72 consecutive hours including weekends and holidays.

1) Acceptable curing methods include covering with wet burlap and plastic sheeting, periodic hand misting, and periodic mist spraying using system of pipes, mist heads, and timers.

2) Adjust curing methods to ensure that pointing mortar is damp throughout its depth without eroding surface mortar.

f. Hairline cracking within the mortar or mortar separation at edge of a joint is unacceptable. Completely remove such mortar and repoint.

6. Pointing with Sealant:

a. After raking out, keep joints dry and free of mortar and debris.

b. Clean and prepare joint surfaces according to Division 07 Section "Joint Sealants". Prime joint surfaces unless sealant manufacturer recommends against priming. Do not allow primer to spill or migrate onto adjoining surfaces.

c. Fill sealant joints with specified joint sealant according to Division 07 Section "Joint Sealants" and the following:

1) Install cylindrical sealant backing beneath the sealant, except where space is insufficient. There, install bond-breaker tape.

2) Install sealant using only proven installation techniques that will ensure that sealant will be deposited in a uniform, continuous ribbon, without gaps or air pockets, and with complete wetting of the joint bond surfaces equally on both sides. Fill joint flush with surrounding masonry and matching the contour of adjoining mortar joints.

3) Install sealant as recommended by sealant manufacturer but within the following general limitations, measured at the center (thin) section of the bead:

a) Fill joints to a depth equal to joint width, but not more than 1/2 inch (13 mm) deep or less than 1/4 inch (6 mm) deep.

4) Immediately after first tooling, apply ground-mortar aggregate to sealant, gently pushing aggregate into the surface of sealant. Retool sealant to form smooth, uniform beads, slightly concave. Remove excess sealant and aggregate from surfaces adjacent to joint.

5) Do not allow sealant to overflow or spill onto adjoining surfaces, or to migrate into the voids of adjoining surfaces, particularly rough textures. Remove excess and spillage of sealant promptly as the work progresses. Clean adjoining surfaces by the means necessary to eliminate evidence of spillage, without damage to adjoining surfaces or finishes, as demonstrated in an approved mockup.

d. Cure sealant according to Division 07 Section "Joint Sealants".

7. Where repointing work precedes cleaning of existing masonry, allow mortar to harden at least 30 days before beginning cleaning work.

P. Final Cleaning

1. After mortar has fully hardened, thoroughly clean exposed masonry surfaces of excess mortar and foreign matter; use wood scrapers, stiff-nylon or -fiber brushes, and clean water, spray applied at low pressure.

a. Do not use metal scrapers or brushes.

b. Do not use acidic or alkaline cleaners.

2. Wash adjacent woodwork and other nonmasonry surfaces. Use detergent and soft brushes or cloths.

3. Clean mortar and debris from roof; remove debris from gutters and downspouts. Rinse off roof and flush gutters and downspouts.
4. Sweep and rake adjacent pavement and grounds to remove mortar and debris. Where necessary, pressure wash pavement surfaces to remove mortar, dust, dirt, and stains.

Q. Field Quality Control
1. Inspectors: Engage qualified independent inspectors to perform inspections and prepare test reports. Allow inspectors use of lift devices and scaffolding, as needed, to perform inspections.
2. the Owner's Project Representatives: the Owner will assign Project representatives to help carry out the Owner's responsibilities at the site, including observing progress and quality of portion of the Work completed. Allow the Owner's Project representatives use of lift devices and scaffolding, as needed, to observe progress and quality of portion of the Work completed.
3. Notify inspectors and the Owner's Project representatives in advance of times when lift devices and scaffolding will be relocated. Do not relocate lift devices and scaffolding until inspectors and the Owner's Project representatives have had reasonable opportunity to make inspections and observations of work areas at lift device or scaffold location.

END OF SECTION 04910

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Task	Specification	Specification Description
04930	04910	Clay Masonry Restoration And Cleaning

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Task	Specification	Specification Description
05140	01352	No Specification Required
05150	05500	Metal Fabrications
05180	01352	No Specification Required

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SECTION 05310 - STEEL DECK

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for steel deck. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Roof deck.
b. Acoustical roof deck.
c. Cellular roof deck.
d. Acoustical cellular roof deck.
e. Composite floor deck.
f. Electrified cellular floor deck.
g. Noncomposite form deck.
h. Noncomposite vented form deck.

C. Submittals
1. Product Data: For each type of deck, accessory, and product indicated.
2. LEED Submittal:
a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
1) Include statement indicating costs for each product having recycled content.
3. Shop Drawings: Show layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.
4. Product Certificates.
5. Welding certificates.
6. Field quality-control test and inspection reports.
7. Research/Evaluation Reports: For steel deck.

D. Quality Assurance
1. Welding: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."
2. Fire-Test-Response Characteristics: Where indicated, provide steel deck units identical to those tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.
a. Fire-Resistance Ratings: Indicated by design designations of applicable testing and inspecting agency.
b. Steel deck units shall be identified with appropriate markings of applicable testing and inspecting agency.
3. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."
4. Electrical Raceway Units: Provide UL-labeled cellular floor-deck units complying with UL 209 and listed in UL's "Electrical Construction Equipment Directory" for use with standard header ducts and outlets for electrical distribution systems.
5. FMG Listing: Provide steel roof deck evaluated by FMG and listed in its "Approval Guide, Building Materials" for Class 1 fire rating and Class 1-90 windstorm ratings.

6. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.

E. Delivery, Storage, And Handling
1. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
2. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.
a. Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.

1.2 PRODUCTS

A. Roof Deck
a. Steel Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 30, and with the following:
b. Prime-Painted Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), Grade 33 (230) **OR** 40 (275) **OR** 80 (550), **as directed**, minimum, shop primed with manufacturer's standard baked-on, rust-inhibitive primer.
1) Color: Manufacturer's standard **OR** Gray **OR** White **OR** Gray top surface with white underside, **as directed**.
c. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230) **OR** 40 (275) **OR** 80 (550), **as directed**, G60 (Z180) **OR** G90 (Z275), **as directed**, zinc coating.
d. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230) **OR** 40 (275) **OR** 80 (550), **as directed**, G60 (Z180) zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.
1) Color: Manufacturer's standard **OR** Gray **OR** White **OR** Gray top surface with white underside, **as directed**.
e. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Structural Steel (SS), Grade 33 (230) minimum, AZ50 (AZ150) aluminum-zinc alloy coating.
f. Deck Profile: As indicated **OR** Type NR, narrow rib **OR** Type IR, intermediate rib **OR** Type WR, wide rib **OR** Type 3DR, deep rib **OR** Long span, **as directed**.
g. Cellular Deck Profile: As indicated **OR** Type WR, wide rib **OR** Type 3DR, deep rib **OR** Long span, **as directed**, with bottom plate.
h. Profile Depth: As indicated **OR** 1-1/2 inches (38 mm) **OR** 2 inches (51 mm) **OR** 3 inches (76 mm) **OR** 4-1/2 inches (114 mm) **OR** 6 inches (152 mm) **OR** 7-1/2 inches (190 mm), **as directed**.
i. Design Uncoated-Steel Thickness: As indicated **OR** 0.0295 inch (0.75 mm) **OR** 0.0358 inch (0.91 mm) **OR** 0.0474 inch (1.20 mm) **OR** 0.0598 inch (1.52 mm) **OR** 0.0747 inch (1.90 mm), **as directed**.
j. Design Uncoated-Steel Thicknesses; Deck Unit/Bottom Plate: As indicated **OR** 0.0358/0.0358 inch (0.91/0.91 mm) **OR** 0.0358/0.0474 inch (0.91/1.20 mm) **OR** 0.0474/0.0474 inch (1.20/1.20 mm) **OR** 0.0474/0.0598 inch (1.20/1.52 mm) **OR** 0.0598/0.0474 inch (1.52/1.20 mm) **OR** 0.0598/0.0598 inch (1.52/1.52 mm), **as directed**.
k. Span Condition: As indicated **OR** Simple span **OR** Double span **OR** Triple span or more, **as directed**.
l. Side Laps: Overlapped **OR** Interlocking seam, **as directed**.

B. Acoustical Roof Deck
1. Acoustical Steel Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 30, and with the following:

a. Prime-Painted Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), Grade 33 (230) **OR** 40 (275) **OR** 80 (550), **as directed**, minimum, shop primed with manufacturer's standard baked-on, rust-inhibitive primer.
   1) Color: Manufacturer's standard **OR** Gray **OR** White **OR** Gray top surface with white underside, **as directed**.
b. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230) **OR** 40 (275) **OR** 80 (550), **as directed**, G60 (Z180) **OR** G90 (Z275), **as directed**, zinc coating.
c. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230) **OR** 40 (275) **OR** 80 (550), **as directed**, G60 (Z180) zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.
   1) Color: Manufacturer's standard **OR** Gray **OR** White **OR** Gray top surface with white underside, **as directed**.
d. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Structural Steel (SS), Grade 33 (230) minimum, AZ50 (AZ150) aluminum-zinc alloy coating.
e. Deck Profile: As indicated **OR** Type WR, wide rib **OR** Type 3DR, deep rib **OR** Long span, **as directed**.
f. Cellular Deck Profile: As indicated **OR** Type WR, wide rib **OR** Type 3DR, deep rib **OR** Long span, **as directed**, with bottom plate.
g. Profile Depth: As indicated **OR** 1-1/2 inches (38 mm) **OR** 2 inches (51 mm) **OR** 3 inches (76 mm) **OR** 4-1/2 inches (114 mm) **OR** 6 inches (152 mm) **OR** 7-1/2 inches (190 mm), **as directed**.
h. Design Uncoated-Steel Thickness: As indicated **OR** 0.0295 inch (0.75 mm) **OR** 0.0358 inch (0.91 mm) **OR** 0.0474 inch (1.20 mm) **OR** 0.0598 inch (1.52 mm), **as directed**.
i. Design Uncoated-Steel Thicknesses; Deck Unit/Bottom Plate: As indicated **OR** 0.0358/0.0358 inch (0.91/0.91 mm) **OR** 0.0358/0.0474 inch (0.91/1.20 mm) **OR** 0.0474/0.0358 inch (1.20/0.91 mm) **OR** 0.0474/0.0474 inch (1.20/1.20 mm) **OR** 0.0474/0.0598 inch (1.20/1.52 mm) **OR** 0.0598/0.0474 inch (1.52/1.20 mm) **OR** 0.0598/0.0598 inch (1.52/1.52 mm), **as directed**.
j. Span Condition: As indicated **OR** Simple span **OR** Double span **OR** Triple span or more, **as directed**.
k. Side Laps: Overlapped **OR** Interlocking seam**, as directed**.
l. Acoustical Perforations: Deck units with manufacturer's standard perforated vertical webs **OR** Cellular deck units with manufacturer's standard perforated flat-bottom plate welded to ribbed deck, **as directed**.
m. Sound-Absorbing Insulation: Manufacturer's standard premolded roll or strip of glass or mineral fiber.
   1) Factory install sound-absorbing insulation into cells of cellular deck.
   2) Installation of sound-absorbing insulation is specified in Division 05.
n. Acoustical Performance: NRC 0.65 **OR** 0.75 **OR** 0.80 **OR** 0.85 **OR** 0.90, **as directed**, tested according to ASTM C 423.

C. Composite Floor Deck
1. Composite Steel Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 30, with the minimum section properties indicated, and with the following:
   a. Prime-Painted Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), Grade 33 (230) **OR** 40 (275) **OR** 80 (550), **as directed**, minimum, with top surface phosphatized and unpainted and underside surface shop primed with manufacturers' standard gray **OR** white, **as directed**, baked-on, rust-inhibitive primer.
   b. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230), G30 (Z90) **OR** G60 (Z180) **OR** G90 (Z275), **as directed**, zinc coating.
   c. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230), G30 (Z90) **OR** G60 (Z180), **as directed**, zinc coating; with unpainted top surface and cleaned and pretreated bottom surface primed with manufacturer's standard gray **OR** white, **as directed**, baked-on, rust-inhibitive primer.

d. Profile Depth: 1-1/2 inches (38 mm) **OR** 2 inches (51 mm) **OR** 3 inches (76 mm) **OR** As indicated, **as directed**.
e. Design Uncoated-Steel Thickness: 0.0295 inch (0.75 mm) **OR** 0.0358 inch (0.91 mm) **OR** 0.0474 inch (1.20 mm) **OR** 0.0598 inch (1.52 mm), **as directed**.
f. Span Condition: As indicated **OR** Simple span **OR** Double span **OR** Triple span or more, a**s directed**.

D. Electrified Cellular Floor Deck
1. Electrified Cellular Floor Deck: Fabricate steel sheet cellular floor-deck panels, consisting of a ribbed top section welded to a lower flat-bottom sheet with interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck" in SDI Publication No. 30. Fabricate deck to the minimum section properties, width of panel, number and area of cells per panel indicated, and the following:
a. Cellular Deck Type: Composite **OR** Noncomposite, **as directed**.
b. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230), G60 (Z180) **OR** G90 (Z275), **as directed**, zinc coating.
c. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230), G60 (Z180) zinc coating; with underside surface cleaned, pretreated, and primed with manufacturer's standard gray **OR** white, **as directed**, baked-on, rust-inhibitive primer.
d. Profile Depth: 1-1/2 inches (38 mm) **OR** 2 inches (51 mm) **OR** 3 inches (76 mm) **OR** As indicated, **as directed**.
e. Design Uncoated-Steel Thicknesses; Deck Unit/Bottom Plate: 0.0358/0.0358 inch (0.91/0.91 mm) **OR** 0.0358/0.0474 inch (0.91/1.20 mm) **OR** 0.0358/0.0598 inch (0.91/1.52 mm) **OR** 0.0474/0.0358 inch (1.20/0.91 mm) **OR** 0.0474/0.0474 inch (1.20/1.20 mm) **OR** 0.0474/0.0598 inch (1.20/1.52 mm) **OR** 0.0598/0.0474 inch (1.52/1.20 mm) **OR** 0.0598/0.0598 inch (1.52/1.52 mm), **as directed**.
f. Span Condition: As indicated **OR** Simple span **OR** Double span **OR** Triple span or more, **as directed**.
g. Factory punch holes, of size and arrangement indicated, into each deck cell at preset inserts and header duct locations.

E. Noncomposite Form Deck
1. Noncomposite Steel Form Deck: Fabricate ribbed-steel sheet noncomposite form-deck panels to comply with "SDI Specifications and Commentary for Noncomposite Steel Form Deck," in SDI Publication No. 30, with the minimum section properties indicated, and with the following:
a. Uncoated Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), Grade 33 (230) **OR** 40 (275) **OR** 80 (550), **as directed**, minimum.
b. Prime-Painted Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), Grade 33 (230) **OR** 40 (275) **OR** 80 (550), **as directed**, minimum, with underside **OR** top and underside, **as directed**, surface shop primed with manufacturer's standard baked-on, rust-inhibitive primer.
1) Color: Manufacturer's standard **OR** Gray **OR** White **OR** Gray top surface with white underside, **as directed**.
c. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230) **OR** 40 (275) **OR** 80 (550), **as directed**, G30 (Z90) **OR** G60 (Z180) **OR** G90 (Z275), **as directed**, zinc coating.
d. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230) **OR** 80 (550), **as directed**, G60 (Z180) zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.
1) Color: Manufacturer's standard **OR** Gray **OR** White **OR** Gray top surface with white underside, **as directed**.
e. Profile Depth: 9/16 inch (14 mm) **OR** 15/16 inch (24 mm) **OR** 1-5/16 inches (33 mm) **OR** 1-1/2 inches (38 mm), **as directed**.

f. Design Uncoated-Steel Thickness: 0.0149 inch (0.38 mm) **OR** 0.0179 inch (0.45 mm) **OR** 0.0239 inch (0.61 mm) **OR** 0.0295 inch (0.75 mm) **OR** 0.0358 inch (0.91 mm) **OR** 0.0474 inch (1.20 mm) **OR** 0.0598 inch (1.52 mm), **as directed**.
g. Span Condition: As indicated **OR** Simple span **OR** Double span **OR** Triple span or more, **as directed**.
h. Side Laps: Overlapped **OR** Interlocking seam, **as directed**.

F. Noncomposite Vented Form Deck
1. Noncomposite Vented Steel Form Deck: Fabricate ribbed- and vented-steel sheet noncomposite form-deck panels to comply with "SDI Specifications and Commentary for Noncomposite Steel Form Deck," in SDI Publication No. 30, and with the following:
a. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230) **OR** 40 (275) **OR** 80 (550), **as directed**, G30 (Z90) **OR** G60 (Z180) **OR** G90 (Z275), **as directed**, zinc coating.
b. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230) **OR** 80 (550), **as directed**, G30 (Z90) **OR** G60 (Z180), **as directed**, zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.
1) Color: Manufacturer's standard **OR** Gray **OR** White **OR** Gray top surface with white underside, **as directed**.
c. Profile Depth: 9/16 inch (14 mm) **OR** 15/16 inch (24 mm) **OR** 1-5/16 inches (33 mm) **OR** 1-1/2 inches (38 mm), a**s directed**.
d. Design Uncoated-Steel Thickness: 0.0149 inch (0.38 mm) **OR** 0.0179 inch (0.45 mm) **OR** 0.0239 inch (0.61 mm) **OR** 0.0295 inch (0.75 mm) **OR** 0.0358 inch (0.91 mm) **OR** 0.0474 inch (1.20 mm) **OR** 0.0598 inch (1.52 mm), **as directed**.
e. Span Condition: As indicated **OR** Simple span **OR** Double span **OR** Triple span or more, **as directed**.
f. Side Laps: Overlapped **OR** Interlocking seam, **as directed**.
g. Vent Slot Area: Manufacturer's standard vent slots providing 1-1/2 percent open area.

G. Accessories
1. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
2. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
3. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 (4.8-mm) minimum diameter.
4. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
5. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), not less than 0.0359-inch (0.91-mm) design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
6. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), of same material and finish as deck, and of thickness and profile indicated **OR** recommended by SDI Publication No. 30 for overhang and slab depth, **as directed**.
7. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.
8. Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.
9. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0598 inch (1.52 mm) **OR** 0.0747 inch (1.90 mm), **as directed**, thick, with factory-punched hole of 3/8-inch (9.5-mm) minimum diameter.
10. Recessed Sump Pans: Single-piece steel sheet, 0.0747 inch (1.90 mm) thick, of same material and finish as deck, with 3-inch- (76-mm-) wide flanges and level **OR** sloped, **as directed**, recessed pans of 1-1/2-inch (38-mm) minimum depth. For drains, cut holes in the field.
11. Flat Sump Plate: Single-piece steel sheet, 0.0747 inch (1.90 mm) thick, of same material and finish as deck. For drains, cut holes in the field.

12. Galvanizing Repair Paint: ASTM A 780 **OR** SSPC-Paint 20 or DOD-P-21035, with dry film containing a minimum of 94 percent zinc dust by weight, **as directed**.
13. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

1.3 EXECUTION

A. Installation, General
1. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 30, manufacturer's written instructions, and requirements in this Section.
2. Install temporary shoring before placing deck panels, if required to meet deflection limitations.
3. Locate deck bundles to prevent overloading of supporting members.
4. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
   a. Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.
5. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
6. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
7. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
8. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
9. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

B. Roof-Deck Installation
1. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches (38 mm) long, and as follows:
   a. Weld Diameter: 5/8 inch (16 mm) **OR** 3/4 inch (19 mm), **as directed**, nominal.
   b. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds 18 inches (450 mm) apart, maximum **OR** 12 inches (305 mm) apart in the field of roof and 6 inches (150 mm) apart in roof corners and perimeter, based on roof-area definitions in FMG Loss Prevention Data Sheet 1-28 **OR** as indicated, **as directed**.
   c. Weld Washers: Install weld washers at each weld location.
2. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of 1/2 of the span or 18 inches (450 mm) **OR** 36 inches (910 mm), **as directed**, and as follows:
   a. Mechanically fasten with self-drilling, No. 10 (4.8-mm-) diameter or larger, carbon-steel screws.
   b. Mechanically clinch or button punch.
   c. Fasten with a minimum of 1-1/2-inch- (38-mm-) long welds.
3. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches (38 mm), with end joints as follows:
   a. End Joints: Lapped 2 inches (51 mm) minimum **OR** Butted **OR** Lapped 2 inches (51 mm) minimum or butted at Contractor's option, **as directed**.
4. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and weld **OR** mechanically fasten, **as directed**, flanges to top of deck. Space welds **OR** mechanical fasteners, **as directed**, not more than 12 inches (305 mm) apart with at least one weld **OR** fastener, **as directed**, at each corner.
   a. Install reinforcing channels or zees in ribs to span between supports and weld **OR** mechanically fasten, **as directed**.

5. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld **OR** Mechanically fasten, **as directed**, to substrate to provide a complete deck installation.
   a. Weld cover plates at changes in direction of roof-deck panels, unless otherwise indicated.
6. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.
7. Sound-Absorbing Insulation: Installation into topside ribs of deck as specified in Division 05.

C. Floor-Deck Installation
1. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:
   a. Weld Diameter: 5/8 inch (16 mm) **OR** 3/4 inch (19 mm), **as directed**, nominal.
   b. Weld Spacing: Weld edge ribs of panels at each support. Space additional welds an average of 12 inches (305 mm) apart, but not more than 18 inches (457 mm) apart.
      OR
      Weld Spacing: Space and locate welds as indicated.
   c. Weld Washers: Install weld washers at each weld location.
2. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of half of the span or 36 inches (910 mm), and as follows:
   a. Mechanically fasten with self-drilling, No. 10 (4.8-mm-) diameter or larger, carbon-steel screws.
   b. Mechanically clinch or button punch.
   c. Fasten with a minimum of 1-1/2-inch- (38-mm-) long welds.
3. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches (38 mm), with end joints as follows:
   a. End Joints: Lapped **OR** Butted, **as directed**.
4. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations, unless otherwise indicated.
5. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.
6. Electrified Cellular Floor Deck: Install cellular floor system with deck assembled from all-cellular units **OR** alternating cellular units with noncellular composite units **OR** units indicated, **as directed**.
7. Install piercing hanger tabs at 14 inches (355 mm) apart in both directions, within 9 inches (228 mm) of walls at ends, and not more than 12 inches (305 mm) from walls at sides, unless otherwise indicated.

D. Field Quality Control
1. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
2. Field welds will be subject to inspection.
3. Testing agency will report inspection results promptly and in writing to Contractor and the Owner.
4. Remove and replace work that does not comply with specified requirements.
5. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

E. Repairs And Protection
1. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
2. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces **OR** top surface, **as directed**, of prime-painted deck immediately after installation, and apply repair paint.
   a. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.

3. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION 05310

SECTION 05410 - STRUCTURAL STEEL

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for structural steel. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Structural steel.
   b. Prefabricated building columns.
   c. Grout.

C. Definitions
1. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."
2. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SLRS" or along grid lines designated as "SLRS" on Drawings, including columns, beams, and braces and their connections.
3. Heavy Sections: Rolled and built-up sections as follows:
   a. Shapes included in ASTM A 6/A 6M with flanges thicker than 1-1/2 inches (38 mm).
   b. Welded built-up members with plates thicker than 2 inches (50 mm).
   c. Column base plates thicker than 2 inches (50 mm).
4. Protected Zone: Structural members or portions of structural members indicated as "Protected Zone" on Drawings. Connections of structural and nonstructural elements to protected zones are limited.
5. Demand Critical Welds: Those welds, the failure of which would result in significant degradation of the strength and stiffness of the Seismic-Load-Resisting System and which are indicated as "Demand Critical" or "Seismic Critical" on Drawings.

D. Performance Requirements
1. Connections: Provide details of connections **OR** simple shear connections, **as directed**, required by the Contract Documents to be selected or completed by structural-steel fabricator, including comprehensive engineering design by a qualified professional engineer, **as directed**, to withstand loads indicated and comply with other information and restrictions indicated.
   a. Select and complete connections using schematic details indicated and AISC 360.
   b. Use LRFD; data are given at factored-load level **OR** ASD; data are given at service-load level, **as directed**.
2. Moment Connections: Type PR, partially **OR** FR, fully, **as directed**, restrained.
3. Construction: Moment frame **OR** Braced frame **OR** Shear wall system **OR** Combined system of moment frame and braced frame **OR** Combined system of moment frame and shear walls **OR** Combined system of braced frame and shear walls **OR** Combined system of moment frame, braced frame, and shear walls, **as directed**.

E. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:
   a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.

3. Shop Drawings: Show fabrication of structural-steel components.
   a. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
   b. Include embedment drawings.
   c. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
   d. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
   e. Identify members and connections of the seismic-load-resisting system.
   f. Indicate locations and dimensions of protected zones.
   g. Identify demand critical welds.
   h. For structural-steel connections indicated to comply with design loads, include structural design data signed and sealed by the qualified professional engineer responsible for their preparation, **as directed**.
4. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for each welded joint whether prequalified or qualified by testing **OR** qualified by testing, **as directed**, including the following:
   a. Power source (constant current or constant voltage).
   b. Electrode manufacturer and trade name, for demand critical welds.
5. Qualification Data: For qualified Installer **OR** fabricator **OR** professional engineer **OR** testing agency, **as directed**.
6. Welding certificates.
7. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
8. Mill test reports for structural steel, including chemical and physical properties.
9. Product Test Reports: For the following:
   a. Bolts, nuts, and washers including mechanical properties and chemical analysis.
   b. Direct-tension indicators.
   c. Tension-control, high-strength bolt-nut-washer assemblies.
   d. Shear stud connectors.
   e. Shop primers.
   f. Nonshrink grout.
10. Source quality-control reports.

F. Quality Assurance
1. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.
2. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category ACSE **OR** CSE, **as directed**.
3. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement P1 **OR** P2 **OR** P3, **as directed**, or SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."
4. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   a. Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.
5. Comply with applicable provisions of the following specifications and documents:
   a. AISC 303.
   b. AISC 341 and AISC 341s1.
   c. AISC 360.
   d. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
6. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
a. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.
2. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
a. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
b. Clean and relubricate bolts and nuts that become dry or rusty before use.
c. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

H. Coordination
1. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.
2. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.2 PRODUCTS

A. Structural-Steel Materials
1. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 **OR** 50, **as directed**, percent.
OR
Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than the following:
a. W-Shapes: 60 percent.
b. Channels, Angles, M **OR** S, **as directed**,-Shapes: 60 percent.
c. Plate and Bar: 25 percent.
d. Cold-Formed Hollow Structural Sections: 25 percent.
e. Steel Pipe: 25 percent.
f. All Other Steel Materials: 25 percent.
2. W-Shapes: ASTM A 992/A 992M **OR** ASTM A 572/A 572M, Grade 50 (345) **OR** ASTM A 529/A 529M, Grade 50 (345) **OR** ASTM A 913/A 913M, Grade 50 (345), **as directed**.
3. Channels, Angles, M **OR** S, **as directed**,-Shapes: ASTM A 36/A 36M **OR** ASTM A 572/A 572M, Grade 50 (345) **OR** ASTM A 529/A 529M, Grade 50 (345) **OR** ASTM A 913/A 913M, Grade 50 (345), **as directed**.
4. Plate and Bar: ASTM A 36/A 36M **OR** ASTM A 572/A 572M, Grade 50 (345) **OR** ASTM A 529/A 529M, Grade 50 (345), **as directed**.
5. Corrosion-Resisting Structural-Steel Shapes, Plates, and Bars: ASTM A 588/A 588M, Grade 50 (345).
6. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B **OR** C, **as directed**, structural tubing.
7. Corrosion-Resisting Cold-Formed Hollow Structural Sections: ASTM A 847/A 847M, structural tubing.
8. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.
a. Weight Class: Standard **OR** Extra strong **OR** Double-extra strong, **as directed**.
b. Finish: Black **OR** Galvanized **OR** Black except where indicated to be galvanized, **as directed**.

9. Steel Castings: ASTM A 216/A 216M, Grade WCB with supplementary requirement S11.
10. Steel Forgings: ASTM A 668/A 668M.
11. Welding Electrodes: Comply with AWS requirements.

B. Bolts, Connectors, And Anchors
1. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, (ASTM A 563M, Class 8S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers; all with plain finish.
   a. Direct-Tension Indicators: ASTM F 959, Type 325 (ASTM F 959M, Type 8.8), compressible-washer type with plain finish.
2. High-Strength Bolts, Nuts, and Washers: ASTM A 490 (ASTM A 490M), Type 1, heavy-hex steel structural bolts or tension-control, bolt-nut-washer assemblies with splined ends, **as directed**; ASTM A 563, Grade DH, (ASTM A 563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers with plain finish.
   a. Direct-Tension Indicators: ASTM F 959, Type 490 (ASTM F 959M, Type 10.9), compressible-washer type with plain finish.
3. Zinc-Coated High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH (ASTM A 563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers.
   a. Finish: Hot-dip zinc coating **OR** Mechanically deposited zinc coating, **as directed**.
   b. Direct-Tension Indicators: ASTM F 959, Type 325 (ASTM F 959M, Type 8.8), compressible-washer type with mechanically deposited zinc coating **OR** mechanically deposited zinc coating, baked epoxy-coated, **as directed**, finish.
4. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex **OR** round, **as directed**, head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.
   a. Finish: Plain **OR** Mechanically deposited zinc coating, **as directed**.
5. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.
6. Unheaded Anchor Rods: ASTM F 1554, Grade 36 **OR** ASTM F 1554, Grade 55, weldable **OR** ASTM A 354 **OR** ASTM A 449 **OR** ASTM A 572/A 572M, Grade 50 (345) **OR** ASTM A 36/A 36M, **as directed**.
   a. Configuration: Straight **OR** Hooked, **as directed**.
   b. Nuts: ASTM A 563 (ASTM A 563M) hex **OR** heavy-hex, **as directed**, carbon steel.
   c. Plate Washers: ASTM A 36/A 36M carbon steel.
   d. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened carbon steel.
   e. Finish: Plain **OR** Hot-dip zinc coating, ASTM A 153/A 153M, Class C **OR** Mechanically deposited zinc coating, ASTM B 695, Class 50, **as directed**.
7. Headed Anchor Rods: ASTM F 1554, Grade 36 **OR** ASTM F 1554, Grade 55, weldable **OR** ASTM A 354 **OR** ASTM A 449, **as directed**, straight.
   a. Nuts: ASTM A 563 (ASTM A 563M) hex **OR** heavy-hex, **as directed**, carbon steel.
   b. Plate Washers: ASTM A 36/A 36M carbon steel.
   c. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened carbon steel.
   d. Finish: Plain **OR** Hot-dip zinc coating, ASTM A 153/A 153M, Class C **OR** Mechanically deposited zinc coating, ASTM B 695, Class 50, **as directed**.
8. Threaded Rods: ASTM A 36/A 36M **OR** ASTM A 193/A 193M, Grade B7 **OR** ASTM A 354, Grade BD **OR** ASTM A 449 **OR** ASTM A 572/A 572M, Grade 50 (345), **as directed**.
   a. Nuts: ASTM A 563 (ASTM A 563M) hex **OR** heavy-hex, **as directed**, carbon steel.
   b. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened **OR** ASTM A 36/A 36M, **as directed**, carbon steel.
   c. Finish: Plain **OR** Hot-dip zinc coating, ASTM A 153/A 153M, Class C **OR** Mechanically deposited zinc coating, ASTM B 695, Class 50, **as directed**.
9. Clevises and Turnbuckles: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1035.
10. Eye Bolts and Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1030.

11. Sleeve Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1018.
12. Structural Slide Bearings: Low-friction assemblies, of configuration indicated, that provide vertical transfer of loads and allow horizontal movement perpendicular to plane of expansion joint while resisting movement within plane of expansion joint.
    a. Mating Surfaces: PTFE and PTFE **OR** PTFE and mirror-finished stainless steel, **as directed**.
    b. Coefficient of Friction: Not more than 0.03 **OR** 0.04 **OR** 0.05 **OR** 0.06 **OR** 0.10 **OR** 0.12, **as directed**.
    c. Design Load: Not less than 2,000 psi (13.7 MPa) **OR** 5,000 psi (34 MPa) **OR** 6,000 psi (41 MPa), **as directed**.
    d. Total Movement Capability: 2 inches (50 mm).

C. Primer
1. Primer: Comply with Division 07 OR Division 09 Section(s) "High-performance Coatings" **OR** Division 07 AND Division 09 Section(s) "High-performance Coatings", **as directed**.
   OR
   Primer: SSPC-Paint 25, Type I **OR** Type II, **as directed**, zinc oxide, alkyd, linseed oil primer.
   OR
   Primer: SSPC-Paint 25 BCS, Type I **OR** Type II, **as directed**, zinc oxide, alkyd, linseed oil primer.
   OR
   Primer: SSPC-Paint 23, latex primer.
   OR
   Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat, **as directed**.
2. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20 **OR** ASTM A 780, **as directed**.

D. Grout
1. Metallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.
2. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

E. Fabrication
1. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.
    a. Camber structural-steel members where indicated.
    b. Fabricate beams with rolling camber up.
    c. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
    d. Mark and match-mark materials for field assembly.
    e. If shop priming is required, complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
2. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
    a. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.
3. Bolt Holes: Cut, drill, mechanically thermal cut, **as directed**, or punch standard bolt holes perpendicular to metal surfaces.
4. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
5. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 1, "Solvent Cleaning" **OR** SSPC-SP 2, "Hand Tool Cleaning" **OR** SSPC-SP 3, "Power Tool Cleaning", **as directed**.
6. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

7. Steel Wall-Opening Framing: Select true and straight members for fabricating steel wall-opening framing to be attached to structural steel. Straighten as required to provide uniform, square, and true members in completed wall framing.
8. Welded Door Frames: Build up welded door frames attached to structural steel. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk machine screws, uniformly spaced not more than 10 inches (250 mm) o.c. unless otherwise indicated.
9. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.
    a. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning, **unless directed otherwise**.
    b. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
    c. Weld threaded nuts to framing and other specialty items indicated to receive other work.

F. Shop Connections
1. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
    a. Joint Type: Snug tightened **OR** Pretensioned **OR** Slip critical, **as directed**.
2. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M, **as directed**, for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
    a. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

G. Prefabricated Building Columns
1. Prefabricated building columns consisting of load-bearing structural-steel members protected by concrete fireproofing encased in an outer non-load-bearing steel shell.
2. Fire-Resistance Ratings: Provide prefabricated building column listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for ratings indicated, based on testing according to ASTM E 119.
    a. Fire-Resistance Rating: 4 hours **OR** 3 hours **OR** 2 hours **OR** As indicated, **as directed**.

H. Shop Priming
1. If shop priming is required, shop prime steel surfaces except the following:
    a. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches (50 mm).
    b. Surfaces to be field welded.
    c. Surfaces to be high-strength bolted with slip-critical connections.
    d. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
    e. Galvanized surfaces.
2. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
    a. SSPC-SP 2, "Hand Tool Cleaning."
    b. SSPC-SP 3, "Power Tool Cleaning."
    c. SSPC-SP 7/NACE No. 4, "Brush-Off Blast Cleaning."
    d. SSPC-SP 11, "Power Tool Cleaning to Bare Metal."
    e. SSPC-SP 14/NACE No. 8, "Industrial Blast Cleaning."
    f. SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
    g. SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning."
    h. SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning."
    i. SSPC-SP 8, "Pickling."
3. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5

mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
   a. Stripe paint corners, crevices, bolts, welds, and sharp edges.
   b. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.
4. Painting: Prepare steel and apply a one-coat, nonasphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils (0.038 mm).

I. Galvanizing
1. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.
   a. Fill vent and drain holes that will be exposed in the finished Work unless they will function as weep holes, by plugging with zinc solder and filing off smooth.
   b. Galvanize lintels, shelf angles, and welded door frames attached to structural-steel frame and located in exterior walls.

J. Source Quality Control
1. Testing Agency: Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.
   a. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
2. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.
3. Bolted Connections: Shop-bolted connections will be inspected **OR** tested and inspected, **as directed**, according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
4. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
   a. Liquid Penetrant Inspection: ASTM E 165.
   b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
   c. Ultrasonic Inspection: ASTM E 164.
   d. Radiographic Inspection: ASTM E 94.
5. In addition to visual inspection, shop-welded shear connectors will be tested and inspected according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
   a. Bend tests will be performed if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
   b. Tests will be conducted on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1/D1.1M.

1.3 EXECUTION

A. Examination
1. Verify, with steel Erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
   a. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in

intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

a. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

C. Erection

1. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
2. Base Bearing and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
   a. Set plates for structural members on wedges, shims, or setting nuts as required.
   b. Weld plate washers to top of baseplate.
   c. Snug-tighten **OR** Pretension, **as directed**, anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
   d. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts, **as directed**.
3. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
4. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
   a. Level and plumb individual members of structure.
   b. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
5. Splice members only where indicated.
6. Do not use thermal cutting during erection unless approved by the Owner. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.
7. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.
8. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

D. Field Connections

1. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
   a. Joint Type: Snug tightened **OR** Pretensioned **OR** Slip critical, **as directed**.
2. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M, **as directed**, for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
   a. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
   b. Remove backing bars or runoff tabs where indicated, back gouge, and grind steel smooth.
   c. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

E. Prefabricated Building Columns

1. Install prefabricated building columns to comply with AISC 360, manufacturer's written recommendations, and requirements of testing and inspecting agency that apply to the fire-resistance rating indicated.

F. Field Quality Control
   1. Testing Agency: Engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.
   2. Bolted Connections: Bolted connections will be inspected **OR** tested and inspected, **as directed**, according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
   3. Welded Connections: Field welds will be visually inspected according to AWS D1.1/D1.1M.
      a. In addition to visual inspection, field welds will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
         1) Liquid Penetrant Inspection: ASTM E 165.
         2) Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
         3) Ultrasonic Inspection: ASTM E 164.
         4) Radiographic Inspection: ASTM E 94.
   4. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
      a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
      b. Conduct tests on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1/D1.1M.
   5. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

G. Repairs And Protection
   1. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780.
   2. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
      a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

      OR

      Touchup Painting: Cleaning and touchup painting are specified in Division 07.

END OF SECTION 05410

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SECTION 05410a - COLD-FORMED METAL FRAMING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for cold-formed metal framing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Exterior load-bearing wall framing.
b. Interior load-bearing wall framing.
c. Exterior non-load-bearing wall framing.
d. Floor joist framing.
e. Roof trusses.
f. Roof rafter framing.
g. Ceiling joist framing.

C. Performance Requirements
1. Structural Performance: Provide cold-formed metal framing capable of withstanding design loads within limits and under conditions indicated.
a. Design Loads: **As directed.**
b. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
1) Exterior Load-Bearing Wall Framing: Horizontal deflection of 1/240 **OR** 1/360 **OR** 1/600 **OR** 1/720, **as directed**, of the wall height.
2) Interior Load-Bearing Wall Framing: Horizontal deflection of 1/240 **OR** 1/360, **as directed**, of the wall height under a horizontal load of 5 lbf/sq. ft. (239 Pa).
3) Exterior Non-Load-Bearing Framing: Horizontal deflection of 1/240 **OR** 1/360 **OR** 1/600 **OR** 1/720, **as directed**, of the wall height.
4) Floor Joist Framing: Vertical deflection of 1/480 for live loads and l/360 for total loads of the span.
5) Roof Trusses: Vertical deflection of 1/240 **OR** 1/360, **as directed**, of the span.
6) Scissor Roof Trusses: Horizontal deflection of 1-1/4 inches (32 mm) <Insert dimension> at reactions.
7) Roof Rafter Framing: Horizontal deflection of 1/240 **OR** 1/360, **as directed**, of the horizontally projected span.
8) Ceiling Joist Framing: Vertical deflection of 1/240 **OR** 1/360, **as directed**, of the span.
c. Design framing systems to provide for movement of framing members without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F (67 deg C).
d. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
1) Upward and downward movement of 1/2 inch (13 mm) **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**.
2. Cold-Formed Steel Framing, General: Design according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions."
a. Headers: Design according to AISI's "Standard for Cold-Formed Steel Framing - Header Design."

b. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.
c. Roof Trusses: Design according to AISI's "Standard for Cold-Formed Steel Framing - Truss Design."

D. Submittals
1. Product Data: For each type of product and accessory indicated.
2. LEED Submittal:
a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
1) Include statement indicating costs for each product having recycled content.
3. Shop Drawings: Show layout, spacings, sizes, thicknesses, and types of cold-formed metal framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
a. For cold-formed metal framing indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
4. Welding certificates.
5. Qualification data.
6. Product test reports.
7. Research/evaluation reports.

E. Quality Assurance
1. Engineering Responsibility: Preparation of Shop Drawings, design calculations, and other structural data by a qualified professional engineer.
2. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of cold-formed metal framing that are similar to those indicated for this Project in material, design, and extent.
3. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E 329 to conduct the testing indicated.
4. Product Tests: Mill certificates or data from a qualified independent testing agency**,** or in-house testing with calibrated test equipment, **as directed**, indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, ductility, and metallic-coating thickness.
5. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code--Steel," and AWS D1.3, "Structural Welding Code--Sheet Steel."
6. Fire-Test-Response Characteristics: Where indicated, provide cold-formed metal framing identical to that of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.
7. AISI Specifications and Standards: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" and its "Standard for Cold-Formed Steel Framing - General Provisions."
a. Comply with AISI's "Standard for Cold-Formed Steel Framing - Truss Design."
b. Comply with AISI's "Standard for Cold-Formed Steel Framing - Header Design."
8. Comply with AISI's "Standard for Cold-Formed Steel Framing - Prescriptive Method for One and Two Family Dwellings" as applicable.
9. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling.
2. Store cold-formed metal framing, protect with a waterproof covering, and ventilate to avoid condensation.

1.2 PRODUCTS

A. Materials
1. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
2. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:
a. Grade: ST33H (ST230H) **OR** ST50H (ST340H) **OR** As required by structural performance, **as directed**.
b. Coating: G60 (Z180), A60 (ZF180), AZ50 (AZ150), or GF30 (ZGF90) **OR** G90 (Z275) or equivalent, **as directed**.
3. Steel Sheet for Vertical Deflection **OR** Drift, **as directed**, Clips: ASTM A 653/A 653M, structural steel, zinc coated, of grade and coating as follows:
a. Grade: 50 (340), Class 1 or 2 **OR** As required by structural performance, **as directed**.
b. Coating: G90 (Z275).

B. Load-Bearing Wall Framing
1. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges.
2. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges.
3. Steel Box or Back-to-Back Headers: Manufacturer's standard C-shapes used to form header beams, of web depths indicated, punched, with stiffened flanges.
4. Steel Double-L Headers: Manufacturer's standard L-shapes used to form header beams, of web depths indicated.

C. Exterior Non-Load-Bearing Wall Framing
1. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges.
2. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges.
3. Vertical Deflection Clips: Manufacturer's standard bypass **OR** head, **as directed**, clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
4. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal and lateral loads and transfer them to the primary structure.
5. Double Deflection Tracks: Manufacturer's double, deep-leg, U-shaped steel tracks, consisting of nested inner and outer tracks; unpunched, with unstiffened flanges.
a. Outer Track: Of web depth to allow free vertical movement of inner track, with flanges designed to support horizontal and lateral loads and transfer them to the primary structure.
b. Inner Track: Of web depth indicated, and as follows:
6. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure.

D. Floor Joist Framing
1. Steel Joists: Manufacturer's standard C-shaped steel joists, of web depths indicated, unpunched, **OR** punched, **OR** punched, with enlarged service holes, **as directed**, with stiffened flanges, and as follows:
2. Steel Joist Track: Manufacturer's standard U-shaped steel joist track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:

E. Roof Trusses
1. Roof Truss Members:

a. Manufacturer's standard-shape steel sections.
OR
Manufacturer's standard C-shaped steel sections, of web depths indicated, unpunched, with stiffened flanges.

F. Roof-Rafter Framing
1. Steel Rafters: Manufacturer's standard C-shaped steel sections, of web depths indicated, unpunched, with stiffened flanges.
2. Built-up Members: Built-up members of manufacturer's standard C-shaped steel section, with stiffened flanges, nested into a U-shaped steel section joist track, with unstiffened flanges; unpunched; of web depths indicated.

G. Ceiling Joist Framing
1. Steel Ceiling Joists: Manufacturer's standard C-shaped steel sections, of web depths indicated, unpunched, **OR** punched with enlarged service holes, **as directed**, with stiffened flanges, and as follows:

H. Framing Accessories
1. Fabricate steel-framing accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.
2. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
a. Supplementary framing.
b. Bracing, bridging, and solid blocking.
c. Web stiffeners.
d. Anchor clips.
e. End clips.
f. Foundation clips.
g. Gusset plates.
h. Stud kickers, knee braces, and girts.
i. Joist hangers and end closures.
j. Hole reinforcing plates.
k. Backer plates.

I. Anchors, Clips, And Fasteners
1. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.
2. Anchor Bolts: ASTM F 1554, Grade 36 **OR** 55, **as directed**, threaded carbon-steel hex-headed bolts **OR** headless, hooked bolts **OR** headless bolts, with encased end threaded, **as directed**, and carbon-steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153/A 153M, Class C **OR** mechanically deposition according to ASTM B 695, Class 50, **as directed**.
3. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.
4. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing per ASTM E 1190 conducted by a qualified independent testing agency.
5. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.
a. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.
6. Welding Electrodes: Comply with AWS standards.

J. Miscellaneous Materials

1. Galvanizing Repair Paint: SSPC-Paint 20 or DOD-P-21035 **OR** ASTM A 780, **as directed**.
2. Cement Grout: Portland cement, ASTM C 150, Type I; and clean, natural sand, ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
3. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, and plasticizing and water-reducing agents, complying with ASTM C 1107, with fluid consistency and 30-minute working time.
4. Shims: Load bearing, high-density multimonomer plastic, nonleaching.
5. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch (6.4 mm) thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

K. Fabrication
1. Fabricate cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
   a. Fabricate framing assemblies using jigs or templates.
   b. Cut framing members by sawing or shearing; do not torch cut.
   c. Fasten cold-formed metal framing members by welding, screw fastening, clinch fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
      1) Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
      2) Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by not less than three exposed screw threads.
   d. Fasten other materials to cold-formed metal framing by welding, bolting, or screw fastening, according to Shop Drawings.
2. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.
3. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet (1:960) and as follows:
   a. Spacing: Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
   b. Squareness: Fabricate each cold-formed metal framing assembly to a maximum out-of-square tolerance of 1/8 inch (3 mm).

1.3 EXECUTION

A. Preparation
1. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.
2. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that are required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.
3. Install load bearing shims or grout between the underside of wall bottom track or rim track and the top of foundation wall or slab at stud or joist locations to ensure a uniform bearing surface on supporting concrete or masonry construction.
4. Install sealer gaskets to isolate the underside of wall bottom track or rim track and the top of foundation wall or slab at stud or joist locations.

B. Installation, General
1. Cold-formed metal framing may be shop or field fabricated for installation, or it may be field assembled.

2. Install cold-formed metal framing according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions" and to manufacturer's written instructions unless more stringent requirements are indicated.
3. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
   a. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch (1.6 mm).
4. Install cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened.
   a. Cut framing members by sawing or shearing; do not torch cut.
   b. Fasten cold-formed metal framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
      1) Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
      2) Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.
5. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.
6. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
7. Do not bridge building expansion and control joints with cold-formed metal framing. Independently frame both sides of joints.
8. Install insulation, specified in Division 07 Section "Building Insulation", in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.
9. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's standard punched openings.
10. Erection Tolerances: Install cold-formed metal framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet (1:960) and as follows:
    a. Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

C. Load-Bearing Wall Installation
1. Install continuous top and bottom tracks sized to match studs. Align tracks accurately and securely anchor at corners and ends, and at spacings as follows:
   a. Anchor Spacing: 24 inches (610 mm) **OR** 32 inches (813 mm) **OR** To match stud spacing **OR** As shown on Shop Drawings, **as directed**.
2. Squarely seat studs against top and bottom tracks with gap not exceeding of 1/8 inch (3 mm) between the end of wall framing member and the web of track. Fasten both flanges of studs to top and bottom tracks. Space studs as follows:
   a. Stud Spacing:
      1) 12 inches (305 mm) **OR** 16 inches (406 mm) **OR** 19.2 inches (488 mm) **OR** 24 inches (610 mm) **OR** As indicated, **as directed**.
      2) 300 mm **OR** 400 mm **OR** 600 mm **OR** As indicated, **as directed**.
3. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar configurations.
4. Align studs vertically where floor framing interrupts wall-framing continuity. Where studs cannot be aligned, continuously reinforce track to transfer loads.
5. Align floor and roof framing over studs. Where framing cannot be aligned, continuously reinforce track to transfer loads.
6. Anchor studs abutting structural columns or walls, including masonry walls, to supporting structure as indicated.

7. Install headers over wall openings wider than stud spacing. Locate headers above openings as indicated. Fabricate headers of compound shapes indicated or required to transfer load to supporting studs, complete with clip-angle connectors, web stiffeners, or gusset plates.
   a. Frame wall openings with not less than a double stud at each jamb of frame as indicated on Shop Drawings. Fasten jamb members together to uniformly distribute loads.
   b. Install runner tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with clip angles or by welding, and space jack studs same as full-height wall studs.
8. Install supplementary framing, blocking, and bracing in stud framing indicated to support fixtures, equipment, services, casework, heavy trim, furnishings, and similar work requiring attachment to framing.
   a. If type of supplementary support is not indicated, comply with stud manufacturer's written recommendations and industry standards in each case, considering weight or load resulting from item supported.
9. Install horizontal bridging in stud system, spaced 48 inches (1220 mm) **OR** as indicated **OR** as indicated on Shop Drawings, **as directed**. Fasten at each stud intersection.
   a. Bridging:
      1) Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs with a minimum of 2 screws into each flange of the clip angle for framing members up to 6 inches (150 mm) deep.
         OR
         Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
         OR
         Proprietary bridging bars installed according to manufacturer's written instructions.
10. Install steel sheet diagonal bracing straps to both stud flanges, terminate at and fasten to reinforced top and bottom tracks. Fasten clip-angle connectors to multiple studs at ends of bracing and anchor to structure.
11. Install miscellaneous framing and connections, including supplementary framing, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

D. Exterior Non-Load-Bearing Wall Installation
   1. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.
   2. Fasten both flanges of studs to bottom **OR** top and bottom, **as directed**, track, unless otherwise indicated. Space studs as follows:
      a. Stud Spacing:
         1) 12 inches (305 mm) **OR** 16 inches (406 mm) **OR** 19.2 inches (488 mm) **OR** 24 inches (610 mm) **OR** As indicated, **as directed**.
         2) 300 mm **OR** 400 mm **OR** 480 mm **OR** 600 mm **OR** As indicated, **as directed**.
   3. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.
   4. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
      a. Install single-leg deflection tracks and anchor to building structure.
      b. Install double deep-leg deflection tracks and anchor outer track to building structure.
      c. Connect vertical deflection clips to bypassing **OR** infill, **as directed**, studs and anchor to building structure.
      d. Connect drift clips to cold formed metal framing and anchor to building structure.
   5. Install horizontal bridging in wall studs, spaced in rows indicated on Shop Drawings but not more than 48 inches (1220 mm) apart. Fasten at each stud intersection.
      a. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches (305 mm) **OR** 18 inches (450 mm), **as directed**, of single deflection track. Install a combination of flat, taut, steel sheet straps of width and thickness indicated and stud or

stud-track solid blocking of width and thickness matching studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.

1) Install solid blocking at 96-inch (2440-mm) centers **OR** centers indicated **OR** centers indicated on Shop Drawings, **as directed**.

b. Bridging:

1) Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.

OR

Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.

OR

Proprietary bridging bars installed according to manufacturer's written instructions.

6. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, fasteners, and stud girts, to provide a complete and stable wall-framing system.

E. Joist Installation

1. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated on Shop Drawings.
2. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.
   a. Install joists over supporting frame with a minimum end bearing of 1-1/2 inches (38 mm).
   b. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections as indicated on Shop Drawings.
3. Space joists not more than 2 inches (51 mm) from abutting walls, and as follows:
   a. Joist Spacing:
      1) 12 inches (305 mm) **OR** 16 inches (406 mm) **OR** 19.2 inches (488 mm) **OR** 24 inches (610 mm) **OR** As indicated, **as directed**.
      2) 300 mm **OR** 400 mm **OR** 480 mm **OR** 600 mm **OR** As indicated, **as directed**.
4. Frame openings with built-up joist headers consisting of joist and joist track, nesting joists, or another combination of connected joists if indicated.
5. Install joist reinforcement at interior supports with single, short length of joist section located directly over interior support, with lapped joists of equal length to joist reinforcement, or as indicated **OR** as indicated on Shop Drawings, **as directed**.
   a. Install web stiffeners to transfer axial loads of walls above.
6. Install bridging at intervals indicated **OR** indicated on Shop Drawings, **as directed**. Fasten bridging at each joist intersection as follows:
   a. Bridging:
      1) Joist-track solid blocking of width and thickness indicated, secured to joist webs.

      OR

      Combination of flat, taut, steel sheet straps of width and thickness indicated and joist-track solid blocking of width and thickness indicated. Fasten flat straps to bottom flange of joists and secure solid blocking to joist webs.
7. Secure joists to load-bearing interior walls to prevent lateral movement of bottom flange.
8. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

F. Truss Installation

1. Install, bridge, and brace trusses according to Shop Drawings and requirements in this Section.
2. Truss Spacing:
   a. 16 inches (406 mm) **OR** 19.2 inches (488 mm) **OR** 24 inches (610 mm) **OR** 32 inches (813 mm) **OR** 48 inches (1220 mm) **OR** As indicated, **as directed**.
   b. 400 mm **OR** 480 mm **OR** 600 mm **OR** 800 mm **OR** 1200 mm, **as directed**.

3. Do not alter, cut, or remove framing members or connections of trusses.
4. Erect trusses with plane of truss webs plumb and parallel to each other, align, and accurately position at spacings indicated.
5. Erect trusses without damaging framing members or connections.
6. Align webs of bottom chords and load-bearing studs or continuously reinforce track to transfer loads to structure. Anchor trusses securely at all bearing points.
7. Install continuous bridging and permanently brace trusses as indicated on Shop Drawings and designed according to LGSEA's Technical Note 551e, "Design Guide for Permanent Bracing of Cold-Formed Steel Trusses," **as directed**.

G. Field Quality Control
1. Testing: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
2. Field and shop welds will be subject to testing and inspecting.
3. Testing agency will report test results promptly and in writing to Contractor and the Owner.
4. Remove and replace work where test results indicate that it does not comply with specified requirements.
5. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

H. Repairs And Protection
1. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed metal framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
2. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed metal framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 05410a

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Task	Specification	Specification Description
05410	03620	Plant-Precast Structural Concrete
05410	05500	Metal Fabrications

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SECTION 05500 - METAL FABRICATIONS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for metal fabrications. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary

1. Section Includes:
   a. Steel framing and supports for ceiling-hung toilet compartments.
   b. Steel framing and supports for operable partitions.
   c. Steel framing and supports for overhead doors and grilles.
   d. Steel framing and supports for countertops.
   e. Steel framing and supports for mechanical and electrical equipment.
   f. Steel framing and supports for applications where framing and supports are not specified in other Sections.
   g. Steel framing and supports (outriggers) for window-washing equipment including mounting brackets and anchorages.
      OR
      Mounting brackets and anchorages for window-washing equipment.
   h. Elevator machine beams, hoist beams, and divider beams.
   i. Steel shapes for supporting elevator door sills.
   j. Steel girders for supporting wood frame construction.
   k. Steel pipe columns for supporting wood frame construction.
   l. Prefabricated building columns.
   m. Shelf angles.
   n. Metal ladders.
   o. Ladder safety cages.
   p. Alternating tread devices.
   q. Metal ships' ladders and pipe crossovers.
   r. Metal floor plate and supports.
   s. Structural-steel door frames.
   t. Miscellaneous steel trim including steel angle corner guards, steel edgings, and loading-dock edge angles.
   u. Metal bollards.
   v. Pipe **OR** Downspout, **as directed**, guards.
   w. Abrasive metal nosings, treads, and thresholds.
   x. Cast-iron wheel guards.
   y. Metal downspout boots.
   z. Loose bearing and leveling plates for applications where they are not specified in other Sections.
2. Products furnished, but not installed, under this Section:
   a. Loose steel lintels.
   b. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
   c. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

C. Performance Requirements

1. Delegated Design: Design ladders and alternating tread devices, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Structural Performance of Aluminum Ladders: Aluminum ladders, including landings, shall withstand the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.
3. Structural Performance of Alternating Tread Devices: Alternating tread devices shall withstand the effects of loads and stresses within limits and under conditions specified in ICC's International Building Code.
4. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
   a. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

D. Submittals
1. Product Data: For the following:
   a. Nonslip aggregates and nonslip-aggregate surface finishes.
   b. Prefabricated building columns.
   c. Metal nosings and treads.
   d. Paint products.
   e. Grout.
2. LEED Submittals:
   a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: Indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content. Include statement indicating costs for each product having recycled content.
3. Shop Drawings: Show fabrication and installation details for metal fabrications.
   a. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
4. Samples: For each type and finish of extruded nosing and tread.
5. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
6. Qualification Data: For qualified professional engineer.
7. Mill Certificates: Signed by manufacturers of stainless-steel certifying that products furnished comply with requirements.
8. Welding certificates.
9. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

E. Quality Assurance
1. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. Welding Qualifications: Qualify procedures and personnel according to the following:
   a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   b. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
   c. AWS D1.6, "Structural Welding Code - Stainless Steel."

F. Project Conditions
1. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

G. Coordination

1. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
2. Coordinate installation of anchorages and steel weld plates and angles for casting into concrete. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.2 PRODUCTS

A. Metals, General
1. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Ferrous Metals
1. Recycled Content of Steel Products: Provide products with average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
2. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
3. Stainless-Steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666, Type 304 **OR** Type 316L, **as directed**.
4. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304 **OR** Type 316L, **as directed**.
5. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.
6. Rolled-Stainless-Steel Floor Plate: ASTM A 793.
7. Abrasive-Surface Floor Plate: Steel plate with abrasive granules rolled into surface or with abrasive material metallically bonded to steel.
8. Steel Tubing: ASTM A 500, cold-formed steel tubing.
9. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40) unless otherwise indicated.
10. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.
    a. Size of Channels: 1-5/8 by 1-5/8 inches (41 by 41 mm) **OR** As indicated, **as directed**.
    b. Material: Galvanized steel, ASTM A 653/A 653M, commercial steel, Type B **OR** structural steel, Grade 33 (Grade 230), **as directed**, with G90 (Z275) coating; 0.108-inch (2.8-mm) (12 gage) **OR** 0.079-inch (2-mm) (14 gage) **OR** 0.064-inch (1.6-mm) (16 gage), **as directed**, nominal thickness.
    OR
    Material: Cold-rolled steel, ASTM A 1008/A 1008M, commercial steel, Type B **OR** structural steel, Grade 33 (Grade 230), **as directed**; 0.0966-inch (2.5-mm) (12 gage) **OR** 0.0677-inch (1.7-mm) (14 gage) **OR** 0.0528-inch (1.35-mm) (16 gage), **as directed**, minimum thickness; unfinished **OR** coated with rust-inhibitive, baked-on, acrylic enamel **OR** hot-dip galvanized after fabrication, **as directed**.
11. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

C. Nonferrous Metals
1. Aluminum Plate and Sheet: ASTM B 209 (ASTM B 209M), Alloy 6061-T6.
2. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T6.
3. Aluminum-Alloy Rolled Tread Plate: ASTM B 632/B 632M, Alloy 6061-T6.
4. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.
5. Bronze Plate, Sheet, Strip, and Bars: ASTM B 36/B 36M, Alloy UNS No. C28000 (muntz metal, 60 percent copper).
6. Bronze Extrusions: ASTM B 455, Alloy UNS No. C38500 (extruded architectural bronze).
7. Bronze Castings: ASTM B 584, Alloy UNS No. C83600 (leaded red brass) or No. C84400 (leaded semired brass).

8. Nickel Silver Extrusions: ASTM B 151/B 151M, Alloy UNS No. C74500.
9. Nickel Silver Castings: ASTM B 584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).

D. Fasteners
1. General: Unless otherwise indicated, provide Type 304 **OR** Type 316, **as directed**, stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
   a. Provide stainless-steel fasteners for fastening aluminum.
   b. Provide stainless-steel fasteners for fastening stainless steel.
   c. Provide stainless-steel fasteners for fastening nickel silver.
   d. Provide bronze fasteners for fastening bronze.
2. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with hex nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.
3. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 325, Type 3 (ASTM A 325M, Type 3); with hex nuts, ASTM A 563, Grade C3 (ASTM A 563M, Class 8S3); and, where indicated, flat washers.
4. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F 593 (ASTM F 738M); with hex nuts, ASTM F 594 (ASTM F 836M); and, where indicated, flat washers; Alloy Group 1 (A1) **OR** Group 2 (A4), **as directed**.
5. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.
   a. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
6. Eyebolts: ASTM A 489.
7. Machine Screws: ASME B18.6.3 (ASME B18.6.7M).
8. Lag Screws: ASME B18.2.1 (ASME B18.2.3.8M).
9. Wood Screws: Flat head, ASME B18.6.1.
10. Plain Washers: Round, ASME B18.22.1 (ASME B18.22M).
11. Lock Washers: Helical, spring type, ASME B18.21.1 (ASME B18.21.2M).
12. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
13. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.
14. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.
   a. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.
   b. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 1 (A1) **OR** Group 2 (A4), **as directed**, stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).
15. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches (41 by 22 mm) by length indicated with anchor straps or studs not less than 3 inches (75 mm) long at not more than 8 inches (200 mm) o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.

E. Miscellaneous Materials
1. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

2. Shop Primers: Provide primers that comply with Division 07 OR Division 09 Section(s) "High-performance Coatings" **OR** Division 07 AND Division 09 Section(s) "High-performance Coatings", **as directed**.
3. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
   a. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
4. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
5. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
6. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
7. Nonshrink, Metallic Grout: Factory-packaged, ferrous-aggregate grout complying with ASTM C 1107, specifically recommended by manufacturer for heavy-duty loading applications.
8. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
9. Concrete: Comply with requirements in Division 03 Section "Cast-in-place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 3000 psi (20 MPa).

F. Fabrication, General
1. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
2. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
3. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
4. Form exposed work with accurate angles and surfaces and straight edges.
5. Weld corners and seams continuously to comply with the following:
   a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   b. Obtain fusion without undercut or overlap.
   c. Remove welding flux immediately.
   d. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
6. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
7. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
8. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
9. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
   a. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches (3.2 by 38 mm), with a minimum 6-inch (150-mm) embedment and 2-inch (50-mm) hook, not less than 8 inches (200 mm) from ends and corners of units and 24 inches (600 mm) o.c., unless otherwise indicated.

G. Miscellaneous Framing And Supports
1. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

2. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
   a. Fabricate units from slotted channel framing where indicated.
   b. Furnish inserts for units installed after concrete is placed.
3. Fabricate supports for operable partitions from continuous steel beams of sizes indicated **OR** recommended by partition manufacturer, **as directed**, with attached bearing plates, anchors, and braces as indicated **OR** recommended by partition manufacturer, **as directed**. Drill or punch bottom flanges of beams to receive partition track hanger rods; locate holes where indicated on operable partition Shop Drawings.
4. Fabricate steel girders for wood frame construction from continuous steel shapes of sizes indicated.
   a. Provide bearing plates welded to beams where indicated.
   b. Drill or punch girders and plates for field-bolted connections where indicated.
   c. Where wood nailers are attached to girders with bolts or lag screws, drill or punch holes at 24 inches (600 mm) o.c.
5. Fabricate steel pipe columns for supporting wood frame construction from steel pipe with steel baseplates and top plates as indicated. Drill or punch baseplates and top plates for anchor and connection bolts and weld to pipe with fillet welds all around. Make welds the same size as pipe wall thickness unless otherwise indicated.
   a. Unless otherwise indicated, fabricate from Schedule 40 steel pipe.
   b. Unless otherwise indicated, provide 1/2-inch (12.7-mm) baseplates with four 5/8-inch (16-mm) anchor bolts and 1/4-inch (6.4-mm) top plates.
6. Galvanize miscellaneous framing and supports where indicated.
   OR
   Prime miscellaneous framing and supports with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**, where indicated.

H. Prefabricated Building Columns
1. General: Provide prefabricated building columns consisting of load-bearing structural-steel members protected by concrete fireproofing encased in an outer non-load-bearing steel shell. Fabricate connections to comply with details shown or as needed to suit type of structure indicated.
2. Fire-Resistance Ratings: Provide prefabricated building columns listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for ratings indicated, based on testing according to ASTM E 119.
   a. Fire-Resistance Rating: 4 hours **OR** 3 hours **OR** 2 hours **OR** As indicated, **as directed**.

I. Shelf Angles
1. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch (19-mm) bolts, spaced not more than 6 inches (150 mm) from ends and 24 inches (600 mm) o.c., unless otherwise indicated.
   a. Provide mitered and welded units at corners.
   b. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches (50 mm) larger than expansion or control joint.
2. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.
3. Galvanize shelf angles located in exterior walls.
   OR
   Prime shelf angles located in exterior walls with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.
4. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

J. Metal Ladders

1. General:
   a. Comply with ANSI A14.3 unless otherwise indicated.
   b. For elevator pit ladders, comply with ASME A17.1.
2. Steel Ladders:
   a. Space siderails 16 inches (406 mm) **OR** 18 inches (457 mm), **as directed**, apart unless otherwise indicated.
   b. Space siderails of elevator pit ladders 12 inches (300 mm) apart.
   c. Siderails: Continuous, 3/8-by-2-1/2-inch (9.5-by-64-mm) **OR** 1/2-by-2-1/2-inch (12.7-by-64-mm), **as directed**, steel flat bars, with eased edges.
   d. Rungs: 3/4-inch- (19-mm-) diameter **OR** 3/4-inch- (19-mm-) square **OR** 1-inch- (25-mm-) diameter **OR** 1-inch- (25-mm-) square, **as directed**, steel bars.
   e. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
   f. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
   g. Provide nonslip surfaces on top of each rung by coating with abrasive material metallically bonded to rung.
   h. Provide platforms as indicated fabricated from welded or pressure-locked steel bar grating, supported by steel angles. Limit openings in gratings to no more than 1/2 inch (12 mm) **OR** 3/4 inch (19 mm), **as directed**, in least dimension.
   i. Support each ladder at top and bottom and not more than 60 inches (1500 mm) o.c. with welded or bolted steel brackets.
   j. Galvanize ladders **OR** exterior ladders, **as directed**, including brackets and fasteners.
      OR
      Prime ladders **OR** exterior ladders, **as directed**, including brackets and fasteners, with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.
3. Aluminum Ladders:
   a. Space siderails 16 inches (406 mm) **OR** 18 inches (457 mm), **as directed**, apart unless otherwise indicated.
   b. Siderails: Continuous extruded-aluminum channels or tubes, not less than 2-1/2 inches (64 mm) deep, 3/4 inch (19 mm) wide, and 1/8 inch (3.2 mm) thick.
   c. Rungs: Extruded-aluminum tubes, not less than 3/4 inch (19 mm) deep and not less than 1/8 inch (3.2 mm) thick, with ribbed tread surfaces.
   d. Fit rungs in centerline of siderails; fasten by welding or with stainless-steel fasteners or brackets and aluminum rivets.
   e. Provide platforms as indicated fabricated from pressure-locked aluminum bar grating or extruded-aluminum plank grating, supported by extruded-aluminum framing. Limit openings in gratings to no more than 1/2 inch (12 mm) **OR** 3/4 inch (19 mm), **as directed**, in least dimension.
   f. Support each ladder at top and bottom and not more than 60 inches (1500 mm) o.c. with welded or bolted aluminum brackets.
   g. Provide minimum 72-inch- (1830-mm-) high, hinged security door with padlock hasp at foot of ladder to prevent unauthorized ladder use.

K. Ladder Safety Cages
1. General:
   a. Fabricate ladder safety cages to comply with ANSI A14.3 **OR** 1996 BOCA Code **OR** OSHA regulations, **as directed**. Assemble by welding or with stainless-steel fasteners.
   b. Provide primary hoops at tops and bottoms of cages and spaced not more than 20 feet (6 m) o.c. Provide secondary intermediate hoops spaced not more than 48 inches (1200 mm) o.c. between primary hoops.
   c. Fasten assembled safety cage to ladder rails and adjacent construction by welding or with stainless-steel fasteners unless otherwise indicated.
2. Steel Ladder Safety Cages:
   a. Primary Hoops: 1/4-by-4-inch (6.4-by-100-mm) flat bar hoops.

b. Secondary Intermediate Hoops: 1/4-by-2-inch (6.4-by-50-mm) flat bar hoops.
c. Vertical Bars: 3/16-by-1-1/2-inch (4.8-by-38-mm) flat bars secured to each hoop.
d. Galvanize ladder safety cages, including brackets and fasteners.
OR
Prime ladder safety cages, including brackets and fasteners, with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.

3. Aluminum Ladder Safety Cages:
a. Primary Hoops: 1/4-by-4-inch (6.4-by-100-mm) flat bar hoops.
b. Secondary Intermediate Hoops: 1/4-by-2-inch (6.4-by-50-mm) flat bar hoops.
c. Vertical Bars: 1/4-by-2-inch (6.4-by-50-mm) flat bars secured to each hoop.

L. Alternating Tread Devices
1. Alternating Tread Devices: Fabricate alternating tread devices to comply with ICC's International Building Code. Fabricate of open-type construction with channel or plate stringers and pipe and tube railings unless otherwise indicated. Provide brackets and fittings for installation.
a. Fabricate from steel **OR** stainless steel **OR** aluminum, **as directed**, and assemble by welding or with stainless-steel fasteners.
b. Comply with applicable railing requirements in Division 05 Section "Pipe And Tube Railings".
2. Galvanize steel **OR** exterior steel, **as directed**, alternating tread devices, including treads, railings, brackets, and fasteners.
OR
Prime steel **OR** exterior steel, **as directed**, alternating tread devices, including treads, railings, brackets, and fasteners, with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.

M. Metal Ships' Ladders And Pipe Crossovers
1. Provide metal ships' ladders and pipe crossovers where indicated. Fabricate of open-type construction with channel or plate stringers and pipe and tube railings unless otherwise indicated. Provide brackets and fittings for installation.
a. Fabricate ships' ladders and pipe crossovers, including railings from steel **OR** stainless steel **OR** aluminum, **as directed**.
b. Fabricate treads **OR** treads and platforms, **as directed**, from welded or pressure-locked steel bar grating **OR** pressure-locked stainless-steel bar grating **OR** pressure-locked aluminum bar grating **OR** extruded-aluminum plank grating, **as directed**. Limit openings in gratings to no more than 1/2 inch (12 mm) **OR** 3/4 inch (19 mm), **as directed**, in least dimension.
c. Fabricate treads **OR** treads and platforms, **as directed**, from rolled-steel floor plate **OR** rolled-stainless-steel floor plate **OR** rolled-aluminum-alloy tread plate **OR** abrasive-surface floor plate, **as directed**.
d. Comply with applicable railing requirements in Division 5 Section "Pipe and Tube Railings."
2. Galvanize steel **OR** exterior steel, **as directed**, ships' ladders and pipe crossovers, including treads, railings, brackets, and fasteners.
OR
Prime steel **OR** exterior steel, **as directed**, ships' ladders and pipe crossovers, including treads, railings, brackets, and fasteners, with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.

N. Metal Floor Plate
1. Fabricate from rolled-steel floor **OR** rolled-stainless-steel floor **OR** rolled-aluminum-alloy tread **OR** abrasive-surface floor, **as directed**, plate of thickness indicated below:
a. Thickness: 1/8 inch (3.2 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/4 inch (6.4 mm) **OR** 5/16 inch (8 mm) **OR** 3/8 inch (9.5 mm) **OR** As indicated, **as directed**.
2. Provide grating sections where indicated fabricated from welded or pressure-locked steel bar grating **OR** pressure-locked stainless steel bar grating **OR** pressure-locked aluminum bar grating

OR extruded-aluminum plank grating, **as directed**. Limit openings in gratings to no more than 1/2 inch (12 mm) **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, in least dimension.

3. Provide steel **OR** stainless-steel **OR** aluminum, **as directed**, angle supports as indicated.
4. Include steel **OR** stainless-steel **OR** aluminum, **as directed**, angle stiffeners, and fixed and removable sections as indicated.
5. Provide flush steel **OR** stainless-steel **OR** aluminum, **as directed**, bar drop handles for lifting removable sections, one at each end of each section.

O. Structural-Steel Door Frames

1. Fabricate structural-steel door frames from steel shapes, plates, and bars of size and to dimensions indicated, fully welded together, with 5/8-by-1-1/2-inch (16-by-38-mm) steel channel stops, unless otherwise indicated. Plug-weld built-up members and continuously weld exposed joints. Secure removable stops to frame with countersunk machine screws, uniformly spaced at not more than 10 inches (250 mm) o.c. Reinforce frames and drill and tap as necessary to accept finish hardware.
   a. Provide with integrally welded steel strap anchors for securing door frames into adjoining concrete or masonry.
2. Extend bottom of frames to floor elevation indicated with steel angle clips welded to frames for anchoring frame to floor with expansion shields and bolts.
3. Galvanize steel **OR** exterior steel, **as directed**, frames.
   OR
   Prime steel **OR** exterior steel, **as directed**, frames with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.

P. Miscellaneous Steel Trim

1. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
2. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
   a. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.
3. Galvanize miscellaneous steel **OR** exterior miscellaneous steel, **as directed**, trim.
   OR
   Prime miscellaneous steel **OR** exterior miscellaneous steel, **as directed**, trim with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.

Q. Metal Bollards

1. Fabricate metal bollards from Schedule 40 steel pipe **OR** Schedule 80 steel pipe **OR** 1/4-inch (6.4-mm) wall-thickness rectangular steel tubing **OR** steel shapes, as indicated, **as directed**.
   a. Cap bollards with 1/4-inch- (6.4-mm-) thick steel plate (not required if bollards are concrete filled).
   b. Where bollards are indicated to receive controls for door operators, provide necessary cutouts for controls and holes for wire.
   c. Where bollards are indicated to receive light fixtures, provide necessary cutouts for fixtures and holes for wire.
2. Fabricate bollards with 3/8-inch- (9.5-mm-) thick steel baseplates for bolting to concrete slab (for mounting bollards on structural slab or on existing pavement). Drill baseplates at all four corners for 3/4-inch (19-mm) anchor bolts.
   a. Where bollards are to be anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.
3. Fabricate sleeves for bollard anchorage from steel pipe or tubing with 1/4-inch- (6.4-mm-) thick steel plate welded to bottom of sleeve. Make sleeves not less than 8 inches (200 mm) deep and 3/4 inch (19 mm) larger than OD of bollard.

4. Fabricate internal sleeves for removable bollards from Schedule 40 steel pipe or 1/4-inch (6.4-mm) wall-thickness steel tubing with an OD approximately 1/16 inch (1.5 mm) less than ID of bollards. Match drill sleeve and bollard for 3/4 inch (19 mm) steel machine bolt.
5. Prime bollards with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.

R. Pipe Or Downspout Guards
1. Fabricate pipe **OR** downspout, **as directed**, guards from 3/8-inch- (9.5-mm-) thick by 12-inch- (300-mm-) wide steel plate, bent to fit flat against the wall or column at both ends and to fit around pipe with 2-inch (50-mm) clearance between pipe and pipe guard. Drill each end for two 3/4-inch (19-mm) anchor bolts.
2. Galvanize pipe **OR** downspout, **as directed**, guards.
   OR
   Prime pipe **OR** downspout, **as directed**, guards with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.

S. Abrasive Metal Nosings, Treads And Thresholds
1. Cast-Metal Units: Cast iron **OR** aluminum **OR** bronze (leaded red or semired brass) **OR** nickel silver (leaded nickel bronze), **as directed**, with an integral-abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in lengths necessary to accurately fit openings or conditions.
   a. Nosings: Cross-hatched units, 4 inches (100 mm) wide with 1/4-inch (6-mm) **OR** 1-inch (25-mm), **as directed**, lip, for casting into concrete steps.
      OR
      Nosings: Cross-hatched units, 1-1/2 by 1-1/2 inches (38 by 38 mm), for casting into concrete curbs.
   b. Treads: Cross-hatched units, full depth of tread with 3/4-by-3/4-inch (19-by-19-mm) nosing, for application over bent plate treads or existing stairs.
   c. Thresholds: Fluted-saddle-type units, 5 inches (125 mm) wide by 1/2 inch (12 mm) high, with tapered edges.
      OR
      Thresholds: Fluted-interlocking- (hook-strip-) type units, 5 inches (125 mm) wide by 5/8 inch (16 mm) high, with tapered edge.
      OR
      Thresholds: Plain-stepped- (stop-) type units, 5 inches (125 mm) wide by 1/2 inch (12 mm) high, with 1/2-inch (12-mm) step.
2. Extruded Units: Aluminum **OR** Bronze, **as directed**, with abrasive filler consisting of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder. Fabricate units in lengths necessary to accurately fit openings or conditions.
   a. Provide ribbed units, with abrasive filler strips projecting 1/16 inch (1.5 mm) above aluminum extrusion.
      OR
      Provide solid-abrasive-type units without ribs.
   b. Nosings: Square-back units, 1-7/8 inches (48 mm) **OR** 3 inches (75 mm) **OR** 4 inches (100 mm), **as directed**, wide, for casting into concrete steps.
      OR
      Nosings: Beveled-back units, 3 inches (75 mm) **OR** 4 inches (100 mm), **as directed**, wide with 1-3/8-inch (35-mm) lip, for surface mounting on existing stairs.
      OR
      Nosings: Two-piece units, 3 inches (75 mm) wide, with subchannel for casting into concrete steps.
   c. Treads: Square **OR** Beveled, **as directed**,-back units, full depth of tread with 1-3/8-inch (35-mm) lip, for application over existing stairs.
3. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.

4. Drill for mechanical anchors and countersink. Locate holes not more than 4 inches (100 mm) from ends and not more than 12 inches (300 mm) o.c., evenly spaced between ends, unless otherwise indicated. Provide closer spacing if recommended by manufacturer.
   a. Provide two rows of holes for units more than 5 inches (125 mm) wide, with two holes aligned at ends and intermediate holes staggered.
5. Apply bituminous paint to concealed surfaces of cast-metal units.
6. Apply clear lacquer to concealed surfaces of extruded units.

T. Cast-Iron Wheel Guards
1. Provide wheel guards made from cast iron, 3/4 inch (19 mm) thick, hollow-core construction, of size and shape indicated. Provide holes for countersunk anchor bolts and grouting.
2. Prime cast iron wheel guards with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.

U. Metal Downspout Boots
1. Provide downspout boots made from cast iron **OR** cast aluminum, **as directed**, in heights indicated with inlets of size and shape to suit downspouts. Provide units with flanges and holes for countersunk anchor bolts.
   a. Outlet: Vertical, to discharge into pipe **OR** Horizontal, to discharge into pipe **OR** At 35 degrees from horizontal, to discharge onto splash block or pavement, **as directed**.
2. Prime cast iron downspout boots with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.

V. Loose Bearing And Leveling Plates
1. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
2. Galvanize plates.
   OR
   Prime plates with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.

W. Loose Steel Lintels
1. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.
2. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span but not less than 8 inches (200 mm) unless otherwise indicated.
3. Galvanize loose steel lintels located in exterior walls.
4. Prime loose steel lintels located in exterior walls with zinc-rich primer **OR** primer specified in Division 09 Section "High-performance Coatings", **as directed**.

X. Steel Weld Plates And Angles
1. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

Y. Finishes, General
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Finish metal fabrications after assembly.
3. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

Z. Steel And Iron Finishes

1. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
   a. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
2. Shop prime iron and steel items not indicated to be galvanized, **as directed**, unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
   a. Shop prime with universal shop primer **OR** primers specified in Division 07, **as directed**, unless zinc-rich primer is **OR** primers specified in Division 09 Section "High-performance Coatings" are, **as directed**, indicated.
3. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning" **OR** SSPC-SP 3, "Power Tool Cleaning" **OR** requirements indicated below, **as directed**:
   a. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   b. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   c. Items Indicated to Receive Primers Specified in Division 9 Section "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   d. Other Items: SSPC-SP 3, "Power Tool Cleaning."
4. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
   a. Stripe paint corners, crevices, bolts, welds, and sharp edges.

AA. Aluminum Finishes
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. As-Fabricated Finish: AA-M10 (Mechanical Finish: as fabricated, unspecified).
3. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

1.3 EXECUTION

A. Installation, General
1. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
2. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
3. Field Welding: Comply with the following requirements:
   a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   b. Obtain fusion without undercut or overlap.
   c. Remove welding flux immediately.
   d. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
4. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
5. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

6. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
   a. Cast Aluminum: Heavy coat of bituminous paint.
   b. Extruded Aluminum: Two coats of clear lacquer.

B. Installing Miscellaneous Framing And Supports
1. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
2. Anchor supports for operable partitions securely to and rigidly brace from building structure.
3. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.
   a. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.
4. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installing Bearing and Leveling Plates" Article.
   a. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

C. Installing Prefabricated Building Columns
1. Install prefabricated building columns to comply with AISC's "Specification for Structural Steel Buildings" and with requirements applicable to listing and labeling for fire-resistance rating indicated.

D. Installing Metal Bollards
1. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.
   a. Do not fill removable bollards with concrete.
2. Anchor bollards to existing construction with expansion anchors **OR** anchor bolts **OR** through bolts, **as directed**. Provide four 3/4-inch (19-mm) bolts at each bollard unless otherwise indicated.
   a. Embed anchor bolts at least 4 inches (100 mm) in concrete.
3. Anchor bollards in concrete with pipe sleeves preset and anchored into concrete **OR** in formed or core-drilled holes not less than 8 inches (200 mm) deep and 3/4 inch (19 mm) larger than OD of bollard, **as directed**. Fill annular space around bollard solidly with nonshrink, nonmetallic grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch (3 mm) toward bollard.
4. Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches (75 mm) above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.
5. Anchor internal sleeves for removable bollards in concrete by inserting into pipe sleeves preset into concrete **OR** formed or core-drilled holes not less than 8 inches (200 mm) deep and 3/4 inch (19 mm) larger than OD of sleeve, **as directed**. Fill annular space around internal sleeves solidly with nonshrink, nonmetallic grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch (3 mm) toward internal sleeve.
6. Anchor internal sleeves for removable bollards in place with concrete footings. Center and align sleeves in holes 3 inches (75 mm) above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace sleeves in position until concrete has cured.
7. Place removable bollards over internal sleeves and secure with 3/4-inch (19-mm) machine bolts and nuts. After tightening nuts, drill holes in bolts for inserting padlocks. Owner will furnish padlocks.
8. Fill bollards solidly with concrete, mounding top surface to shed water.
   a. Do not fill removable bollards with concrete.

E. Installing Pipe Guards

1. Provide pipe guards at exposed vertical pipes in parking garage where not protected by curbs or other barriers. Install by bolting to wall or column with expansion anchors. Provide four 3/4-inch (19-mm) bolts at each pipe guard. Mount pipe guards with top edge 26 inches (660 mm) above driving surface.

F. Installing Nosings, Treads, And Thresholds
1. Center nosings on tread widths unless otherwise indicated.
2. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.
3. Seal thresholds exposed to exterior with elastomeric sealant complying with Division 07 Section "Joint Sealants" to provide a watertight installation.

G. Installing Cast-Iron Wheel Guards
1. Anchor wheel guards to concrete or masonry construction to comply with manufacturer's written instructions. Fill cores solidly with concrete.

H. Installing Bearing And Leveling Plates
1. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
2. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.
   a. Use nonshrink grout, either metallic or nonmetallic, in concealed locations where not exposed to moisture; use nonshrink, nonmetallic grout in exposed locations unless otherwise indicated.
   b. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

I. Adjusting And Cleaning
1. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
   a. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.

   OR

   Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 07.
2. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 05500

Task	Specification	Specification Description
05501	05500	Metal Fabrications
05504	05500	Metal Fabrications
05505	05500	Metal Fabrications
05506	01352	No Specification Required
05506	05410a	Cold-Formed Metal Framing
05506	05500	Metal Fabrications
05507	05500	Metal Fabrications

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SECTION 05510 - METAL STAIRS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for metal stairs. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Preassembled steel stairs with concrete-filled, precast concrete, epoxy-resin-filled, and abrasive-coating-finished formed-metal treads.
b. Industrial-type stairs with steel floor plate and grating treads.
c. Ornamental steel-framed stairs.
d. Railings and Steel tube railings attached to metal stairs.
e. Handrails and Steel tube handrails attached to walls adjacent to metal stairs.
f. Railing gates at the level of exit discharge.

C. Performance Requirements
1. Delegated Design: Design metal stairs, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Structural Performance of Stairs: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.
a. The following are based on the 2006 International Building Code (IBC):
1) Uniform Load: 100 lbf/sq. ft. (4.79 kN/sq. m).
2) Concentrated Load: 300 lbf (1.33 kN) applied on an area of 4 sq. in. (2580 sq. mm).
3) Uniform and concentrated loads need not be assumed to act concurrently.
b. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above, **as applicable**.
c. Limit deflection of treads, platforms, and framing members to L/240 **OR** L/360, **as directed**, or 1/4 inch (6.4 mm), whichever is less. Preassembled steel stair manufacturers usually design stairs to L/240; retaining L/360 will decrease bounce and may be required to prevent cracking of plaster or gypsum board soffits. If brittle materials such as marble, granite, or ceramic tiles are used on treads and platforms, deflection limit should be reduced to L/720.
3. Structural Performance of Railings: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated. The following loads are based on the 2006 IBC.
a. Handrails and Top Rails of Guards:
1) Uniform load of 50 lbf/ ft. (0.73 kN/m) applied in any direction.
2) Concentrated load of 200 lbf (0.89 kN) applied in any direction.
3) Uniform and concentrated loads need not be assumed to act concurrently.
b. Infill of Guards:
1) Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
2) Infill load and other loads need not be assumed to act concurrently.
4. Seismic Performance: Metal stairs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
a. Component Importance Factor is 1.5.

D. Submittals
1. Product Data: For metal stairs and the following:

a. Prefilled metal-pan stair treads.
b. Precast concrete treads.
c. Epoxy-resin-filled stair treads.
d. Nonslip aggregates and nonslip-aggregate finishes.
e. Abrasive nosings.
f. Metal floor plate treads.
g. Paint products.
h. Grout.

2. LEED Submittals:
   a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: Indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content. Include statement indicating costs for each product having recycled content.
3. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
4. Samples: For the following products, in manufacturer's standard sizes:
   a. Precast concrete treads.
   b. Epoxy-resin-filled stair treads.
   c. Stair treads with nonslip-aggregate surface finish.
   d. Metal floor plate treads.
   e. Grating treads.
   f. Abrasive nosings.
5. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
6. Qualification Data: For qualified professional engineer **OR** testing agency, **as directed**.
7. Welding certificates.
8. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.
9. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for stairs and railings.
   a. Test railings according ASTM E 894 and ASTM E 935.

E. Quality Assurance
1. Installer Qualifications: Fabricator of products.
2. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," for class of stair designated, unless more stringent requirements are indicated.
   a. Preassembled Stairs:
      1) Commercial class - typical enclosed stair (welds are required to be smooth).
      2) Service class - economy enclosed stair.
   b. Industrial-Type Stairs: Industrial class - typical for exposed locations in industrial facilities or for exterior stairs.
   c. Ornamental Stairs: Architectural class - ornamental stairs in exposed locations (joints are required to be concealed to maximum extent possible).
3. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
4. Welding Qualifications: Qualify procedures and personnel according to the following:
   a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   b. AWS D1.3, "Structural Welding Code - Sheet Steel."

F. Coordination
1. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
2. Coordinate installation of anchorages for metal stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items

with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

3. Coordinate locations of hanger rods and struts with other work so that they will not encroach on required stair width and will be within the fire-resistance-rated stair enclosure.

1.2 PRODUCTS

A. Metals, General

1. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Ferrous Metals

1. Recycled Content of Steel Products: Provide products with average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
2. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
3. Steel Tubing: ASTM A 500 (cold formed) **OR** ASTM A 513, **as directed**.
4. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.
5. Abrasive-Surface Floor Plate: Steel plate with abrasive granules rolled into surface or with abrasive material metallically bonded to steel.
6. Steel Bars for Grating Treads: ASTM A 36/A 36M or steel strip, ASTM A 1011/A 1011M or ASTM A 1018/A 1018M.
7. Wire Rod for Grating Crossbars: ASTM A 510 (ASTM A 510M).
8. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.
9. Uncoated, Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, either commercial steel, Type B, or structural steel, Grade 25 (Grade 170), unless another grade is required by design loads; exposed.
10. Uncoated, Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, either commercial steel, Type B, or structural steel, Grade 30 (Grade 205), unless another grade is required by design loads.
11. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating, either commercial steel, Type B, or structural steel, Grade 33 (Grade 230), unless another grade is required by design loads.
12. Expanded-Metal, Carbon Steel: ASTM F 1267, Type I (expanded) **OR** Type II (expanded and flattened), **as directed**, Class 1 (uncoated).
    a. Style Designation: 3/4 number 13 **OR** 1-1/2 number 10, **as directed**.
13. Perforated Metal: Cold-rolled steel sheet, ASTM A 1008/A 1008M, or hot-rolled steel sheet, ASTM A 1011/A 1011M, commercial steel Type B, 0.060 inch (1.52 mm) thick, with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows **OR** with 1/8-by-1-inch (3.2-by-25.4-mm) round end slotted holes in staggered rows, **as directed**.
14. Perforated Metal: Galvanized-steel sheet, ASTM A 653/A 653M, G90 (Z275) coating, commercial steel Type B, 0.064 inch (1.63 mm) thick, with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows.
15. Woven-Wire Mesh: Intermediate-crimp, diamond **OR** square, **as directed**, pattern, 2-inch (50-mm) woven-wire mesh, made from 0.135-inch (3.5-mm) nominal diameter wire complying with ASTM A 510 (ASTM A 510M).

C. Nonferrous Metals

1. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T6.
2. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.
3. Bronze Extrusions: ASTM B 455, Alloy UNS No. C38500 (extruded architectural bronze).
4. Bronze Castings: ASTM B 584, Alloy UNS No. C83600 (leaded red brass) or No. C84400 (leaded semired brass).

5. Nickel Silver Castings: ASTM B 584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).

D. Abrasive Nosings
1. Cast-Metal Units: Cast iron **OR** aluminum **OR** bronze **OR** nickel silver, **as directed**, with an integral abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in lengths necessary to accurately fit openings or conditions.
   a. Configuration: Cross-hatched units, 3 inches (75 mm) **OR** 4 inches (100 mm), **as directed**, wide without lip.
      OR
      Configuration: Cross-hatched angle-shaped units, same depth as bar-grating treads and 1 to 1-1/2 inches (25 to 38 mm) wide.
2. Extruded Units: Aluminum **OR** Bronze, **as directed**, units with abrasive filler consisting of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder. Fabricate units in lengths necessary to accurately fit openings or conditions.
   a. Provide ribbed units, with abrasive filler strips projecting 1/16 inch (1.5 mm) above aluminum extrusion.
      OR
      Provide solid-abrasive-type units without ribs.
   b. Nosings: Square-back units, 1-7/8 inches (48 mm) **OR** 3 inches (75 mm) **OR** 4 inches (100 mm), **as directed**, wide, without lip.
      OR
      Nosings: Two-piece units, 3 inches (75 mm) wide, with subchannel for casting into concrete.
3. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.
4. Apply bituminous paint to concealed surfaces of cast-metal units set into concrete.
5. Apply clear lacquer to concealed surfaces of extruded units set into concrete.

E. Fasteners
1. General: Provide zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5 where built into exterior walls. Select fasteners for type, grade, and class required.
2. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with hex nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.
3. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.
   a. Provide mechanically deposited or hot-dip, zinc-coated anchor bolts for exterior stairs **OR** stairs indicated to be galvanized **OR** stairs indicated to be shop primed with zinc-rich primer, **as directed**.
4. Machine Screws: ASME B18.6.3 (ASME B18.6.7M).
5. Lag Screws: ASME B18.2.1 (ASME B18.2.3.8M).
6. Plain Washers: Round, ASME B18.22.1 (ASME B18.22M).
7. Lock Washers: Helical, spring type, ASME B18.21.1 (ASME B18.21.2M).
8. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
   a. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.
   b. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 1 (A1) **OR** Group 2 (A4), **as directed**, stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

F. Miscellaneous Materials

1. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
2. Shop Primers: Provide primers that comply with Division 07 OR Division 09 Section(s) "High-performance Coatings" **OR** Division 07 AND Division 09 Section(s) "High-performance Coatings", **as directed**.
3. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
   a. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
4. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
5. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
6. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
7. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
8. Concrete Materials and Properties: Comply with requirements in Division 3 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi (20 MPa) unless otherwise indicated.
9. Nonslip-Aggregate Concrete Finish: Factory-packaged abrasive aggregate made from fused, aluminum-oxide grits or crushed emery; rustproof and nonglazing; unaffected by freezing, moisture, or cleaning materials.
10. Welded Wire Fabric: ASTM A 185/A 185M, 6 by 6 inches (152 by 152 mm), W1.4 by W1.4, unless otherwise indicated.

G. Precast Concrete Treads
1. Concrete Materials and Properties: Comply with requirements in Division 03 Section "Cast-in-place Concrete" for normal-weight, ready-mixed concrete with a minimum 28-day compressive strength of 5000 psi (35 MPa) and a total air content of not less than 4 percent or more than 6 percent.
2. Reinforcing Wire Fabric: Galvanized, welded wire fabric, 2 by 2 inches (50 by 50 mm) by 0.062-inch- (1.6-mm-) diameter wire; comply with ASTM A 185/A 185M and ASTM A 82/A 82M, except for minimum wire size.

H. Fabrication, General
1. Provide complete stair assemblies, including metal framing, hangers, struts, railings, **as directed**, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.
   a. Join components by welding unless otherwise indicated.
   b. Use connections that maintain structural value of joined pieces.
   c. Fabricate treads and platforms of exterior stairs so finished walking surfaces slope to drain.
2. Preassembled Stairs: Assemble stairs in shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
3. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
4. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
5. Form exposed work with accurate angles and surfaces and straight edges.
6. Weld connections to comply with the following:
   a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   b. Obtain fusion without undercut or overlap.
   c. Remove welding flux immediately.
   d. Weld exposed corners and seams continuously unless otherwise indicated.

e. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 welds: no evidence of a welded joint **OR** Type 2 welds: completely sanded joint, some undercutting and pinholes okay **OR** Type 3 welds: partially dressed weld with spatter removed **OR** Type 4 welds: good quality, uniform undressed weld with minimal splatter, **as directed**.

7. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated. Locate joints where least conspicuous.
8. Fabricate joints that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

I. Steel-Framed Stairs
1. Stair Framing:
   a. Fabricate stringers of steel plates **OR** channels **OR** tubes, **as directed**.
      1) Provide closures for exposed ends of channel **OR** tube, **as directed**, stringers.
   b. Construct platforms of steel plate **OR** channel **OR** tube, **as directed**, headers and miscellaneous framing members as needed to comply with performance requirements **OR** indicated, **as directed**.
   c. Weld or bolt, **as directed**, stringers to headers; weld or bolt, **as directed**, framing members to stringers and headers. If using bolts, fabricate and join so bolts are not exposed on finished surfaces.
   d. Where stairs are enclosed by gypsum board **OR** gypsum board shaft-wall, **as directed**, assemblies, provide hanger rods or struts to support landings from floor construction above or below. Locate hanger rods and struts where they will not encroach on required stair width and will be within the fire-resistance-rated stair enclosure.
   e. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.
2. Metal-Pan Stairs: Form risers, subtread pans, and subplatforms to configurations shown from steel sheet of thickness needed to comply with performance requirements but not less than 0.067 inch (1.7 mm) **OR** indicated, **as directed**.
   a. Steel Sheet: Uncoated cold **OR** hot, **as directed**,-rolled steel sheet unless otherwise indicated.
      OR
      Steel Sheet: Galvanized-steel sheet, where indicated.
   b. Directly weld metal pans to stringers; locate welds on top of subtreads where they will be concealed by concrete fill. Do not weld risers to stringers.
      OR
      Attach risers and subtreads to stringers with brackets made of steel angles or bars. Weld brackets to stringers and attach metal pans to brackets by welding, riveting, or bolting.
   c. Shape metal pans to include nosing integral with riser.
   d. Attach abrasive nosings to risers.
   e. At Contractor's option, provide stair assemblies with metal-pan subtreads filled with reinforced concrete during fabrication.
   f. Provide epoxy-resin-filled treads, reinforced with glass fibers, with slip-resistant, abrasive surface.
   g. Provide subplatforms of configuration indicated or, if not indicated, the same as subtreads. Weld subplatforms to platform framing.
      1) Smooth Soffit Construction: Construct subplatforms with flat metal under surfaces to produce smooth soffits.
3. Abrasive-Coating-Finished, Formed-Metal Stairs: Form risers, treads, and platforms to configurations shown from steel sheet of thickness needed to comply with performance requirements but not less than 0.097 inch (2.5 mm) **OR** indicated, **as directed**.
   a. Steel Sheet: Uncoated hot-rolled steel sheet unless otherwise indicated.
   b. Directly weld risers and treads to stringers; locate welds on underside of stairs.

c. Provide platforms of configuration indicated or, if not indicated, the same as treads. Weld platforms to platform framing.
d. Finish tread and platform surfaces with manufacturer's standard epoxy-bonded abrasive finish.

4. Metal Floor Plate Stairs: Form treads and platforms to configurations shown from rolled-steel **OR** abrasive-surface, **as directed**, floor plate of thickness needed to comply with performance requirements, but not less than 1/4 inch (6.4 mm) **OR** needed to comply with performance requirements, but not less than 3/16 inch (4.8 mm) **OR** needed to comply with performance requirements, but not less than 1/8 inch (3.2 mm) **OR** indicated, **as directed**.
   a. Form treads with integral nosing and back edge stiffener. Form risers of same material as treads.
      OR
      Form treads with integral nosing and back edge stiffener. Form risers from steel sheet not less than 0.097 inch (2.5 mm) thick, welded to tread nosings and stiffeners and to platforms.
      OR
      Form treads with integral nosing and back edge stiffener, and with open risers.
   b. Weld steel supporting brackets to stringers and weld treads to brackets.
   c. Fabricate platforms with integral nosings matching treads and weld to platform framing.
5. Metal Bar-Grating Stairs: Form treads and platforms to configurations shown from metal bar grating; fabricate to comply with NAAMM MBG 531, "Metal Bar Grating Manual."
   a. Fabricate treads and platforms from welded or pressure-locked steel grating with 1-1/4-by-3/16-inch (32-by-5-mm) bearing bars at 15/16 inch (24 mm) o.c. **OR** 1-by-3/16-inch (25-by-5-mm) bearing bars at 11/16 inch (17 mm) o.c. **OR** 1-by-1/8-inch (25-by-3-mm) bearing bars at 7/16 inch (11 mm) o.c., **as directed**, and crossbars at 4 inches (100 mm) o.c.
      OR
      Fabricate treads and platforms from welded or pressure-locked steel grating with openings in gratings no more than 5/16 inch (8 mm) **OR** 1/2 inch (12 mm) **OR** 3/4 inch (19 mm), **as directed**, in least dimension.
   b. Surface: Plain **OR** Serrated, **as directed**.
   c. Finish: Shop primed **OR** Painted **OR** Galvanized, **as directed**.
   d. Fabricate grating treads with rolled-steel floor plate **OR** cast abrasive, **as directed**, nosing and with steel angle or steel plate carrier at each end for stringer connections. Secure treads to stringers with bolts.
   e. Fabricate grating platforms with nosing matching that on grating treads. Provide toeplates at open-sided edges of grating platforms. Weld grating to platform framing.

J. Stair Railings
1. Comply with applicable requirements in Division 05 Section(s) "Pipe And Tube Railings" OR "Ornamental Railings", **as directed**.
   a. Fabricate newels of square steel tubing and provide newel caps of pressed steel **OR** gray-iron castings, **as directed**, as shown.
   b. Rails may be bent at corners, rail returns, and wall returns, instead of using prefabricated fittings.
   c. Connect posts to stair framing by direct welding unless otherwise indicated.
2. Steel Tube Railings: Fabricate railings to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of tube, post spacings, and anchorage, but not less than that needed to withstand indicated loads.
   a. Rails and Posts: 1-5/8-inch- (41-mm-) diameter **OR** 1-1/2-inch- (38-mm-) square, **as directed**, top and bottom rails and 1-1/2-inch- (38-mm-) square posts.
   b. Picket Infill: 1/2-inch- (13-mm-) square pickets spaced less than 4 inches (100 mm) clear.
   c. Expanded-Metal Infill: Expanded-metal panels edged with U-shaped channels made from steel sheet not less than 0.043 inch (1.1 mm) thick. Orient expanded metal with long dimension of diamonds parallel to top rail **OR** perpendicular to top rail **OR** vertical, **as directed**.

d. Perforated-Metal Infill: Perforated-metal panels edged with U-shaped channels made from metal sheet, of same metal as perforated metal and not less than 0.043 inch (1.1 mm) thick. Orient perforated metal with pattern parallel to top rail **OR** perpendicular to top rail **OR** horizontal **OR** vertical **OR** as indicated on Drawings, **as directed**.

e. Mesh Infill: Woven wire mesh crimped into 1-by-1/2-by-1/8-inch (25-by-13-by-3-mm) steel channel frames. Orient wire mesh with diamonds vertical **OR** wires perpendicular and parallel to top rail **OR** wires horizontal and vertical, **as directed**.

f. Intermediate Rails Infill: 1-5/8-inch- (41-mm-) diameter **OR** 1-1/2-inch- (38-mm-) square, **as directed**, intermediate rails spaced less than 12 inches (305 mm) **OR** 21 inches (533 mm), **as directed**, clear.

g. Gates: Form gates from steel tube of same size and shape as top rails, with infill to match guards. Provide with cam-type, self-closing **OR** spring, **as directed**, hinges for fastening to wall and overlapping stop with rubber bumper to prevent gate from opening in direction opposite egress.

3. Welded Connections: Fabricate railings with welded connections. Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
   a. Finish welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 welds: no evidence of a welded joint **OR** Type 2 welds: completely sanded joint, some undercutting and pinholes okay **OR** Type 3 welds: partially dressed weld with spatter removed **OR** Type 4 welds: good quality, uniform undressed weld with minimal splatter, **as directed**.
4. Form changes in direction of railings as follows:
   a. As detailed.
      OR
      By bending or by inserting prefabricated elbow fittings.
      OR
      By flush bends or by inserting prefabricated flush-elbow fittings.
      OR
      By radius bends of radius indicated or by inserting prefabricated elbow fittings of radius indicated.
      OR
      By inserting prefabricated elbow fittings **OR** flush-elbow fittings **OR** elbow fittings of radius indicated, **as directed**.
5. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
6. Close exposed ends of railing members with prefabricated end fittings.
7. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch (6 mm) or less.
8. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting components and for attaching to other work. Furnish inserts and other anchorage devices for connecting to concrete or masonry work.
   a. Connect posts to stair framing by direct welding unless otherwise indicated.
   b. For galvanized railings, provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous-metal components.
   c. For nongalvanized railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors embedded in exterior masonry and concrete construction.
9. Fillers: Provide fillers made from steel plate, or other suitably crush-resistant material, where needed to transfer wall bracket loads through wall finishes to structural supports. Size fillers to suit wall finish thicknesses and to produce adequate bearing area to prevent bracket rotation and overstressing of substrate.

K. Finishes

1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Finish metal stairs after assembly.
3. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
   a. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
   b. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
4. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning" **OR** SSPC-SP 3, "Power Tool Cleaning" **OR** minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed products, **as directed**:
   a. Exterior Stairs: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   b. Interior Stairs: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning" for stairs that are to receive zinc-rich primer or primer specified in Division 09 Section "High-performance Coatings".
      OR
      Interior Stairs: SSPC-SP 3, "Power Tool Cleaning."
5. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
   a. Stripe paint corners, crevices, bolts, welds, and sharp edges.

1.3 EXECUTION

A. Installation, General
1. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.
2. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.
3. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.
4. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
5. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
6. Field Welding: Comply with requirements for welding in "Fabrication, General" Article.
7. Place and finish concrete fill for treads and platforms to comply with Division 03 Section "Cast-in-place Concrete"
   a. Install abrasive nosings with anchors fully embedded in concrete. Center nosings on tread width.
8. Install precast concrete treads with adhesive supplied by manufacturer.

B. Installing Metal Stairs With Grouted Baseplates
1. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of baseplates.
2. Set steel stair baseplates on wedges, shims, or leveling nuts. After stairs have been positioned and aligned, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.

a. Use nonmetallic, nonshrink grout unless otherwise indicated.
b. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

C. Installing Railings
1. Adjust railing systems before anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated or, if not indicated, as required by design loads. Plumb posts in each direction. Secure posts and rail ends to building construction as follows:
a. Anchor posts to steel by welding directly to steel supporting members.
b. Anchor handrail ends to concrete and masonry with steel round flanges welded to rail ends and anchored with postinstalled anchors and bolts.
2. Attach handrails to wall with wall brackets. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt **OR** with predrilled hole for exposed bolt anchorage, **as directed**. Provide bracket with 1-1/2-inch (38-mm) clearance from inside face of handrail and finished wall surface. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads. Secure wall brackets to building construction as required to comply with performance requirements **OR** as follows, **as directed**:
a. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
b. For hollow masonry anchorage, use toggle bolts.
c. For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.
d. For steel-framed partitions, use hanger or lag bolts set into fire-retardant-treated, **as directed**, wood backing between studs. Coordinate with stud installation to locate backing members.
OR
For steel-framed partitions, use self-tapping screws fastened to steel framing or to concealed steel reinforcements.
OR
For steel-framed partitions, use toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

D. Adjusting And Cleaning
1. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
a. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.
OR
Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 07 OR Division 09 Section(s) "High-performance Coatings" **OR** Division 07 AND Division 09 Section(s) "High-performance Coatings", **as directed**.
2. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 05510

SECTION 05510a - FABRICATED SPIRAL STAIRS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for fabricated spiral stairs. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes fabricated spiral stairs with steel central-supporting columns and radiating treads.

C. Performance Requirements
1. Delegated Design: Design fabricated spiral stairs, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Structural Performance of Stairs: Fabricated spiral stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to SEI/ASCE 7:
   a. Uniform Load: 40 lbf/sq. ft. (1.92 kN/sq. m) **OR** 100 lbf/sq. ft. (4.79 kN/sq. m), **as directed**.
   b. Concentrated Load: 300 lbf (1.33 kN) applied on an area of 4 sq. in. (2580 sq. mm).
   c. Uniform and concentrated loads need not be assumed to act concurrently.
   d. Railing Loads: Stairs shall withstand stresses resulting from railing loads in addition to loads specified above.
3. Structural Performance of Railings: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to SEI/ASCE 7:
   a. Handrails:
      1) Uniform load of 20 lbf/ft. (0.29 kN/m) **OR** 50 lbf/ft. (0.73 kN/m), **as directed**, applied in any direction.
      2) Concentrated load of 200 lbf (0.89 kN) applied in any direction.
      3) Uniform and concentrated loads need not be assumed to act concurrently.
   b. Top Rails of Guards:
      1) Uniform load of 20 lbf/ft. (0.29 kN/m) applied in any direction **oR** 50 lbf/ft. (0.73 kN/m) applied in any direction **OR** 50 lbf/ft. (0.73 kN/m) applied horizontally and concurrently, with 100 lbf/ft. (1.46 kN/m) applied vertically downward, **as directed**.
      2) Concentrated load of 200 lbf (0.89 kN) applied in any direction.
      3) Uniform and concentrated loads need not be assumed to act concurrently.
   c. Infill of Guards:
      1) Concentrated load of 50 lbf (0.22 kN) **OR** 200 lbf (0.89 kN), **as directed,** applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
      2) Uniform load of 25 lbf/sq. ft. (1.2 kN/sq. m) applied horizontally.
      3) Infill load and other loads need not be assumed to act concurrently.
4. Seismic Performance: Fabricated spiral stairs shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
   a. Component Importance Factor is 1.5 **OR** 1.0, **as directed**.
5. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.

D. Submittals
1. Product Data: For each type of product indicated.

2. LEED Submittal:
   a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
      1) Include statement indicating costs for each product having recycled content.
3. Shop Drawings.
4. Samples: For the following products, in manufacturer's standard sizes:
   a. Treads.
   b. Metal with painted finish.
   c. Railing members.
5. Delegated-Design Submittal: For fabricated spiral stairs indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
6. Welding certificates.

E. Quality Assurance
1. Welding Qualifications: Qualify procedures and personnel according to the following:
   a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   b. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
   c. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.2 PRODUCTS

A. Materials
1. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
2. Brackets, Flanges, and Anchors: Same metal and finish as supported item unless otherwise indicated.
3. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
4. Steel Bars for Grating Treads and Platforms: ASTM A 36/A 36M or ASTM A 1011/A 1011M.
5. Wire Rod for Grating Crossbars: ASTM A 510 (ASTM A 510M).
6. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or Grade D.
7. Steel Pipe Columns: ASTM A 53/A 53M, Schedule 40. Provide Schedule 80 for columns larger than NPS 4 (DN 100) and where required to support loads.
8. Steel Pipe Railings: ASTM A 53/A 53M, Schedule 40.
9. Steel Tubing: Either cold-formed steel tubing complying with ASTM A 500 or mandrel-drawn mechanical tubing complying with ASTM A 513, Type 5.
10. Iron Castings: Either gray iron complying with ASTM A 48/A 48M or malleable iron complying with ASTM A 47/A 47M unless otherwise indicated or required by structural loads.
11. Aluminum Sheet and Plate: ASTM B 209 (ASTM B 209M), Alloy 6061-T6.
12. Aluminum-Alloy Rolled Tread Plate: ASTM B 632/B 632M, Alloy 6061-T6.
13. Aluminum Pipe and Structural Round Tubing: ASTM B 429, Alloy 6063-T6.
14. Extruded-Aluminum Tubing: ASTM B 221 (ASTM B 221M), Alloy 6063-T5/T52.
15. Aluminum Castings: ASTM B 26/B 26M, Alloy 319.0-F.
16. Extruded-Bronze Handrails: ASTM B 455, Alloy UNS No. C38500 (architectural bronze).
17. Seamless Bronze Tubing: ASTM B 135 (ASTM B 135M), Alloy UNS No. C23000 (red brass, 85 percent copper).
18. Seamless Brass Tubing: ASTM B 135 (ASTM B 135M), Alloy UNS No. C26000 (cartridge brass, 70 percent copper).
19. Stainless-Steel Tubing: ASTM A 554, Grade MT 304.

B. Miscellaneous Materials

1. Fasteners: For connecting stair components and for anchoring stairs to other construction, select fasteners of the type, grade, and class required to produce connections capable of withstanding design loadings.
   a. For aluminum, provide fasteners fabricated from Type 304 stainless steel.
   b. For steel and cast iron, use plated steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating.
2. Lacquer for Copper Alloys: Clear, air-drying, acrylic lacquer specially developed for coating copper-alloy products.
3. Shop Primers: Provide primers that comply with Division 09 Section(s) "Exterior Painting" OR "Interior Painting" **as directed**.
4. Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with finish paint systems indicated.
5. Shop Primer for Galvanized Steel: Primer formulated for use over zinc-coated metal and compatible with finish paint systems indicated.
6. Shop Primer for Aluminum: Primer formulated for use over aluminum and compatible with finish paint systems indicated.
7. Wood for Stair Treads, Handrails, and Platforms: Unless directed otherwise, laminated red oak, sanded to 120-grit smoothness. Apply uniform coat of manufacturer's standard clear sealer.
8. Rubber Wearing Surfaces: Manufacturer's standard, 1/4-inch- (6-mm-) thick, molded-rubber covering in pattern and color indicated or, if not indicated, as selected by the Owner from manufacturer's standard colors and patterns.

C. Fabrication
1. Assemble spiral stairs in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
2. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
3. Form work true to line and level with accurate angles and surfaces.
4. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
5. Cut, reinforce, drill, and tap as needed to receive hardware, screws, and similar items.
6. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
   a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   b. Obtain fusion without undercut or overlap.
   c. Remove flux immediately.
   d. Provide Type 1 **OR** Type 2 **OR** Type 3, **as directed**, welds according to NOMMA Guideline 1, "Joint Finishes."
   e. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and, except for fillet welds, welded surface matches contours of adjoining surfaces.
7. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated. Locate joints where least conspicuous.
8. Fabricate center column from steel **OR** aluminum, **as directed**, pipe welded to baseplate for anchorage to floor structure. Brace column at upper floors by means of landings attached to column and floor structure unless otherwise indicated. Provide cap for column if top is exposed.
9. Provide cast-aluminum **OR** cast-iron, **as directed**, treads and platforms, **as directed**, with integral frames, legs, and hubs.
   a. Provide treads and platforms, **as directed**, with abrasive surfaces.
10. Provide steel-bar grating treads and platforms, **as directed**, with welded hubs and as follows:
    a. Radial grating treads.

OR

Abrasive **OR** Rolled-steel, floor-plate, **as directed**, nosings.

OR

Straight flanges and welded-on legs.

OR

Tapered flanges without legs.

11. Provide formed steel **OR** aluminum, **as directed**,-plate treads and platforms, **as directed**, welded to hubs or center column and as follows:
    a. Straight flanges and welded-on legs.

    OR

    Tapered flanges without legs.

    OR

    Pan treads without legs.

    OR

    One-piece treads and risers, without legs.

    OR

    Rolled-steel, floor-plate wearing surfaces.

    OR

    Aluminum-alloy, rolled tread-plate wearing surfaces.

    OR

    Smooth steel-plate wearing surfaces.

    OR

    Rubber wearing surfaces.

    OR

    Plywood subtread for covering with finish flooring specified in another Section.
12. Provide steel-framed treads and platforms, **as directed**, welded to hubs or center column and without legs; wearing surface as follows:
    a. Cast iron with integral abrasive.

    OR

    Smooth steel plate with integral abrasive.

    OR

    Wood.

    OR

    Plywood insert for covering with finish flooring specified in another Section.
13. Railings: Provide railing system indicated, uniformly bent to spiral shape, and continuing at top to form guardrail around floor opening.
    a. Space balusters less than 4 inches (102 mm), clear.

    OR

    Space balusters to provide one baluster per tread, but spaced less than 21 inches (533 mm), clear.

    b. Space intermediate rails less than 4 inches (101 mm) **OR** 21 inches (533 mm), **as directed,** clear.
    c. Locate bottom rail so that a 6-inch- (152-mm-) diameter sphere cannot pass between the stair and rail.
    d. Fabricate top rail from 1-1/4- to 2-inch- (32- to 51-mm-) OD steel pipe or round tubing.

    OR

    Fabricate top rail from steel of shape and size indicated.

    OR

    Fabricate top rail from 1-1/4- to 2-inch- (32- to 51-mm-) OD round aluminum **OR** bronze **OR** brass **OR** stainless-steel, **as directed**, tubing.

    OR

    Fabricate top rail from extruded bronze of shape and size indicated.

    OR

    Fabricate top rail from wood of shape and size indicated.

e. Fabricate balusters from 7/8-inch- (22-mm-) OD **OR** 1-inch- (25-mm-) OD **OR** 1-1/4-inch- (32-mm-) OD steel pipe or round tubing.
OR
Fabricate balusters from 1/2-inch- (13-mm-) OD **OR** 5/8-inch- (16-mm-) OD round steel bars **OR** tubing, **as directed**.
OR
Fabricate balusters from 1/2-inch- (13-mm-) **OR** 5/8-inch- (16-mm-) **OR** 3/4-inch- (19-mm-), **as directed**, square steel bars **OR** tubing, **as directed**.
OR
Fabricate balusters from 5/8-inch- (16-mm-) OD **OR** 3/4-inch- (19-mm-) OD, **as directed**, round aluminum tubing.

f. Fabricate intermediate rails from 7/8-inch- (22-mm-) OD **OR** 1-inch- (25-mm-) OD **OR** 1-1/4-inch- (32-mm-) OD, **as directed**, steel pipe or round tubing.
OR
Fabricate intermediate rails from steel pipe or round tubing same size as top rail.
OR
Fabricate intermediate rails from 5/8-inch- (16-mm-) OD **OR** 3/4-inch- (19-mm-) OD, **as directed**, round steel bars **OR** tubing, **as directed**.
OR
Fabricate intermediate rails from 5/8-inch- (16-mm-) OD **OR** 3/4-inch- (19-mm-) OD **OR** 1-inch- (25-mm-) OD **OR** 1-1/4-inch- (32-mm-) OD, **as directed**, round aluminum tubing.
OR
Fabricate intermediate rails from round aluminum tubing same size as top rail.

D. Steel And Iron Finishes
1. Galvanized Finish: Hot-dip galvanize stairs after fabrication to comply with ASTM A 123/A 123M.
2. Preparation for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.
3. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC's surface-preparation specifications and environmental exposure conditions of installed stairs:
   a. Exteriors (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   b. Interiors (SSPC Zone 1A): SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."
4. Apply shop primer to prepared surfaces of handrails and railing components unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

E. Aluminum Finishes
1. Conversion-Coated and Factory-Primed Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid chromate-fluoride-phosphate conversion coating; Organic Coating: shop primer).
   a. Apply shop primer with a minimum dry film thickness of 1.5 mils (0.04 mm).
2. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
   a. Color and Gloss: As selected by the Owner from manufacturer's full range.

F. Stainless-Steel Finishes
1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finishes: Grind and polish surfaces to produce uniform finish indicated, free of cross scratches.
   a. Run grain of directional finishes with long dimension of each piece.
   b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
   c. Directional Satin Finish: No. 4.
   d. Reflective, Directional Polish: No. 7.

e. Mirrorlike Reflective, Nondirectional Polish: No. 8.

G. Copper-Alloy Finishes
1. Finish designations for copper alloys comply with the system established for designating copper-alloy finish systems defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products."
2. Buffed Finish: M21 (Mechanical Finish: buffed, smooth specular).
3. Buffed Finish, Lacquered: M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear organic, air drying, as specified below).
4. Medium-Satin Finish, Lacquered: M32-O6x (Mechanical Finish: directionally textured, medium satin; Coating: clear organic, air drying, as specified below).
   a. Clear Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
5. Statuary Conversion Coating over Satin Finish: M31-C55 (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide).
   a. Color: Match the Owner's sample.

1.3 EXECUTION

A. Installation
1. Fastening to In-Place Construction: Provide anchorage devices and fasteners where needed for securing fabricated spiral stairs to in-place construction; include threaded fasteners for concrete and masonry inserts, through bolts, lag bolts, wood screws, and other connectors as required.
2. Assemble fabricated spiral stair components to comply with manufacturer's written instructions, with each component aligned and in correct relation to each other, securely anchored to the supporting column and adjacent structure.
3. Do not cut, alter, or drill stair components in the field that do not fit properly. Return components that do not fit to manufacturer for adjustment.
4. Install fabricated spiral stairs accurately in location, alignment, and elevation; level and plumb; and according to manufacturer's written instructions.
5. Install fabricated spiral stairs by welding to steel structure or to weld plates cast into concrete unless otherwise indicated.
6. Field Welding:
   a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   b. Obtain fusion without undercut or overlap.
   c. Remove welding flux immediately.
   d. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

B. Cleaning And Protection
1. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint and paint exposed areas with same material.
2. For galvanized surfaces, clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A 780.
   a. Paint repaired areas with same material used for shop painting.
3. Protect finished tread surfaces during construction by covering with 1/2-inch- (13-mm-) thick plywood secured with plastic strapping or another nonmarring fastening method.

END OF SECTION 05510a

Task	Specification	Specification Description
05510	05500	Metal Fabrications
05511	05500	Metal Fabrications
05511	05521	Pipe And Tube Railings

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SECTION 05521 - PIPE AND TUBE RAILINGS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for pipe and tube railings. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Steel pipe and tube railings.
b. Aluminum pipe and tube railings.
c. Stainless-steel pipe and tube railings.

C. Performance Requirements
1. Delegated Design: Design railings, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
a. Steel: 72 percent of minimum yield strength.
b. Aluminum: The lesser of minimum yield strength divided by 1.65 or minimum ultimate tensile strength divided by 1.95.
c. Stainless Steel: 60 percent of minimum yield strength.
3. Structural Performance: Railings shall withstand the effects of gravity loads and loads and stresses within limits and under conditions indicated. Following loads are examples only and are based on the 2006 International Building Code (IBC).
a. Handrails and Top Rails of Guards:
1) Uniform load of 50 lbf/ ft. (0.73 kN/m) applied in any direction.
2) Concentrated load of 200 lbf (0.89 kN) applied in any direction.
3) Uniform and concentrated loads need not be assumed to act concurrently.
b. Infill of Guards:
1) Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
2) Infill load and other loads need not be assumed to act concurrently.
4. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
a. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
5. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

D. Submittals
1. Product Data: For the following:
a. Manufacturer's product lines of mechanically connected railings.
b. Railing brackets.
c. Grout, anchoring cement, and paint products.
2. LEED Submittals:
a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: Indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content. Include statement indicating costs for each product having recycled content.
3. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

4. Samples: For each type of exposed finish required.
   a. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
   b. Fittings and brackets.
   c. Assembled Sample of railing system, made from full-size components, including top rail, post, handrail, and infill. Sample need not be full height.
      1) Show method of finishing **OR** connecting, **as directed**, members at intersections.
5. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
6. Qualification Data: For qualified professional engineer **OR** testing agency, .
7. Mill Certificates: Signed by manufacturers of stainless-steel products certifying that products furnished comply with requirements.
8. Welding certificates.
9. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.
10. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.

E. Quality Assurance
1. Source Limitations: Obtain each type of railing from single source from single manufacturer.
2. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
3. Welding Qualifications: Qualify procedures and personnel according to the following:
   a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   b. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
   c. AWS D1.6, "Structural Welding Code - Stainless Steel."

F. Project Conditions
1. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

G. Coordination And Scheduling
1. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
2. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
3. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

1.2 PRODUCTS

A. Metals, General
1. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
2. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

B. Steel And Iron

1. Recycled Content of Steel Products: Provide products with average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
2. Tubing: ASTM A 500 (cold formed) or ASTM A 513.
3. Pipe: ASTM A 53/A 53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.
   a. Provide galvanized finish for exterior installations and where indicated.
4. Plates, Shapes, and Bars: ASTM A 36/A 36M.
5. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.
6. Expanded Metal: ASTM F 1267, Type I (expanded) **OR** Type II (expanded and flattened), **as directed**, Class 1 (uncoated).
   a. Style Designation: 3/4 number 13 **OR** 1-1/2 number 10, **as directed**.
7. Perforated Metal: Cold-rolled steel sheet, ASTM A 1008/A 1008M, or hot-rolled steel sheet, ASTM A 1011/A 1011M, commercial steel Type B, 0.060 inch (1.52 mm) thick, with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows.
8. Perforated Metal: Galvanized-steel sheet, ASTM A 653/A 653M, G90 (Z275) coating, commercial steel Type B, 0.064 inch (1.63 mm) thick, with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows **OR** with 1/8-by-1-inch (3.2-by-25.4-mm) round end slotted holes in staggered rows, **as directed**.
9. Woven-Wire Mesh: Intermediate-crimp, diamond **OR** square, **as directed**, pattern, 2-inch (50-mm) woven-wire mesh, made from 0.135-inch (3.5-mm) nominal diameter wire complying with ASTM A 510 (ASTM A 510M).

C. Aluminum
1. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required.
2. Extruded Bars and Tubing: ASTM B 221 (ASTM B 221M), Alloy 6063-T5/T52.
3. Extruded Structural Pipe and Round Tubing: ASTM B 429/B 429M, Alloy 6063-T6.
   a. Provide Standard Weight (Schedule 40) pipe, unless otherwise indicated.
4. Drawn Seamless Tubing: ASTM B 210 (ASTM B 210M), Alloy 6063-T832.
5. Plate and Sheet: ASTM B 209 (ASTM B 209M), Alloy 6061-T6.
6. Die and Hand Forgings: ASTM B 247 (ASTM B 247M), Alloy 6061-T6.
7. Castings: ASTM B 26/B 26M, Alloy A356.0-T6.
8. Perforated Metal: Aluminum sheet, ASTM B 209 (ASTM B 209M), Alloy 6061-T6, 0.063 inch (1.60 mm) thick, with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows.
9. Woven-Wire Mesh: Intermediate-crimp, diamond **OR** square, **as directed**, pattern, 2-inch (50-mm) woven-wire mesh, made from 0.162-inch (4.1-mm) nominal diameter wire complying with ASTM B 211 (ASTM B 211M), Alloy 6061-T94.

D. Stainless Steel
1. Tubing: ASTM A 554, Grade MT 304 **OR** Grade MT 316L, **as directed**.
2. Pipe: ASTM A 312/A 312M, Grade TP 304 **OR** Grade TP 316L, **as directed**.
3. Castings: ASTM A 743/A 743M, Grade CF 8 or CF 20 **OR** Grade CF 8M or CF 3M, **as directed**.
4. Plate and Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304 **OR** Type 316L, **as directed**.
5. Expanded Metal: ASTM F 1267, Type I (expanded) **OR** Type II (expanded and flattened), **as directed**, Class 3 (corrosion-resistant steel), made from stainless-steel sheet, ASTM A 240/A 240M or ASTM A 666, Type 304 **OR** Type 316, **as directed**.
   a. Style Designation: 3/4 number 13 **OR** 1-1/2 number 10, **as directed**.
6. Perforated Metal: Stainless-steel sheet, ASTM A 240/A 240M or ASTM A 666, Type 304 **OR** Type 316L, **as directed**, 0.062 inch (1.59 mm) thick, with 1/4-inch (6.4-mm) holes 3/8 inch (9.5 mm) o.c. in staggered rows.
7. Woven-Wire Mesh: Intermediate-crimp, diamond **OR** square, **as directed**, pattern, 2-inch (50-mm) woven-wire mesh, made from 0.135-inch (3.5-mm) nominal diameter wire complying with ASTM A 580/A 580M, Type 304 **OR** Type 316, **as directed**.

E. Fasteners
1. General: Provide the following:
   a. Ungalvanized-Steel Railings: Plated steel fasteners complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5 for zinc coating.
   b. Hot-Dip Galvanized Railings: Type 304 stainless-steel or hot-dip zinc-coated steel fasteners complying with ASTM A 153/A 153M or ASTM F 2329 for zinc coating.
   c. Aluminum Railings: Type 304 **OR** Type 316, **as directed**, stainless-steel fasteners.
   d. Stainless-Steel Railings: Type 304 **OR** Type 316, **as directed**, stainless-steel fasteners.
2. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads, **as directed**.
3. Fasteners for Interconnecting Railing Components:
   a. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless otherwise indicated.
      OR
      Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.
   b. Provide Phillips **OR** tamper-resistant **OR** square or hex socket, **as directed**, flat-head machine screws for exposed fasteners unless otherwise indicated.
4. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
   a. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.
   b. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 1 (A1) **OR** Group 2 (A4), **as directed**, stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

F. Miscellaneous Materials
1. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
   a. For aluminum and stainless-steel railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
2. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
3. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
4. Shop Primers: Provide primers that comply with Division 07 OR Division 09 Section(s) "High-performance Coatings" **OR** Division 07 AND Division 09 Section(s) "High-performance Coatings", **as directed**.
5. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
   a. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
6. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
7. Shop Primer for Galvanized Steel: Cementitious galvanized metal primer complying with MPI#26 **OR** Vinyl wash primer complying with MPI#80 **OR** Water based galvanized metal primer complying with MPI#134, **as directed**.
8. Intermediate Coats and Topcoats: Provide products that comply with Division 07 OR Division 09 Section(s) "High-performance Coatings" **OR** Division 07 AND Division 09 Section(s) "High-performance Coatings", **as directed**.
9. Epoxy Intermediate Coat: Complying with MPI #77 and compatible with primer and topcoat.
10. Polyurethane Topcoat: Complying with MPI #72 and compatible with undercoat.

11. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
12. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
13. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.
    a. Water-Resistant Product: At exterior locations and where indicated provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

G. Fabrication
1. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
2. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
3. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
4. Form work true to line and level with accurate angles and surfaces.
5. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
6. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
7. Connections: Fabricate railings with welded **OR** nonwelded, **as directed**, connections unless otherwise indicated.
8. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
    a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
    b. Obtain fusion without undercut or overlap.
    c. Remove flux immediately.
    d. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
9. Welded Connections for Aluminum Pipe: Fabricate railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.
10. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
    a. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.
11. Form changes in direction as follows:
    a. As detailed.
       OR
       By bending or by inserting prefabricated elbow fittings.
       OR
       By flush bends or by inserting prefabricated flush-elbow fittings.
       OR
       By radius bends of radius indicated or by inserting prefabricated elbow fittings of radius indicated.
12. Bend members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
13. Close exposed ends of railing members with prefabricated end fittings.

14. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch (6 mm) or less.
15. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.
    a. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers, or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.
16. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.
17. For railing posts set in concrete, provide steel **OR** stainless-steel, **as directed**, sleeves not less than 6 inches (150 mm) long with inside dimensions not less than 1/2 inch (13 mm) greater than outside dimensions of post, with metal plate forming bottom closure.
18. For removable railing posts, fabricate slip-fit sockets from steel **OR** stainless-steel, **as directed**, tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height. Provide socket covers designed and fabricated to resist being dislodged.
    a. Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railings.
19. Expanded-Metal Infill Panels: Fabricate infill panels from expanded metal made from same metal as railings in which they are installed.
    a. Edge panels with U-shaped channels made from metal sheet, of same metal as expanded metal and not less than 0.043 inch (1.1 mm) thick.
    b. Orient expanded metal with long dimension of diamonds parallel to top rail **OR** perpendicular to top rail **OR** horizontal **OR** vertical, **as directed**.
20. Perforated-Metal Infill Panels: Fabricate infill panels from perforated metal made from steel **OR** galvanized steel **OR** aluminum **OR** stainless steel **OR** same metal as railings in which they are installed, **as directed**.
    a. Edge panels with U-shaped channels made from metal sheet, of same metal as perforated metal and not less than 0.043 inch (1.1 mm) thick.
    b. Orient perforated metal with pattern parallel to top rail **OR** perpendicular to top rail **OR** horizontal **OR** vertical **OR** as indicated on Drawings, **as directed**.
21. Woven-Wire Mesh Infill Panels: Fabricate infill panels from woven-wire mesh crimped into 1-by-1/2-by-1/8-inch (25-by-13-by-3-mm) metal channel frames. Make wire mesh and frames from same metal as railings in which they are installed.
    a. Orient wire mesh with diamonds vertical **OR** wires perpendicular and parallel to top rail **OR** wires horizontal and vertical, **as directed**.
22. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

H. Finishes, General
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
3. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
4. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

I. Steel And Iron Finishes
1. Galvanized Railings:

a. Hot-dip galvanize steel **OR** exterior steel, **as directed**, and iron railings, including hardware, after fabrication.
OR
Hot-dip galvanize indicated steel and iron railings, including hardware, after fabrication.
b. Comply with ASTM A 123/A 123M for hot-dip galvanized railings.
c. Comply with ASTM A 153/A 153M for hot-dip galvanized hardware.
d. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
e. Fill vent and drain holes that will be exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

2. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.
3. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.
4. For nongalvanized steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors to be embedded in exterior concrete or masonry.
5. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning" **OR** SSPC-SP 3, "Power Tool Cleaning" **OR** requirements indicated below, **as directed**:
   a. Exterior Railings: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   b. Railings Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   c. Railings Indicated to Receive Primers Specified in Division 9 Section "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   d. Other Railings: SSPC-SP 3, "Power Tool Cleaning."
6. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.
   a. Shop prime uncoated railings with universal shop primer **OR** primers specified in Division 07, **as directed**, unless zinc-rich primer is **OR** primers specified in Division 09 Section "High-performance Coatings" are, **as directed**, indicated.
   b. Do not apply primer to galvanized surfaces.
7. Shop-Painted Finish: Comply with Division 09 Section(s) "Exterior Painting" OR "High-performance Coatings", **as directed**.
   a. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
8. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended by coating manufacturer.
   a. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

J. Aluminum Finishes
1. Mechanical Finish: AA-M12 (Mechanical Finish: nonspecular as fabricated).
2. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
3. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
   a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As selected from full range of industry colors and color densities, **as directed**.
4. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

5. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 **OR** AAMA 2605, **as directed**, and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

   OR

   High-Performance Organic Finish: Three **OR** Four, **as directed**,-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   b. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

K. Stainless-Steel Finishes
1. Remove tool and die marks and stretch lines, or blend into finish.
2. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
3. 180-Grit Polished Finish: Oil-ground, uniform, directionally textured finish.
4. 320-Grit Polished Finish: Oil-ground, uniform, fine, directionally textured finish.
5. Polished and Buffed Finish: Oil-ground, 180-grit finish followed by buffing.
6. Directional Satin Finish: No. 4.
7. Dull Satin Finish: No. 6.
8. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

1.3 EXECUTION

A. Examination
1. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

B. Installation, General
1. Fit exposed connections together to form tight, hairline joints.
2. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
   a. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
   b. Set posts plumb within a tolerance of 1/16 inch in 3 feet (2 mm in 1 m).
   c. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet (5 mm in 3 m).
3. Corrosion Protection: Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
4. Adjust railings before anchoring to ensure matching alignment at abutting joints.
5. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

C. Railing Connections

1. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.
2. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.
3. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches (50 mm) beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches (150 mm) of post.

D. Anchoring Posts
1. Use metal sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.
2. Form or core-drill holes not less than 5 inches (125 mm) deep and 3/4 inch (20 mm) larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.
3. Cover anchorage joint with flange of same metal as post, welded to post after placing anchoring material **OR** attached to post with set screws, **as directed**.
   OR
   Leave anchorage joint exposed with 1/8-inch (3-mm) buildup, sloped away from post **OR** anchoring material flush with adjacent surface, **as directed**.
4. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:
   a. For aluminum pipe railings, attach posts using fittings designed and engineered for this purpose.
   b. For stainless-steel pipe railings, weld flanges to post and bolt to supporting surfaces.
   c. For steel pipe railings, weld flanges to post and bolt to metal supporting surfaces.
5. Install removable railing sections, where indicated, in slip-fit metal sockets cast in concrete.

E. Attaching Railings
1. Anchor railing ends at walls with round flanges anchored to wall construction and welded to railing ends or connected to railing ends using nonwelded connections.
2. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends or connected to railing ends using nonwelded connections.
3. Attach railings to wall with wall brackets, except where end flanges are used. Provide brackets with 1-1/2-inch (38-mm) clearance from inside face of handrail and finished wall surface. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
   a. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt **OR** predrilled hole for exposed bolt anchorage, **as directed**.
   b. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
4. Secure wall brackets and railing end flanges to building construction as follows:
   a. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
   b. For hollow masonry anchorage, use toggle bolts.
   c. For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.
   d. For steel-framed partitions, use hanger or lag bolts set into fire-retardant-treated, **as directed**, wood backing between studs. Coordinate with stud installation to locate backing members.
      OR

For steel-framed partitions, use self-tapping screws fastened to steel framing or to concealed steel reinforcements.
OR
For steel-framed partitions, use toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

F. Adjusting And Cleaning
1. Clean aluminum and stainless steel by washing thoroughly with clean water and soap and rinsing with clean water.
2. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
   a. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.
3. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 07 OR Division 09 Section(s) "High-performance Coatings" **OR** Division 07 AND Division 09 Section(s) "High-performance Coatings", **as directed**.
4. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

G. Protection
1. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

END OF SECTION 05521

Task	Specification	Specification Description
05521	05500	Metal Fabrications
05530	01352	No Specification Required
05530	05500	Metal Fabrications
05535	05500	Metal Fabrications
05540	05500	Metal Fabrications

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SECTION 05720 - ORNAMENTAL METAL

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for ornamental metal. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Decorative window security bars.
b. Decorative mechanical grilles and frames.
c. Decorative-metal-clad, hollow-metal doors and frames.
d. Custom door pulls.
e. Combination hall push-button stations.
f. Metal reveals at wood paneling.
g. Cast-metal rosettes at marble joints.

C. Submittals
1. Product Data: For each type of product indicated, including finishing materials.
2. LEED Submittals:
a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.
3. Shop Drawings: Show fabrication and installation details for decorative metal.
a. Include plans, elevations, component details, and attachments to other work.
b. Indicate materials and profiles of each decorative metal member, fittings, joinery, finishes, fasteners, anchorages, and accessory items.
4. Patterns, Models, or Plaster Castings: Made from proposed patterns for each design of custom casting required.
5. Samples: For each type of exposed finish required.
a. Sections of linear shapes.
b. Full-size Samples of castings and forgings.
1) For custom castings, submit finished Samples showing ability to reproduce detail, cast-metal color, and quality of finish. Samples may be of similar previous work.
c. Samples of welded and brazed joints showing quality of workmanship and color matching of materials.
6. Qualification Data: For qualified fabricator **OR** organic-coating applicator **OR** anodic finisher **OR** powder-coating applicator, **as directed**.
7. Mill Certificates: Signed by manufacturers of stainless-steel certifying that products furnished comply with requirements.
8. Welding certificates.

D. Quality Assurance
1. Fabricator Qualifications: A firm experienced in producing decorative metal similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
2. Installer Qualifications: Fabricator of products.

3. Organic-Coating Applicator Qualifications: A firm experienced in successfully applying organic coatings, of type indicated, to aluminum extrusions and employing competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.
4. Anodic Finisher Qualifications: A firm experienced in successfully applying anodic finishes of type indicated and employing competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.
5. Powder-Coating Applicator Qualifications: A firm experienced in successfully applying powder coatings of type indicated and employing competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.
6. Welding Qualifications: Qualify procedures and personnel according to the following:
   a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   b. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
   c. AWS D1.3, "Structural Welding Code - Sheet Steel."
   d. AWS D1.6, "Structural Welding Code - Stainless Steel."
7. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
1. Store decorative metal in a well-ventilated area, away from uncured concrete and masonry, and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.
2. Deliver and store cast-metal products in wooden crates surrounded by sufficient packing material to ensure that products will not be cracked or otherwise damaged.

F. Project Conditions
1. Field Measurements: Verify actual locations of walls and other construction contiguous with decorative metal by field measurements before fabrication and indicate measurements on Shop Drawings.

G. Coordination
1. Coordinate installation of anchorages for decorative metal items. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.2 PRODUCTS

A. Metals, General
1. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. Provide materials without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Aluminum
1. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties for each aluminum form required not less than that of alloy and temper designated below.
   a. Extruded Bars and Shapes: ASTM B 221 (ASTM B 221M), Alloy 6063-T5/T52.
   b. Extruded Structural Pipe and Round Tubing: ASTM B 429/B 429M, Alloy 6063-T6.
   c. Drawn Seamless Tubing: ASTM B 210 (ASTM B 210M) or ASTM B 483/B 483M, Alloy 6063-T832.
   d. Plate and Sheet: ASTM B 209 (ASTM B 209M), Alloy 3003-H14 **OR** Alloy 5005-H32 **OR** Alloy 6061-T6, **as directed**.
   e. Die and Hand Forgings: ASTM B 247 (ASTM B 247M), Alloy 6061-T6.
   f. Castings: ASTM B 26/B 26M, Alloy A356.0-T6.

C. Copper Alloys

1. Copper and Copper Alloys, General: Provide alloys indicated and temper to suit application and forming methods but with strength and stiffness not less than H01 (quarter-hard) for plate, sheet, strip, and bars and H55 (light-drawn) for tube and pipe.
2. Extruded Shapes, Bronze: ASTM B 455, Alloy UNS No. C38500 (architectural bronze).
3. Extruded Shapes, Brass: ASTM B 249/B 249M, Alloy UNS No. C36000 (free-cutting brass).
4. Extruded Shapes, Nickel Silver: ASTM B 249/B 249M, Alloy UNS No. C79600.
5. Seamless Pipe, Bronze: ASTM B 43, Alloy UNS No. C23000 (red brass, 85 percent copper).
6. Seamless Tube, Bronze: ASTM B 135 (ASTM B 135M), Alloy UNS No. C23000 (red brass, 85 percent copper).
7. Seamless Tube, Brass: ASTM B 135 (ASTM B 135M), Alloy UNS No. C26000 (cartridge brass, 70 percent copper).
8. Seamless Tube, Copper: ASTM B 75 (ASTM B 75M), Alloy UNS No. C12200 (phosphorous deoxidized, high residual phosphorous copper).
9. Castings, Bronze: ASTM B 62, Alloy UNS No. C83600 (85-5-5-5 or No. 1 composition commercial red brass) or ASTM B 584, Alloy UNS No. C86500 (No. 1 manganese bronze).
10. Castings, Brass: ASTM B 584, Alloy UNS No. C85200 (high-copper yellow brass).
11. Castings, Copper: ASTM B 824, with a minimum of 99.9 percent copper.
12. Castings, Nickel Silver: ASTM B 584, Alloy UNS No. C97300 (12 percent leaded nickel silver).
13. Plate, Sheet, Strip, and Bars; Bronze: ASTM B 36/B 36M, Alloy UNS No. C28000 (muntz metal, 60 percent copper).
14. Plate, Sheet, Strip, and Bars; Brass: ASTM B 36/B 36M, Alloy UNS No. C26000 (cartridge brass, 70 percent copper).
15. Plate, Sheet, Strip, and Bars; Copper: ASTM B 152/B 152M, Alloy UNS No. C11000 (electrolytic tough pitch copper) or UNS No. C12200 (phosphorous deoxidized, high-residual phosphorous copper).

D. Stainless Steel
1. Tubing: ASTM A 554, Grade MT 304 **OR** Grade MT 316 **OR** Grade MT 316L, **as directed**.
2. Pipe: ASTM A 312/A 312M, Grade TP 304 **OR** Grade TP 316 **OR** Grade TP 316L, **as directed**.
3. Castings: ASTM A 743/A 743M, Grade CF 8 or CF 20 **OR** Grade CF 8M or CF 3M, **as directed**.
4. Sheet, Strip, Plate, and Flat Bar: ASTM A 666, Type 304 **OR** Type 316 **OR** Type 316L, **as directed**.
5. Bars and Shapes: ASTM A 276, Type 304 **OR** Type 316 **OR** Type 316L, **as directed**.
6. Wire Rope and Fittings:
   a. Wire Rope: 1-by-19 **OR** 7-by-7 **OR** 7-by-19, **as directed**, wire rope made from wire complying with ASTM A 492, Type 316.
   b. Wire-Rope Fittings: Connectors of types indicated, fabricated from stainless steel, and with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.

E. Steel And Iron
1. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
2. Tubing: ASTM A 500 (cold formed) or ASTM A 513, Type 5 (mandrel drawn).
3. Bars: Hot-rolled, carbon steel complying with ASTM A 29/A 29M, Grade 1010.
4. Plates, Shapes, and Bars: ASTM A 36/A 36M.
5. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M unless otherwise indicated.
6. Steel Sheet, Cold Rolled: ASTM A 1008/A 1008M, either commercial steel or structural steel, exposed.

F. Titanium
1. Titanium Strip, Sheet, and Plate: ASTM B 265, Grade 1.
2. Titanium Bars: ASTM B 348, Grade 1.

G. Fasteners
1. Fastener Materials: Unless otherwise indicated, provide the following:
   a. Aluminum Items: Aluminum **OR** Type 304 stainless-steel **OR** Type 316 stainless-steel, **as directed**, fasteners.
   b. Copper-Alloy (Bronze) Items: Silicon bronze (Alloy 651 or Alloy 655) fasteners where concealed, muntz metal (Alloy 280) fasteners where exposed.
   c. Copper-Alloy (Brass) Items: Silicon bronze (Alloy 651 or Alloy 655) fasteners where concealed, brass (Alloy 260 or 360) fasteners where exposed.
   d. Stainless-Steel Items: Type 304 **OR** Type 316, **as directed**, stainless-steel fasteners.
   e. Titanium Items: Type 304 **OR** Type 316, **as directed**, stainless-steel fasteners.
   f. Uncoated-Steel Items: Plated steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating where concealed, Type 304 stainless-steel fasteners where exposed.
   g. Galvanized-Steel Items: Plated steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating.
   h. Dissimilar Metals: Type 304 **OR** Type 316, **as directed**, stainless-steel fasteners.
2. Fasteners for Anchoring to Other Construction: Unless otherwise indicated, select fasteners of type, grade, and class required to produce connections suitable for anchoring indicated items to other types of construction indicated.
3. Provide concealed fasteners for interconnecting components and for attaching decorative metal items to other work unless otherwise indicated **OR** exposed fasteners are unavoidable, **as directed**.
   a. Provide Phillips **OR** tamper-resistant **OR** square or hex socket, **as directed**, flat-head machine screws for exposed fasteners unless otherwise indicated.
4. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
5. Post-Installed Anchors: Torque-controlled expansion type or chemical type.
   a. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5 unless otherwise indicated.
   b. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) **OR** Group 2 (A4), **as directed**, stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

H. Miscellaneous Materials
1. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
   a. For aluminum, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
2. Brazing Rods: For copper alloys, provide type and alloy as recommended by producer of metal to be brazed and as required for color match, strength, and compatibility in fabricated items.
3. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
4. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
5. Lacquer for Copper Alloys: Clear, acrylic lacquer specially developed for coating copper-alloy products.
6. Shop Primers: Provide primers that comply with Division 07 OR Division 09 Section(s) "High-performance Coatings", **as directed**.
7. Universal Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
   a. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
8. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

9. Shop Primer for Galvanized Steel: Cementitious galvanized metal primer complying with MPI#26 **OR** Vinyl wash primer complying with MPI#80 **OR** Water-based galvanized metal primer complying with MPI#134, **as directed**.
10. Intermediate Coats and Topcoats for Steel: Provide products that comply with Division 07 OR Division 09 Section(s) "High-performance Coatings" **OR** Division 07 AND Division 09 Section(s) "High-performance Coatings", **as directed**.
11. Epoxy Intermediate Coat for Steel: Complying with MPI#77 and compatible with primer and topcoat.
12. Polyurethane Topcoat for Steel: Complying with MPI#72 and compatible with undercoat.
13. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

I. Fabrication, General
1. Assemble items in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
2. Make up wire-rope assemblies in the shop to field-measured dimensions with fittings machine swaged. Minimize amount of turnbuckle take-up used for dimensional adjustment so maximum amount is available for tensioning wire ropes. Tag wire-rope assemblies and fittings to identify installation locations and orientations for coordinated installation.
3. Form decorative metal to required shapes and sizes, true to line and level with true curves and accurate angles and surfaces. Finish exposed surfaces to smooth, sharp, well-defined lines and arris.
4. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.
5. Form simple and compound curves in bars, pipe, tubing, and extruded shapes by bending members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces.
6. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
7. Mill joints to a tight, hairline fit. Cope or miter corner joints. Fabricate connections that will be exposed to weather in a manner to exclude water.
8. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.
9. Provide necessary rebates, lugs, and brackets to assemble units and to attach to other work. Cut, reinforce, drill, and tap as needed to receive finish hardware, screws, and similar items unless otherwise indicated.
10. Comply with AWS for recommended practices in shop welding and brazing. Weld and braze behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed joints of flux, and dress exposed and contact surfaces.
    a. Where welding and brazing cannot be concealed behind finished surfaces, finish joints to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 Welds: no evidence of a welded joint **OR** Type 2 Welds: completely sanded joint, some undercutting and pinholes okay **OR** Type 3 Welds: partially dressed weld with spatter removed **OR** Type 4 Welds: good quality, uniform undressed weld with minimal splatter, **as directed**.
11. Provide castings that are sound and free of warp, cracks, blowholes, or other defects that impair strength or appearance. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks.

J. Decorative Window Security Bars
1. General: Fabricate decorative window grilles to designs indicated from steel bars and shapes of sizes and profiles indicated. Form steel bars by bending, forging, coping, mitering, and welding.
2. Welding: Interconnect grille members with full-length, full-penetration welds unless otherwise indicated. Use welding method that is appropriate for metal and finish indicated and that

develops full strength of members joined. Finish exposed welds and surfaces smooth, flush, and blended to match adjoining surfaces.

3. Brackets, Fittings, and Anchors: Provide wall brackets, fittings, and anchors to connect decorative window grilles to other work unless otherwise indicated.
   a. Furnish inserts and other anchorage devices to connect decorative window grilles to concrete and masonry work. Coordinate anchorage devices with supporting structure.
   b. Fabricate anchorage devices that are capable of withstanding loads indicated.

K. Decorative Mechanical Grilles
1. Fabricate decorative grilles from perforated aluminum **OR** brass **OR** bronze **OR** stainless-steel **OR** steel, **as directed**, sheet or plate of thickness, size, and pattern indicated. Form perforations by punching, cutting, or drilling to produce openings of sizes and shapes indicated. Roll, press, and grind perforated metal to flatten and to remove burrs and deformations.
   a. Form perforations to match existing grilles.
      OR
      Drawings indicate perforated metal patterns required and are based on products of one manufacturer. Perforated metal patterns produced by other manufacturers may be considered, provided deviations are minor and do not change design concept as judged solely by the Owner.
2. Drill and countersink grilles for mounting screws at 2 inches (50 mm) from corners and at 10 inches (250 mm) or less o.c. Provide units with oval-head wood **OR** self-tapping machine, **as directed**, screws.
3. Fabricate grille frames from extruded aluminum **OR** brass **OR** bronze, **as directed**, of profiles, and to sizes and shapes indicated. Miter frame members at corners and connect with concealed splice plates welded **OR** brazed, **as directed**, to back of frames.
   a. Secure grilles in frames with 0.5-inch- (12-mm-) long welds **OR** brazing, **as directed**, along perimeter of grilles at 4 inches (100 mm) o.c.
   b. Provide frame profiles to match existing frames.
      OR
      Drawings indicate frame profiles required and are based on products of one manufacturer. Similar frame profiles produced by other manufacturers may be considered, provided deviations are minor and do not change design concept as judged solely by the Owner.
4. Drill and countersink frames for mounting screws at 4 inches (100 mm) from corners and at 16 inches (400 mm) or less o.c. Provide units with oval-head wood **OR** self-tapping machine, **as directed**, screws.

L. Decorative-Metal-Clad Doors And Frames
1. Laminate 0.0403-inch- (1.0-mm-) thick, muntz-metal **OR** 0.0403-inch- (1.0-mm-) thick, brass **OR** 0.0375-inch- (0.95-mm-) thick, stainless-steel **OR** 0.024-inch- (0.6-mm-) thick, titanium, **as directed**, sheets to outside face of hollow-metal doors and frames at locations and to comply with details indicated. Use adhesive recommended by metal fabricator that will fully bond metal to metal and that will prevent telegraphing and oil canning.
   a. Hollow-metal doors and frames are specified in Division 8 Section "Steel Doors and Frames."

M. Custom Door Pulls
1. Fabricate custom door pulls from brass **OR** bronze **OR** stainless-steel, **as directed**, bar stock of profile indicated, fabricated to shapes indicated. Form curves by bending to produce uniform curvature of radii indicated; maintain profile of member throughout entire bend without buckling, twisting, or otherwise deforming exposed surfaces. Where radii of bends are too small to avoid buckling, grind bars after bending to restore original profile. Drill and tap door pulls to receive through bolts for attachment to doors.
2. Fabricate backing plates for custom door pulls from 1/8-inch (3.2-mm) brass **OR** bronze **OR** stainless-steel, **as directed**, sheet. Cut to shape indicated and bevel edges at a 45-degree angle for one-half thickness of metal. Drill and countersink holes where indicated for screws and bolts.

3. Provide units with oval-head through bolts for mounting pulls and with oval-head wood screws for mounting backing plates.

N. Combination Hall Push-Button Stations
1. Fabricate units of brass **OR** bronze **OR** stainless steel, **as directed**, to comply with details indicated. Coordinate with requirements in Division 14 Section "Electric Traction Elevators" to provide integrated, closely fitted assemblies.
   a. Fabricate faceplates from 1/8-inch- (3.2-mm-) thick sheet with edges beveled at a 45-degree angle for one-half thickness of metal.
   b. Provide units with rectangular, split-bowl trash receptacle, designed for recess mounting in nominal 4-inch (100-mm) wall depth. Fabricate recessed cabinets, top rings, and split bowls of same metal as face of units; fabricate removable receptacles of drawn aluminum. Nominal dimensions of units are 10 by 10 by 3-1/2 inches (250 by 250 by 90 mm) in depth.
   c. Provide units with emergency pictorial signs and text, complying with requirements of authorities having jurisdiction, indicating that in fire emergency, elevators should not be used and that stairways should be used instead. Engrave pictorial sign and text into front surface of faceplates to a depth of 1/16 inch (1.6 mm) with engraving painted red. Make signs 5 inches (125 mm) wide by 8 inches (200 mm) high.
   d. Provide cutouts in faceplates of units for push buttons of elevator hall push-button station, card reader, **as directed**, and elevator key switches. Coordinate locations and sizes of cutouts so additional faceplate is not required and so faces of push buttons are flush with fronts of faceplates and key switches project beyond faceplate only by depth of bezel.

O. Metal Reveals
1. Fabricate metal reveals for wood paneling from 3/4-by-3/4-by-1/16-inch (19-by-19-by-3-mm) extruded-bronze **OR** 3/4-by-3/4-by-0.025-inch (19-by-19-by-0.6-mm) brake-formed, stainless-steel **OR** 3/4-by-3/4-by-0.015-inch (19-by-19-by-0.4-mm) brake-formed titanium, **as directed**, channels. Drill for mounting screws 6 inches (150 mm) from ends of channels and not more than 24 inches (600 mm) o.c. Locate mounting screws at same heights for all channels. Provide black-finished, **as directed**, hex-socket, wafer-head screws for mounting reveals.

P. Cast-Metal Rosettes
1. Fabricate cast-metal rosettes to design indicated from aluminum **OR** brass **OR** bronze **OR** nickel silver, **as directed**. Drill and tap castings for threaded mounting studs.
   a. Provide custom castings to match design indicated.
   b. Manufacturer's stock castings may be considered, provided deviations are minor and do not change design concept as judged solely by the Owner.
   c. Drawings indicate cast-metal rosette designs required and are based on products of one manufacturer. Castings produced by other manufacturers may be considered, provided deviations are minor and do not change design concept as judged solely by the Owner.

Q. Finishes, General
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

R. Aluminum Finishes
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
3. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.

a. Color: Champagne **OR** Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As selected from full range of industry colors and color densities, **as directed**.

4. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
5. Siliconized Polyester Finish: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
6. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 **OR** AAMA 2605, **as directed**, and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

   OR

   High-Performance Organic Finish: Three **OR** Four, **as directed**,-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   b. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

S. Copper-Alloy Finishes
1. Finish designations for copper alloys comply with the system established for designating copper-alloy finish systems defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products."
2. Buffed Finish: M21 (Mechanical Finish: buffed, smooth specular).
3. Hand-Rubbed Finish: M31-M34 (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed).
4. Medium-Satin Finish: M32 (Mechanical Finish: directionally textured, medium satin).
5. Fine-Matte Finish: M42 (Mechanical Finish: nondirectional finish, fine matte).
6. Buffed Finish, Lacquered: M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear organic, air drying, as specified below):
   a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
7. Hand-Rubbed Finish, Lacquered: M31-M34-O6x (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed; Coating: clear organic, air drying, as specified below):
   a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
8. Medium-Satin Finish, Lacquered: M32-O6x (Mechanical Finish: directionally textured, medium satin; Coating: clear organic, air drying, as specified below):
   a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
9. Fine-Matte Finish, Lacquered: M42-O6x (Mechanical Finish: nondirectional finish, fine matte; Coating: clear organic, air drying, as specified below):

a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).

10. Statuary Conversion Coating over Satin Finish: M31-C55 (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide), with color matching the Owner's sample.
11. Patina Conversion Coating: M36-C12-C52 (Mechanical Finish: directionally textured, uniform; Chemical Finish: nonetched cleaned, degreased; Chemical Finish: conversion coating, ammonium sulfate), with color matching the Owner's sample.
12. Statuary Conversion Coating, Bright Relieved and Lacquered: M12-C55-M2x-O6x (Mechanical Finish: matte finish, as cast; Chemical Finish: conversion coating, sulfide; Mechanical Finish: buffed, as specified; Coating: clear, organic, air drying, as specified below), with color matching the Owner's sample:
    a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
13. Blackened, Bright Relieved, and Lacquered: M33-O60-M2x-O6x (Mechanical Finish: directionally textured, coarse satin; Coating: black, air drying; Mechanical Finish: buffed, as specified; Coating: clear, organic, air drying, as specified below), with blackening and buffing matching the Owner's sample:
    a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).

T. Stainless-Steel Finishes
1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
    a. Run grain of directional finishes with long dimension of each piece.
3. Bright, Cold-Rolled, Unpolished Finish: No. 2B.
4. Directional Satin Finish: No. 4.
5. Dull Satin Finish: No. 6.
6. Reflective, Directional Polish: No. 7.
7. Mirrorlike Reflective, Nondirectional Polish: No. 8.
8. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
9. Sputter-Coated Finish: Titanium nitride coating deposited by magnetic sputter-coating process over indicated mechanical finish.
10. Colored, Oxide-Film Finish: Clear, oxide interference film produced by degreasing and then immersing in a mixture of chromic and sulfuric acids.
    a. Product: Subject to compliance with requirements, provide INCO colored stainless-steel finish as developed and licensed by International Nickel Co., Ltd.
    b. Color: Match the Owner's sample **OR** As selected from finisher's full range, **as directed**.

U. Steel And Iron Finishes
1. Galvanizing: Hot-dip galvanize products made from rolled, pressed, and forged steel shapes, castings, plates, bars, and strips indicated to be galvanized to comply with ASTM A 123/A 123M.
    a. Hot-dip galvanize steel and iron hardware indicated to be galvanized to comply with ASTM A 153/A 153M.
    b. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
    c. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
2. Preparing Galvanized Items for Shop Priming: After galvanizing, thoroughly clean decorative metal of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.

3. Preparing Nongalvanized Items for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning" **OR** SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning" **OR** requirements indicated below, **as directed**:
   a. Exteriors (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   b. Interiors (SSPC Zone 1A): SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."
4. Primer Application: Apply shop primer to prepared surfaces of items unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.
   a. Shop prime uncoated ferrous-metal surfaces with universal shop primer **OR** primers specified in Division 07, **as directed**, unless zinc-rich primer is **OR** primers specified in Division 09 Section "High-performance Coatings" are, **as directed**, indicated.
   b. Do not apply primer to galvanized surfaces.
5. Shop-Painted Finish: Comply with Division 09 Section(s) "Exterior Painting" OR "High-performance Coatings", **as directed**.
   a. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
6. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended by coating manufacturer.
   a. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
7. Powder-Coat Finish: Prepare, treat, and coat nongalvanized ferrous metal to comply with resin manufacturer's written instructions and as follows:
   a. Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   b. Treat prepared metal with iron-phosphate pretreatment, rinse, and seal surfaces.
   c. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils (0.04 mm).
   d. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
8. Powder-Coat Finish: Prepare, treat, and coat galvanized metal to comply with resin manufacturer's written instructions and as follows:
   a. Prepare galvanized metal by thoroughly removing grease, dirt, oil, flux, and other foreign matter.
   b. Treat prepared metal with zinc-phosphate pretreatment, rinse, and seal surfaces.
   c. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils (0.04 mm).
   d. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

V. Titanium Finishes
1. General: Fabricate items from finished titanium stock, taking care not to damage finish during fabrication. Protect finish as needed during fabrication by applying a strippable, temporary protective covering.
2. Dull Matte Finish: Pickled and annealed.
3. Bright Matte Finish: Vacuum annealed.

1.3 EXECUTION

A. Examination
1. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of decorative metal.

2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Installation, General
1. Provide anchorage devices and fasteners where needed to secure decorative metal to in-place construction.
2. Perform cutting, drilling, and fitting required to install decorative metal. Set products accurately in location, alignment, and elevation, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items to be built into concrete, masonry, or similar construction.
3. Fit exposed connections accurately together to form tight, hairline joints or, where indicated, uniform reveals and spaces for sealants and joint fillers. Where cutting, welding, and grinding are required for proper shop fitting and jointing of decorative metal, restore finishes to eliminate evidence of such corrective work.
4. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.
5. Install concealed gaskets, joint fillers, insulation, and flashings as work progresses.
6. Restore protective coverings that have been damaged during shipment or installation. Remove protective coverings only when there is no possibility of damage from other work yet to be performed at same location.
   a. Retain protective coverings intact; remove coverings simultaneously from similarly finished items to preclude nonuniform oxidation and discoloration.
7. Field Welding: Comply with applicable AWS specification for procedures of manual shielded metal arc welding and requirements for welding and for finishing welded connections in "Fabrication, General" Article. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
8. Field Brazing: Comply with requirements for brazing and for finishing brazed connections in "Fabrication, General" Article. Braze connections that are not to be left as exposed joints but cannot be shop brazed because of shipping size limitations.
9. Corrosion Protection: Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

C. Installing Decorative Window Security Bars
1. Fasten security bar frames to concrete and masonry walls with cast-in-place or postinstalled anchors. Peen exposed threads of anchors to prevent removal of security bars.

D. Installing Decorative Mechanical Grilles
1. Mount decorative grilles at heights and in positions indicated, adjusting ductwork to be centered on grilles if any.
   a. Secure to framing and blocking with specified fasteners.
   b. On marble, brick, and other solid surfaces, secure with wood screws in lead plugs.

E. Installing Decorative-Metal-Clad, Hollow-Metal Doors And Frames
1. Install doors and frames to comply with requirements specified in Division 08 Section "Steel Doors And Frames".

F. Installing Custom Door Pulls
1. Install door pulls at heights and locations shown. Install with backing plates on both sides of doors. Fasten backing plates to doors with oval-head wood **OR** self-tapping metal, **as directed**, screws and secure pulls through doors and backing plates with oval-head machine screws.

G. Installing Combination Hall Push-Button Stations
1. Coordinate installation of combination hall push-button stations with installation of related elevator signal equipment components specified in Division 14 Section "Electric Traction Elevators". Secure units in place with faceplate overlapping surrounding wall finish and drawn into contact with surrounding wall finish at entire perimeter of faceplate.

H. Installing Metal Reveals At Wood Paneling
   1. Install metal reveals between wood panels as paneling is installed. Secure to wood grounds with specified screws.

I. Installing Cast-Metal Rosettes At Marble Joints
   1. Install cast-metal rosettes at intersections of marble joints where indicated. Install only after marble work is complete and joints are grouted. Secure to wall by drilling a 3/4-inch- (19-mm-) round hole at intersection of marble joints and by filling hole with molding plaster into which threaded stud is embedded. Angle drill and rotate so bottom of hole is larger than at surface.
      a. Secure rosettes in place with masking tape until plaster sets. After plaster has set, remove masking tape and adhesive residue.

J. Cleaning And Protection
   1. Unless otherwise indicated, clean metals by washing thoroughly with clean water and soap, rinsing with clean water, and drying with soft cloths.
   2. Clean copper alloys according to metal finisher's written instructions in a manner that leaves an undamaged and uniform finish matching approved Sample.
   3. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
      a. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.

      OR

      Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 07 OR Division 09 Section(s) "High-performance Coatings" **OR** Division 07 AND Division 09 Section(s) "High-performance Coatings", **as directed**.
   4. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.
   5. Protect finishes of decorative metal from damage during construction period with temporary protective coverings approved by decorative metal fabricator. Remove protective covering at time of Substantial Completion.
   6. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 05720

SECTION 05720a - MISCELLANEOUS ORNAMENTAL METALS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of Trap Pit Doors; Access to Pipe Trenches; Subway Type Gratings; Manhole, Catch and Retention Basins, Hoods; Iron Fences and Railways, Wicket Guard and Fence; Pipe Railings; Chimney Caps; Cast Iron Sills; Expansion Joints; Chimney Cleanout Doors; Ladders; Ladder Rungs; Retractable Ladders and Balconies, Staircases and Counter-Balanced Stairs; Vent Back Frames in Exhaust Opening of Toilet Rooms; Grilles in Exhaust Openings in Toilet Rooms; Access Doors, Dressing Compartment Seat Frames; Stainless Steel; Lumber Rack; Ganging Rods; Auditorium Loudspeaker Grilles; Bronze Saddles (Exterior), Bronze Expansion Saddles (Interior); Bronze Pipe and Tubes; Aluminum Hat and Coat Racks and Hook Strips; Aluminum Angles for Showers; Aluminum Railings; Miscellaneous Ornamental Metal Work; Hardware.

B. Submittals/Shop Drawings
1. Show all locations, markings, quantities, materials, sizes and shapes.
2. Indicate all methods of connecting, anchoring, fastening, bracing and attaching work of other trades.
3. Do not fabricate until approval of Shop Drawing.

C. Quality Assurance
1. Retractable Ladders, Balconies, and Staircases: For use as a supplemental escape device up to 30 feet (9144 mm), comply with requirements of:
   a. Underwriters Laboratories Inc. for use as a supplementary means of egress; provide UL listing data.
   b. BOCA National Building Code, latest approved edition.
   c. ICBO Uniform Building Code; 1994.
   d. ICBO Uniform Fire Code; 1994.
   e. ICBO Uniform Fire Code; 1991.
2. For use as a mechanical equipment ladder, comply with requirements of ICBO Uniform Mechanical Code.
3. Provide Evaluation Reports showing compliance.

D. Product Handling
1. Before shipment to the job, all finished shall be adequately protected for transporting and erecting periods.
2. Replace damaged items with the approval of the Owner and at no additional cost to the Owner.

1.2 PRODUCTS

A. Frame and Covers
1. Aluminum: ASTM B 221, 6063-T6.
2. Bronze: ASTM B 455, Alloy C 38500.
3. Stainless Steel: ASTM A 167, Type 304.

B. Gratings
1. Aluminum Grating, Banding, and Kick Plate: Rectangular, pressure-locked bearing bars, ASTM B 221, 6063-T6, mill finish.
2. Steel Grating:
3. Grating: Rectangular, welded, ASTM A 569.
4. Bands and Kick Plate: ASTM A 36.

5. Finish: Galvanized, ASTM A 386, or painted with fabricator's standard shop primer.

C. Castings (Frames, Covers, Steps, and Sills)
1. Gray Iron: ASTM A 48, Class 30. Malleable Iron, ASTM A 47.
2. Steel: ASTM A 36; Galvanized, ASTM A 386.
3. Aluminum: ASTM B 26, 356-T6.
4. Stainless Steel: ASTM A 743, Grade CF8 or CF20
5. Bronze: ASTM B 455, Alloy C38500 and ASTM B 135, Alloy C2800.
6. Corner Protection: Steel angles with anchors, ASTM A 36; Galvanized, ASTM A 386.
7. Ventilation Boxes: Extruded Aluminum, ASTM B 221, 6063-T6.

D. Pipe and Tube Railings and Ladders
1. Post and rails: Steel pipe, ASTM A 53, Type E or S, Grade B, Schedule 40.
2. Bars and Rungs: ASTM A 36.
3. Finish: Galvanized, ASTM A 386 or shop primer, Fed. Spec. TT-P-86, Type I or II; TT-P-615, Type I, II, or V; TT-P-645.
4. Aluminum: ASTM B 221, 6063-T6, T-52.
5. Steel: ASTM A 36, A 500, A 501.
6. Stainless Steel: ASTM A 544, Grade MT304; ASTM A 312, Grade TP304; ASTM A 167, Type 304.

E. Retractable Ladders and Balconies
1. Ladders
   a. Maintenance-free, aluminum and stainless steel construction.
   b. Rungs: Extruded aluminum, 6005-T5 and 6005-T6 alloy.
   c. Stiles: Extruded aluminum, 6063-T6 alloy.
   d. Support 1,000 pounds (454 kg) per rung individually and 200 pounds per 6 feet (90 kg per 1.83 m) of length simultaneously.
   e. Ground support of gravity loads; building wall support for lateral stability.
   f. Provide deployment handle at each access level.
   g. Provide removable deployment handle at lower access point; provide locking hub and padlock.
   h. Provide dual safety rails at ladders with access from both sides.
   i. Provide reinforcement channel where ladders extend beyond wall support, such as at parapets and roof tops, or where ladder spans open areas in excess of 5 feet (1524 mm) between attachment points.
   j. Height: As directed.
2. Balconies
   a. Aluminum, 6063-T6 alloy.
   b. Provide aluminum access balconies at locations as directed.
   c. Size: As directed.
   d. Railing: 42-inch (1,067 mm) rail 2 sides, restraining chain 1 side.
   e. Platform Capacity: 100 pounds per square foot (488 kg/square m), unless directed otherwise.
   f. Railing Capacity: Uniform load of not less than 50 pounds per lineal foot (74.5 kg per lineal m), unless directed otherwise.
   g. Balustrade: Not less than 36 inches (914 mm) high.
   h. Pickets and Rails: Configured not to pass a sphere 4 inches (100 mm) in diameter. Exception; triangular openings formed by riser, tread, and rail, configured not to pass a sphere 6 inches (150 mm) in diameter.
3. Factory Finish: Clear anodized **OR** Manufacturer's standard shop-applied enamel **OR** As selected from manufacturer's standard colors **OR** Match paint sample supplied by the Owner, **as directed**.

F. Staircases and Counter-Balanced Stairs

1. Provide aluminum staircases, platforms, and counter-balanced stairs at locations indicated on the drawings.
2. Platform Capacity: 100 pounds per square foot (488 kg/square m), unless directed otherwise.
3. Railing Capacity: Uniform load of not less than 50 pounds per lineal foot (74.5 kg per lineal m), unless directed otherwise.
4. Required Width: Minimum 36 inches (914 mm).
5. Stair Rise: 4 inches (102 mm) minimum, 10 inches (254 mm) maximum.
6. Treads: 10 inches (254 mm) in depth.
7. Balustrade: Not less than 36 inches (914 mm) high.
8. Pickets and Rails: Configured not to pass a sphere 4 inches (101.6 mm) in diameter.
   a. Exception: Triangular openings formed by riser, tread, and rail configured not to pass a sphere 6 inches (152.4 mm) in diameter.
   b. Rail Projection: 3-1/2 inches (89 mm) maximum from each side of stairway into required width.

1.3 EXECUTION

A. Trap Pit Doors
1. Furnish and set trap pit doors and frames flush with the finish floors, pavement, grade or as otherwise required. Doors for interior pits shall be of 1/4 inch checkered steel plate set in angle frames having mitered and welded corners and angle seat for covers, provided with bronze lifting handles. Doors and frames for exterior pits shall be of cast iron and hinged with 3-1/2 x 5 inch extra heavy bronze hinges. All doors shall be provided with locking devices.

B. Access to Pipe Trenches
1. Checkered or flat steel plate access doors to pipe trenches below cellar floors shall be made in accordance with detail. Include angle iron frame, anchors, hardware, etc., complete. The steel plate access doors shall be flush with the adjoining floors. Hinges shall be approved bronze flush type. Provide bronze lift handle and approved locking device for each access door.
2. Doors shall be covered with resilient tile where required. Where cement floors occur, top of steel cover shall be flush, but depressed for other finishes as required by the thickness of floor finish. **See other Sections of Specifications for Finish.**
3. All doors under this section unless otherwise specified, shall be secured in place with bronze square shank locking device and brass deck plate with slot and socket holes. Furnish six (6) wrenches for brass deck plates for each different size of locking device.

C. Manhole, Catch and Retention Basins, Hoods
1. Furnish cast iron manhole covers, catch basin covers and cast iron hoods for masonry, manholes, catch basins and retention basins furnished and installed under Division 02.
2. Manhole covers and frames for catch basins shall be of cast iron, with locking device and key, equal to Flockhart Company No. 35-139.
3. Covers and frames for catch basins shall be of cast iron, with locking device and key, equal to Flockhart Company No. 35-328.
4. Covers and frames for catch basins shall be of cast iron, with locking device and key, equal to Flockhart Company No. 18-919.
5. Cast iron hoods for catch basins and manhole shall be equal to Flockhart Company pattern number indicated.

D. Iron Fences and Railings
1. Furnish and erect iron railings, fences, and gates. Materials of fences and railings shall be medium steel, shapes as required.
2. Posts and braces shall be leaded into cast-iron shoes, which shall be embedded in the concrete pavements or blocks. Center picket of each panel of 6 foot fence shall be leaded 2 inches into curb or pavement. Fences and railings on stone copings, platforms, steps or check blocks shall be leaded into sockets cut in same. Gates shall be hung with hinges. Provide all hasps required

for locking gates in both open and closed positions. Double and quadruple gates shall also be furnished with sliding lever bolts and galvanized, malleable iron catches having pipe anchor and drain embedded in concrete. Gates shall be locked open or closed with Type C Padlocks. Rivet the padlocks to the gates as required. Single gates require 1 padlock; double gates, 2 padlocks; quadruple gates, 4 padlocks.

3. Furnish cast-iron shoes for fence posts and set them at the proper time so that they may be cast into the concrete footing and pavements with top flush with finished surfaces.
4. Folding swing gates shall have fast pin to hold in closed position.
5. Unless otherwise required center rails and side rails on outside steps shall be made of 1-1/4 inch solid posts with 2-1/2 inch by 1/2 inch horizontal flats spaced as required, with top rail of two bronze, aluminum or steel channels and steel stiffener. Post at upper level of center railings shall be of malleable cast iron of height required, tapering from 1-3/4 inches at bottom to 1-1/4 inches at top, with finial. All posts shall be leaded-in 4 inches in cheeks and steps.

E. Wicket Guard and Fence
1. Furnish and install wicket guard fence 12 inches high constructed of 1/2 inch round bent steel rods welded together, to form a continuous wicket fence around the concrete curbing at seeded and planted areas. This guard fence shall be set in concrete footing specified under Division 03 Section "Cast-in-place Concrete".

F. Pipe Railings
1. Furnish and erect wrought iron or steel pipe railings and hand rails together with all fittings, flanges, collars, brackets, bolts, etc. of sizes required, all put together and secured in place in a thorough manner. All pipe railings shall be welded assembly, with continuous "V" joints, full thickness of pipe wall, welds filled solid and ground smooth. All radii, curves, sweeps, bends, etc., as indicated on details for pipe fitting assembly shall be maintained in the welded assembly. For pipe handrails in connection with stairs, see Division 05 Section "Pipe And Tube Railings".
2. Center pipe rails and free standing end pipe railings on outside concrete steps shall be made of 1-1/2 inch nominal diameter pipe and have pipe uprights with cast-iron collar and cap fittings secured in place with tap screws. The uprights shall be leaded-in pipe sleeves. Upright at upper level of center radii shall be of 2 inch nominal diameter pipe with approved cap.
3. Handrails at side of outside steps against walls shall be 1 inch nominal diameter pipes, with returns against wall at ends, and supported on galvanized cast-iron brackets and wall plates same as specified for egress stair.
4. Handrails at side of outside steps against iron fences shall be 1 inch nominal diameter, with returns at ends and supported on wrought iron brackets and plates. Handrails at area walls shall be 1-1/4 inch nominal diameter.
5. All outside pipe railings and handrails including fittings, etc., shall be galvanized after fabrication.
6. Furnish the combined pipe sleeve and base plate and turn over same for setting in concrete work.
7. Exterior barrier rails (at areaways, etc.) shall be of 1-1/2 inch nominal diameter pipe; interior barrier rails (at pits, changes in floor levels, etc.) shall be 1-1/4 inch nominal diameter.

G. Chimney Caps
1. Chimneys shall be provided with cast-iron caps.

H. Cast-Iron Sills
1. Furnish cast-iron sills for exterior doors of bulkheads, etc. The sills shall be set in a bed of cement and be substantially secured with bolts or expansion bolts.

I. Expansion Joints
1. Furnish and install all rolled steel members with required anchors at structural expansion joints through slabs. Items cast in concrete shall be furnished when required for setting. Provide bronze plates as required; top surfaces of plates shall be "BRONZOGRIT" or approved equal.

J. Chimney Cleanout Doors

1. Furnish to the mason proper cleanout doors of sizes indicated for chimneys, of 10 gauge steel plate and steel flats. The doors shall have angle-iron frames with strap anchors. Hang door with two 4 x 4 inch steel hinges and secure door with a latch.

K. Ladders
1. Furnish and set ladders 18 inches wide, constructed with steel plate stringers, 3/4 inch diameter single rung treads let in and welded to stringers, angle and flat braces, and when required shall have pipe hand rails all riveted together. Secure ladders with angle clip and expansion bolts at top, bottom and elsewhere as required.

L. Ladder Rungs
1. When ladder rungs are indicated built into mason work, furnish to the mason 5/8 inch galvanized wrought-iron ladder rungs.
2. Ladder rungs in concrete shall be 15 inches wide and shall be built into concrete every 14 inches in height projecting into walls 4 inches on each side.
3. Ladder rungs in brickwork of chimney shall be 18 inches wide, and shall be built into brickwork every 5 courses in height, project 8 inches beyond face of wall and continue 8 inches into wall with a 2 inch return. First rung shall start 10 feet above roof level at chimney.

M. Retractable Ladders, Staircases and Counter-Balanced Stairs
1. Fabrication: Shop fabricate and assemble to maximum extent practicable for installation on-site with minimal labor.
2. Accessories
   a. Provide brackets, spacers, etc, necessary for a complete installation.
      1) Brackets: 6063-T6 aluminum alloy.
      2) Pivot Pins, Springs, Masonry Bolts, Fasteners, and Base Plates: Stainless steel.
   b. Provide removable deployment handle at lower access point of retractable ladders.
      OR
      Provide removable deployment handle at lower access point of retractable ladders and locking hub and padlock.
   c. Fasteners for securement to wood construction: Stainless steel lag bolts; 3/8-inch (9.5 mm) diameter, 4-inches (100 mm) minimum embedment.
   d. Fasteners for securement to steel construction: Stainless steel bolts, nuts, and washers; 3/8-inch (9.5 mm) diameter.
3. Footing: Install concrete footing in accordance with manufacturer's requirements, and in compliance with Division 03 Section "Cast-in-place Concrete".
4. Install components in strict compliance with manufacturer's instructions.
5. Adjust And Clean
   a. Adjust operating parts for smooth deployment and storage.
   b. Remove scraps and debris; leave project site in clean and orderly condition.
   c. Instruct Owner's representative in proper operation.

N. Vent Back Frames in Exhaust Opening of Toilet Rooms
1. Furnish and install 12 gauge bent steel frames in exhaust openings in partitions of toilet rooms. Frames shall be set plumb in partitions to receive the vent grilles. Baffle plates are not required.

O. Grilles in Exhaust Openings
1. Furnish and set in frames at exhaust openings in toilet partitions, approved pressed steel bar type grilles with baked on primer, as manufactured by Tuttle and Bailey, Catalog No. T-80, or approved equal. Grilles shall be secured with tap screws to the frame. The bars of grilles shall be fixed and of rigid construction and shall be set at the angle required. Submit sample of grille for approval.
2. Furnish and install individually adjustable shutters attached to grille frames, in certain toilets where required. Grilles shall be bar type, equal to Register and Grille Mfg. Co. No. 3311 or Tuttle and Bailey No. A-77.

3. In general, vent openings are provided in partitions of all toilet rooms back of water closets; however, certain smaller toilets, are mechanically vented by means of vent openings in ceiling or in partitions close to ceilings.

P. Access Doors
1. Access doors and frames that are to be furnished and installed as part of the work of this Contract shall be furnished and installed under Division 08 Section "Access Doors And Frames".
2. Access doors and frames that are to be furnished and installed in metal lath and plaster walls and ceilings as part of the work of this Contract shall be constructed of high grade sheet steel with 16 gauge frames and 14 gauge doors. Doors shall be equipped with concealed hinges and cylinder locks all keyed alike (furnish six (6) keys); doors in ceilings may have screwdriver operated type of lock. Doors shall have one piece plain trim set flush with finish surface. Stock doors manufactured by Columbia Metal Product Co., Karp Metal Products Co., or approved equal complying with the specifications, may be accepted. Submit sample for approval if not already approved.

Q. Dressing Compartment Seat Frames
1. Where seats are indicated in dressing compartments, furnish and set 1/4 x 1-1/2 inch flat galvanized bent steel brackets.

R. Stainless Steel
1. Stainless Steel and Cabinet Top Supports: Furnish and install adjustable, stainless steel tubing forming legs to support the tops of sinks and cabinets together with the stainless steel screens, collars, plates, etc., of sizes required. The screens shall be wrapped around and tap screwed to the legs of sink tubing.
2. Stainless Steel Jambs at Dressing Compartments: Furnish and install 14 gauge stainless steel tube jambs at doors to dressing compartments adjoining shower stalls. These jambs shall be anchored to the structural facing tile partition with 14 gauge stainless steel straps.
3. Package Slide: Furnish and install stainless steel half round strips and anchors (type 304 (18-8)) for package slide to Receiving Room. Strips shall be plug welded to anchors.
4. Angle and Channel Guards: Furnish and install angle and channel guards in the kitchen and auxiliary areas. Guards shall be 12 gauge stainless steel satin finish of length and dimensions required, secured in place with oval head stainless steel bolts in expansion shields.
5. Stainless Steel Shelf: Furnish and install stainless steel shelves complete with brackets, of gauges required, generally in helps' locker room, over sinks in locker rooms, in eraser cleaning closets, art room and medical office.
   Note: All stainless steel shall be chrome nickel cold rolled alloy designated by trade name Stainless Steel 18-8, No. 4 Finish; it shall contain a minimum of 18% chromium, 8% nickel, and not more than 0.12% carbon, non-magnetic (straight chrome iron not accepted).

S. Lumber Rack
1. Furnish a lumber rack for the woodworking room and general crafts shop, constructed with angles and provided with chains and hoods as required.

T. Hanging Rods
1. Furnish and erect hanging rods of diameters required of wrought-iron or steel pipe supported on approved hangers, brackets or flanges cabinets, closets and elsewhere throughout the building where required.

U. Auditorium Loudspeaker Grilles
1. Furnish and install complete, two (2) loudspeaker grilles in Auditorium. Grilles shall be equal to Blumcraft Deluxe-Line. Grille facets shall have a bronze anodized finish on faces and brushed finish on backs. Supporting bars #258 to have dull black anodized finish.
2. Frame of grilles shall be equal to Blumcraft's trim section WF-4, anodized black, and be secured to masonry with stainless steel screws (slack painted heads) in expansion shields.

3. Sub-frame shall be formed from 1/4" thick aluminum bar with corners mitered, continuously welded and ground smooth and firmly secured in place. Provide continuous piano hinge with 3/16" stop angle.
4. The inside surface of grille shall be entirely covered with black grille cloth equal to "Acousticloth", as manufactured by Merlang or "Lumite", as manufactured by Chicopee. Grille cloth shall be fastened in place. Submit samples for approval.
5. Include continuous angles and all other angles, plates, bars and reinforcing channels, all as required.
6. Contractor is to verify all dimensions at job before fabricating any of the work.
7. Loudspeaker enclosure and sound absorbing blanket will be furnished and installed as part of the work of Division 16 Section "Public Address And Mass Notification Systems".

V. Bronze Saddles (Exterior)
1. All exterior door saddles shall be of bronze unless otherwise indicated. White bronze shall be provided for aluminum doors. Finish shall be "Bronzogrit" or an approved equal.

W. Bronze Expansion Saddles (Interior)
1. Furnish and install bronze expansion saddles generally in the following areas: doors opening off auditorium platform or stage; gymnasium; dance room. None required in store room. Saddles shall consist of bronze flats, plates, and angle clips. Installation shall allow for 3/4 inch expansion. Exposed surfaces of plates and flats shall be "Bronzogrit" or approved equal.

X. Bronze Pipe and Tubes
1. Furnish 1 inch square bronze tubes in toilet rooms and pipe spaces. Tubes shall be turned over to mason for installation. Tubes shall be of proper length (not less than full thickness of wall) and provided with bronze wire bars at one end.

Y. Aluminum Hat and Coat Racks and Hook Strips
1. Furnish and install hat and coat racks and hook strips in locations required. Racks and hook strips shall be constructed of aluminum channels, flats and tubing of sizes required, toggle or expansion bolted to walls to suit conditions. Aluminum shall have alumilite finish.
2. Submit shop drawings for approval.

Z. Aluminum Angles for Showers
1. Furnish and install aluminum angle bracing as required. Angles shall have alumilite finish. Submit shop drawings for approval prior to fabrication.

AA. Aluminum Railings
1. Center and side rails and wall handrails shall be of aluminum when required. Posts and horizontal members shall be solid. Posts shall be 1-1/2 inches square, extend through intermediate rails, secured to top rail with 3/8 inch stud bolts; posts at upper level shall be of height indicated, tapering from 1-3/4 inches at bottom to 1-1/4 inches at top, with finial. Posts shall be solidly set with molten sulphur or other approved non-electrolytic material into a combination 1/4 inch pipe sleeve and base plate welded to same, sleeve shall be welded to stair stringer or tread to suit condition, or set in concrete sub-stair.
2. Exterior Aluminum Railings shall be constructed required. Aluminum posts shall be solid 1-1/2 inches square, extend through bottom rail, let into top rail and continuously welded. Center railing shall have tapered aluminum post of size and taper as required for "center rail". Rails shall be formed to shape indicated from, 3" x 1" solid aluminum flats with rounded edges.
3. Roof railing shall be as required.
4. Grab bars in toilets where indicated.
5. All aluminum railings shall have finish equal to 204-C2 Aluminum Co. of America.

BB. Miscellaneous Ornamental Metal Work
1. Include all other ornamental metal work. Submit shop drawings for approval.

CC. Hardware
1. All hardware specified under Ornamental Metal Work shall match the approved samples in the office of the Owner. One sample of each item shall be submitted for approval of the Owner.
2. The key to all locks furnished under Ornamental Metal Work shall be provided with brass tags attached to the key with a strong metal ring or link and be similar to the tags specified under Hardware. The tags shall have stamped upon them the letters the Owner and the name or number of the room, closets, etc., for which the keys are intended.
3. All type C padlocks mentioned in this Section will be furnished as specified under Hardware. The Contractor for Ornamental Metal Work shall rivet padlock chains referred to in this Section in place.

DD. Painting
1. All Ornamental Metal Work and cast-iron work excepting cast-iron work to be set in concrete and galvanized items shall be thoroughly cleaned and painted one shop coat specified in Division 07.
2. After installation, all damaged surfaces of shop coat and all rough surfaces shall be scraped or sanded smooth and then touched up.

END OF SECTION 05720a

SECTION 05730 - ORNAMENTAL FORMED METAL

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for ornamental formed metal. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Beam wraps.
b. Closures and trim.
c. Column covers.
d. Decorative-metal-clad, hollow-metal doors and frames.
e. Elevator cab and entrance finishes.
f. Escalator enclosures.
g. Filler panels at demountable partitions and/or between dissimilar construction.
h. Heating-cooling unit enclosures.
i. Lighting coves.
j. Metal base.
k. Mullion cladding.
l. Pipe system covers.
m. Pockets for window treatment.
n. Window stools.
o. Exterior fins.
p. Exterior formed-metal-shaped panels.
q. Exterior sunshades.
r. Exterior trellises.
s. Exterior window covers.
t. Metal shapes as part of roof construction.

C. Performance Requirements
1. Delegated Design: Design exterior decorative formed metal items, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Structural Performance: Decorative formed metal items, including anchors and connections, shall withstand the effects of gravity loads and the following loads and stresses without exceeding the allowable design working stress of materials involved and without exhibiting permanent deformation in any components:
a. Wind Loads on Exterior Items: As indicated on Drawings **OR** 20 lbf/sq. ft. (957 Pa) **OR** 30 lbf/sq. ft. (1436 Pa) **OR** As required to meet local Project requirements.
b. Live Loads on Heating-Cooling Unit Enclosures: 100 lbf/sq. ft. (4.8 kN/sq. m) or a concentrated load of 300 lbf (1.3 kN) on an area of 4 sq. in. (26 sq. cm), whichever produces the greater stress.
3. Seismic Performance: Exterior decorative formed metal items, including anchors and connections, shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
a. Component Importance Factor is 1.0.
4. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

a. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

5. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

D. Submittals
1. Product Data: For each type of product indicated. Include finishing materials.
2. LEED Submittals:
   a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.
   b. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
3. Shop Drawings: Show fabrication and installation details for decorative formed metal.
   a. Include plans, elevations, component details, and attachments to other work.
   b. Indicate materials and profiles of each decorative formed metal member, fittings, joinery, finishes, fasteners, anchorages, and accessory items.
4. Samples: For each type of exposed finish required, prepared on 6-inch- (150-mm-) square Samples of metal of same thickness and material indicated for the Work.
5. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
6. Coordination Drawings: For decorative formed metal elements that house items specified in other Sections. Show dimensions of housed items, including locations of housing penetrations and attachments, and necessary clearances.
7. Qualification Data: For qualified Installer, fabricator, organic-coating applicator, anodic finisher, powder-coating applicator and professional engineer.
8. Mill Certificates: Signed by stainless-steel manufacturers certifying that products furnished comply with requirements.
9. Welding certificates.
10. Maintenance Data: For mirrorlike stainless-steel finish and statuary conversion coating copper-alloy finish to include in maintenance manuals.

E. Quality Assurance
1. Fabricator Qualifications: A firm experienced in producing decorative formed metal similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
2. Organic-Coating Applicator Qualifications: A firm experienced in successfully applying organic coatings of type indicated to metals of types indicated and that employs competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.
3. Anodic Finisher Qualifications: A firm experienced in successfully applying anodic finishes of type indicated and that employs competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.
4. Powder-Coating Applicator Qualifications: A firm experienced in successfully applying powder coatings of type indicated to metals of types indicated and that employs competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.
5. Installer Qualifications: Fabricator of products.
6. Welding Qualifications: Qualify procedures and personnel according to the following:
   a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   b. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
   c. AWS D1.3, "Structural Welding Code - Sheet Steel."
   d. AWS D1.6, "Structural Welding Code - Stainless Steel."

7. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Deliver decorative formed metal products wrapped in protective coverings and strapped together in suitable packs or in heavy-duty cartons. Remove protective coverings before they stain or bond to finished surfaces.
2. Store products on elevated platforms in a dry location.

G. Project Conditions
1. Field Measurements: Verify actual locations of walls, columns, beams, and other construction contiguous with decorative formed metal by field measurements before fabrication and indicate measurements on Shop Drawings.

H. Coordination
1. Coordinate installation of anchorages for decorative formed metal items. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
2. Coordinate installation of decorative formed metal with adjacent construction to ensure that wall assemblies, flashings, trim, and joint sealants, are protected against damage from the effects of weather, age, corrosion, and other causes.

1.2 PRODUCTS

A. Sheet Metal
1. General: Provide sheet metal without pitting, seam marks, roller marks, stains, discolorations, or other imperfections where exposed to view on finished units.
2. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
3. Aluminum Sheet: Flat sheet complying with ASTM B 209 (ASTM B 209M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than strength and durability properties of Alloy 5005-H32.
4. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating, either commercial steel or forming steel.
5. Steel Sheet: Uncoated, cold-rolled, ASTM A 1008/A 1008M, commercial steel, exposed or electrolytic zinc-coated, ASTM A 879/A 879M, with steel sheet substrate complying with ASTM A 1008/A 1008M, commercial steel, exposed.
6. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304 **OR** Type 316, **as directed**, stretcher-leveled standard of flatness.
7. Bronze Sheet: ASTM B 36/B 36M, Alloy UNS No. C28000 (muntz metal, 60 percent copper) or Alloy UNS No. C23000 (red brass, 85 percent copper).
8. Brass Sheet: ASTM B 36/B 36M, Alloy UNS No. C26000 (cartridge brass, 70 percent copper).
9. Copper Sheet: ASTM B 370, cold-rolled copper sheet, H00 temper.
10. Titanium Sheet: ASTM B 265, Grade 1.

B. Miscellaneous Materials
1. Gaskets: As required to seal joints in decorative formed metal and remain airtight **OR** weathertight, **as directed**; as recommended in writing by decorative formed metal manufacturer.
   a. ASTM D 1056, Type 1, Class A, grade as recommended by gasket manufacturer to obtain seal for application indicated.
   b. Closed-cell polyurethane foam, adhesive on two sides, release paper protected.
2. Sealants, Exterior: ASTM C 920; elastomeric silicone **OR** polyurethane **OR** polysulfide, **as directed**, sealant; of type, grade, class, and use classifications required to seal joints in

decorative formed metal and remain weathertight; and as recommended in writing by decorative formed metal manufacturer.

3. Sealants, Interior: Nonsag, paintable, nonstaining, latex sealant complying with ASTM C 834; of type and grade required to seal joints in decorative formed metal; and as recommended in writing by decorative formed metal manufacturer.
   a. Use sealant that has a VOC content of not more than 250 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
4. Filler Metal and Electrodes: Provide type and alloy of filler metal and electrodes as recommended by producer of metal to be welded or brazed and as necessary for strength, corrosion resistance, and compatibility in fabricated items.
   a. Use filler metals that will match the color of metal being joined and will not cause discoloration.
5. Fasteners: Fabricated from same basic metal and alloy as fastened metal unless otherwise indicated. Do not use metals that are incompatible with materials joined.
   a. Provide concealed fasteners for interconnecting decorative formed metal items and for attaching them to other work unless otherwise indicated **OR** exposed fasteners are unavoidable or are the standard fastening method, **as directed**.
   b. Provide Phillips **OR** tamper-resistant **OR** square or hex socket, **as directed**, flat-head machine screws for exposed fasteners unless otherwise indicated.
6. Structural Anchors: For applications indicated to comply with certain design loads, provide chemical or torque-controlled expansion anchors with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.
7. Nonstructural Anchors: For applications not indicated to comply with design loads, provide powder-actuated fasteners **OR** metal expansion sleeve anchors **OR** metal-impact expansion anchors, **as directed**, of type, size, and material necessary for type of load and installation indicated, as recommended by manufacturer, unless otherwise indicated.
8. Anchor Materials:
   a. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.
   b. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) **OR** Group 2 (A4), **as directed**, stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).
9. Sound-Deadening Materials:
   a. Insulation: Unfaced, mineral-fiber blanket insulation complying with ASTM C 665, Type I, and passing ASTM E 136 test.
   b. Mastic: Cold-applied asphalt emulsion complying with ASTM D 1187.
10. Backing Materials: Provided or recommended by decorative formed metal manufacturer.
11. Laminating Adhesive: Adhesive recommended by metal fabricator that will fully bond metal to metal and that will prevent telegraphing and oil canning and is compatible with substrate and noncombustible after curing.
    a. Contact Adhesive: VOC content of not more than 80 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
    b. Metal-to-Metal Adhesive: VOC content of not more than 30 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
    c. Multipurpose Construction Adhesive: VOC content of not more than 70 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
    d. Special-Purpose Contact Adhesive: (Contact adhesive used to bond melamine-covered board, metal, unsupported vinyl, ultrahigh molecular weight polyethylene, and rubber or wood veneer, 1/16 inch thick or less, to any surface): 250 g/L.
12. Isolation Coating: Manufacturer's standard alkali-resistant coating **OR** bituminous paint **OR** epoxy coating, **as directed**.

C. Paints And Coatings
   1. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
   2. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
   3. Lacquer for Copper Alloys: Clear, acrylic lacquer specially developed for coating copper-alloy products.
   4. Shop Primers: Comply with Division 07 OR Division 09 Section(s) "High-performance Coatings", **as directed**.
   5. Universal Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
      a. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
   6. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
   7. Shop Primer for Galvanized Steel: Cementitious galvanized metal primer complying with MPI#26 **OR** Vinyl wash primer complying with MPI#80 **OR** Water-based galvanized metal primer complying with MPI#134, **as directed**.
   8. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

D. Fabrication, General
   1. Shop Assembly: Preassemble decorative formed metal items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
   2. Coordinate dimensions and attachment methods of decorative formed metal items with those of adjoining construction to produce integrated assemblies with closely fitting joints and with edges and surfaces aligned unless otherwise indicated.
   3. Form metal to profiles indicated, in maximum lengths to minimize joints. Produce flat, flush surfaces without cracking or grain separation at bends. Fold back exposed edges of unsupported sheet metal to form a 1/2-inch- (12-mm-) wide hem on the concealed side, or ease edges to a radius of approximately 1/32 inch (1 mm) and support with concealed stiffeners.
   4. Increase metal thickness or reinforce with concealed stiffeners, backing materials, or both, as needed to provide surface flatness equivalent to stretcher-leveled standard of flatness and sufficient strength for indicated use.
      a. Support joints with concealed stiffeners as needed to hold exposed faces of adjoining sheets in flush alignment.
   5. Build in straps, plates, and brackets as needed to support and anchor fabricated items to adjoining construction. Reinforce decorative formed metal items as needed to attach and support other construction.
   6. Provide support framing, mounting and attachment clips, splice sleeves, fasteners, and accessories needed to install decorative formed metal items.
   7. Where welding or brazing is indicated, weld or braze joints and seams continuously. Grind, fill, and dress to produce smooth, flush, exposed surfaces in which joints are not visible after finishing is completed.
      a. Use welding and brazing procedures that will blend with and not cause discoloration of metal being joined.

E. Beam Wraps
   1. Form beam wraps from metal of type and thickness indicated below. Fabricate to fit tightly to adjoining construction.
      a. Aluminum Sheet: 0.063 inch (1.60 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
         1) Finish: Baked enamel or powder coat **OR** Siliconized polyester **OR** High-performance organic coating **OR** Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
      b. Steel Sheet: 0.060 inch (1.52 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
         1) Finish: Factory primed **OR** Baked enamel **OR** Powder coat, **as directed**.

c. Stainless-Steel Sheet: 0.050 inch (1.27 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
   1) Finish: No. 2B **OR** No. 4 **OR** No. 6 **OR** No. 7 **OR** No. 8, **as directed**.

2. Fabricate with calk stop angle to retain backer rod and sealant.

F. Closures And Trim
1. Form closures and trim from metal of type and thickness indicated below. Fabricate to fit tightly to adjoining construction, with weathertight joints at exterior installations.
   a. Aluminum Sheet: 0.063 inch (1.60 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
      1) Finish: Baked enamel or powder coat **OR** Siliconized polyester **OR** High-performance organic coating **OR** Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
   b. Galvanized-Steel Sheet: 0.052 inch (1.32 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
      1) Finish: Factory primed **OR** Baked enamel **OR** Siliconized polyester **OR** High-performance organic coating **OR** Powder coat, **as directed**.
   c. Steel Sheet: 0.048 inch (1.21 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
      1) Finish: Factory primed **OR** Baked enamel **OR** Powder coat, **as directed**.
   d. Closures and trim may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view and not exposed to weather.
2. Conceal fasteners where possible; otherwise, locate where they are as inconspicuous as possible. Size fasteners to support closures and trim, with fasteners spaced to prevent buckling or waviness in finished surfaces.
3. Drill and tap holes needed for securing closures and trim to other surfaces.
4. Incorporate gaskets where indicated or needed for concealed, continuous seal at abutting surfaces.
5. Miter or cope trim members at corners and reinforce with bent metal splice plates to form tight joints.

G. Column Covers
1. Spackled-Seam Type: Form column covers from 0.125-inch (3.2-mm) aluminum, rolled to radii indicated. Taper edges of adjoining pieces of column covers, for taping and spackling, to 0.094-inch (2.4-mm) thickness in approximately 1 inch (25 mm) of width. Punch tapered edges for gypsum board screws at 1/2 inch (12 mm) o.c., and mill grooves in tapered edge to improve bond with joint compound.
   a. Support Framing: At vertical joints, provide 1-1/2-by-3-5/8-inch (38-by-89-mm) steel channel support posts formed from 0.040-inch (1.0-mm) galvanized steel.
   b. Joint Treatment Materials: Provide joint treatment compounds and reinforcing tape complying with requirements in Division 9 Section "Gypsum Board."
2. Snap-Together Type: Form column covers to shapes indicated from metal of type and minimum thickness indicated below. Return vertical edges and bend to form hook that will engage continuous mounting clips.
   a. Aluminum Sheet: 0.063 inch (1.60 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
      1) Finish: Baked enamel or powder coat **OR** Siliconized polyester **OR** High-performance organic coating **OR** Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
   b. Steel Sheet: 0.060 inch (1.52 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
      1) Finish: Factory primed **OR** Baked enamel **OR** Powder coat, **as directed**.
   c. Stainless-Steel Sheet: 0.050 inch (1.27 mm) **OR** Thickness required to comply with performance requirements, **as directed**.

1) Finish: No. 2B **OR** No. 4 **OR** No. 6 **OR** No. 7 **OR** No. 8, **as directed**.

d. Bronze Sheet: 0.051 inch (1.29 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
   1) Finish: Buffed finish, lacquered **OR** Hand-rubbed finish, lacquered **OR** Statuary conversion coating over satin finish, **as directed**.

e. Brass Sheet: 0.051 inch (1.29 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
   1) Finish: Buffed **OR** Hand-rubbed, **as directed**, finish, lacquered.

f. Column covers may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view.

g. Form returns at vertical joints to provide hairline V-joints.
   OR
   Form returns at vertical joints to provide 1/2-inch- (12-mm-) **OR** 3/4-inch- (18-mm-), **as directed**, wide reveal at joints. Provide snap-in metal filler strips at reveals that leave reveals 1/2 inch (12 mm) deep **OR** flush, **as directed**.
   OR
   Form returns at vertical joints to accommodate backer rod and sealant.

h. Fabricate column covers with hairline horizontal V-joints produced by forming returns on mating ends of column cover sections. Locate horizontal joints as indicated.
   OR
   Fabricate column covers without horizontal joints.
   OR
   Fabricate column covers with horizontal butt joints, tightly fitted and backed with a sleeve for field splicing with adhesive.
   OR
   Fabricate column covers with 1/2-inch- (12-mm-) wide, **as directed**, reveals at horizontal joints produced by forming returns on mating ends of column cover sections. Provide snap-in metal filler strips at reveals matching reveals at vertical joints. Locate horizontal joints as indicated.

i. Fabricate base **OR** ceiling, **as directed**, ring to match **OR** contrast with, **as directed**, column covers.

j. Fabricate with calk stop/stiffener ring.

k. Apply manufacturer's recommended sound-deadening insulation **OR** mastic, **as directed**, to backs of column covers.

H. Decorative-Metal-Clad Doors And Frames

1. Laminate metal sheets, of type and thickness indicated below, to faces of hollow-metal doors and frames and elevator entrances where indicated:
   a. Bronze Sheet: 0.040 inch (1.02 mm).
      1) Finish: Buffed finish, lacquered **OR** Hand-rubbed finish, lacquered **OR** Statuary conversion coating over satin finish, lacquered, **as directed**.
   b. Brass Sheet: 0.040 inch (1.02 mm).
      1) Finish: Buffed **OR** Hand-rubbed, **as directed**, finish lacquered.
   c. Stainless-Steel Sheet: 0.038 inch (0.95 mm).
      1) Finish: No. 2B **OR** No. 4 **OR** No. 6 **OR** No. 7 **OR** No. 8, **as directed**.
   d. Titanium Sheet: 0.025 inch (0.64 mm).
      1) Finish: Dull **OR** Bright, **as directed**, matte.

I. Escalator Enclosures

1. Form escalator enclosures from metal of type and thickness indicated below. Coordinate size of enclosures, location of cutouts, and method of attachment to adjoining construction.
   a. Stainless-Steel Sheet: 0.062 inch (1.59 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
      1) Finish: No. 2B **OR** No. 4 **OR** No. 6 **OR** No. 7 **OR** No. 8, **as directed**.
   b. Bronze Sheet: 0.081 inch (2.05 mm) **OR** Thickness required to comply with performance requirements, **as directed**.

1) Finish: Buffed finish, lacquered **OR** Hand-rubbed finish, lacquered **OR** Statuary conversion coating over satin finish, **as directed**.

J. Filler Panels
1. Form filler panels for closing ends of partition systems and for other applications indicated. Form from two sheets of metal of type and thickness indicated below, separated by channels formed from the same material, producing a panel of same thickness as partitions **OR** mullions, **as directed**, unless otherwise indicated. Incorporate reveals, trim, and concealed anchorages for attaching to adjacent surfaces.
   a. Galvanized-Steel Sheet: 0.064 inch (1.63 mm).
      1) Finish: Factory primed **OR** Baked enamel **OR** Siliconized polyester **OR** High-performance organic coating **OR** Powder coat, **as directed**.
   b. Steel Sheet: 0.060 inch (1.52 mm).
      1) Finish: Factory primed **OR** Baked enamel **OR** Powder coat, **as directed**.
   c. Filler panels may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view.
2. Fill interior of panel with sound-deadening insulation permanently attached to inside panel faces.
3. Adhesively attach gaskets to filler panel edges where they abut mullions or glazing. Use 1-inch-(25-mm-) square material, unless otherwise indicated, set approximately 1/4 inch (6 mm) into channeled edge of filler panel.
   OR
   Attach gaskets to all edges of panels that abut adjacent surfaces to form a continuous seal. Use compressible gaskets or mastic sealing tape, applied to center of panel edges to be concealed from view, unless otherwise indicated.
4. Do not mechanically fasten filler panels to mullions.

K. Heating-Cooling Unit Enclosures
1. Fabricate heating-cooling unit enclosures from metal of type and thickness indicated below:
   a. Galvanized-Steel Sheet:
      1) Framing: 0.108 inch (2.74 mm) **OR** Thickness required to comply with performance requirements.
      2) Sills and Stools: 0.079 inch (2.01 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
      3) Front Panels and Bases: 0.064 inch (1.63 mm).
      4) Concealed Panels and Trim: 0.040 inch (1.02 mm).
      5) Finish: Factory primed **OR** Baked enamel **OR** Siliconized polyester **OR** High-performance organic coating **OR** Powder coat, **as directed**.
   b. Steel Sheet:
      1) Framing: 0.105 inch (2.66 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
      2) Sills and Stools: 0.075 inch (1.90 mm) **OR** Thickness required to comply with performance requirements, **as directed**.
      3) Front Panels and Bases: 0.060 inch (1.52 mm).
      4) Concealed Panels and Trim: 0.036 inch (0.91 mm).
      5) Finish: Factory primed **OR** Baked enamel **OR** Powder coat, **as directed**.
2. Weld seams and connections unless otherwise indicated or unless other methods are necessary for access to heating and cooling equipment.
3. Incorporate stiffeners or laminated backing using noncombustible materials as needed for strength and rigidity.
   a. Fill space between stiffeners with sound-deadening insulation attached to face sheet with insulation adhesive unless otherwise indicated.
      OR
      Coat concealed faces of metal panels more than 6 inches (150 mm) wide with a heavy coating of sound-deadening mastic applied at the minimum rate of 20 sq. ft./gal. (0.5 sq. m/L).

4. Provide louvers and grilles of size, type, and materials indicated.
   a. For removable grilles, use modular units with recessed openings formed into surfaces of enclosures and without blank filler panels between grilles, so face panels and stools are continuous. Fabricate removable grilles and openings to precise tolerances to produce well-fitted assemblies free of warp or rattle, with grilles supported continuously along parallel edges and with tops flush with top of enclosure.
5. Incorporate removable tops and fronts where indicated or needed for access to heating-cooling units and to piping, ductwork, controls, and electrical service, with panels and openings as follows:
   a. Fabricate with a fitting tolerance of not less than 1/32 inch (0.8 mm) and not more than 1/16 inch (1.6 mm) at each edge, with face of panels flush with adjoining fixed surfaces of enclosure.
   b. Form panels for easy removal without interfering with adjoining construction or furniture. Hold panels in place with concealed clips and hardware that prevent warp and rattle.
6. Incorporate hinged access panels in enclosures for access to heating-cooling unit controls, as either separate elements or integrated with grille openings, as indicated or needed.
7. Coordinate construction, configuration, and dimensions of enclosures with those of heating-cooling units. Provide support for heating-cooling units and controls where indicated. Provide blind knockouts and supports for piping, ductwork, control lines, electrical conduit, and wiring where indicated or needed.
8. Locate fixed surfaces of enclosure to coincide precisely with window mullions and partition system terminations. Provide closures at ends of units, at recessed openings in base of units, and at other locations where needed to conceal unfinished wall or floor surfaces, piping, conduit, ductwork, or heating-cooling units.
   a. Provide built-in partitions (bulkheads) within enclosures between heating-cooling units, located to coincide with mullions and partition system terminations. Seal partitions to faces of enclosures with compressible gaskets or mastic sealing tape, and cover both sides of partitions with sound-deadening insulation attached to partitions with insulation adhesive.

L. Lighting Coves
1. Form lighting coves from metal of type and thickness indicated below. Coordinate size of coves, location of cutouts for electrical wiring, and method of attachment to adjoining construction.
   a. Aluminum Sheet: 0.063 inch (1.60 mm).
      1) Finish: Baked enamel or powder coat **OR** Siliconized polyester **OR** High-performance organic coating **OR** Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
   b. Galvanized-Steel Sheet: 0.052 inch (1.32 mm).
      1) Finish: Factory primed **OR** Baked enamel **OR** Siliconized polyester **OR** High-performance organic coating **OR** Powder coat, **as directed**.
   c. Steel Sheet: 0.048 inch (1.21 mm).
      1) Finish: Factory primed **OR** Baked enamel **OR** Powder coat, **as directed**.
   d. Fabricate light coves with hairline butt joints **OR** tapered edges for taping and spackling, **as directed**.
   e. Provide mitered corners, factory welded with backplates **OR** factory endcaps, **as directed**.
   f. Lighting coves may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view.

M. Metal Base
1. Form metal base from metal of type and thickness indicated below:
   a. Aluminum Sheet: 0.063 inch (1.60 mm).
      1) Finish: Baked enamel or powder coat **OR** Siliconized polyester **OR** High-performance organic coating **OR** Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
   b. Stainless-Steel Sheet: 0.050 inch (1.27 mm).
      1) Finish: No. 2B **OR** No. 4 **OR** No. 6 **OR** No. 7 **OR** No. 8, **as directed**.

N. Mullion Cladding
1. Form mullion cladding from metal of type and thickness indicated below. Fabricate to fit tightly to adjoining construction.
   a. Aluminum Sheet: 0.063 inch (1.60 mm).
      1) Finish: Baked enamel or powder coat **OR** Siliconized polyester **OR** High-performance organic coating **OR** Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
   b. Galvanized-Steel Sheet: 0.052 inch (1.32 mm).
      1) Finish: Factory primed **OR** Baked enamel **OR** Siliconized polyester **OR** High-performance organic coating **OR** Powder coat, **as directed**.
   c. Stainless-Steel Sheet: 0.050 inch (1.27 mm).
      1) Finish: No. 2B **OR** No. 4 **OR** No. 6 **OR** No. 7 **OR** No. 8, **as directed**.

O. Pipe System Covers
1. Form pipe system covers from metal of type and thickness indicated below. Coordinate size of covers, location of cutouts for piping, and method of attachment to adjoining construction.
   a. Galvanized-Steel Sheet: 0.052 inch (1.32 mm).
      1) Finish: Factory primed **OR** Baked enamel **OR** Siliconized polyester **OR** High-performance organic coating **OR** Powder coat, **as directed**.
   b. Steel Sheet: 0.048 inch (1.21 mm).
      1) Finish: Factory primed **OR** Baked enamel **OR** Powder coat, **as directed**.

P. Pockets For Window Treatment
1. Form pockets from metal of type and thickness indicated below, with end closures. Coordinate dimensions and attachment methods with window treatment equipment, window frames, ceiling suspension system, and other related construction to produce a coordinated, closely fitting assembly.
   a. Aluminum Sheet: 0.063 inch (1.60 mm).
      1) Finish: Baked enamel or powder coat **OR** Siliconized polyester **OR** High-performance organic coating **OR** Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
   b. Galvanized-Steel Sheet: 0.052 inch (1.32 mm).
      1) Finish: Factory primed **OR** Baked enamel **OR** Siliconized polyester **OR** High-performance organic coating **OR** Powder coat, **as directed**.
   c. Steel Sheet: 0.048 inch (1.21 mm).
      1) Finish: Factory primed **OR** Baked enamel **OR** Powder coat, **as directed**.
   d. Pockets for window treatment may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view.
2. Reinforce pockets for attaching window treatment equipment and hardware, or increase metal thickness.
3. Divide continuous pockets with built-in partitions located to separate adjoining drapery and blind units, to coincide with window mullions, and to receive filler panels at ends of partitions.

Q. Window Stools
1. Form window stools from metal of type and thickness indicated below, with end closures:
   a. Aluminum Sheet: 0.063 inch (1.60 mm).
      1) Finish: Baked enamel or powder coat **OR** Siliconized polyester **OR** High-performance organic coating **OR** Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
   b. Galvanized-Steel Sheet: 0.052 inch (1.32 mm).
      1) Finish: Factory primed **OR** Baked enamel **OR** Siliconized polyester **OR** High-performance organic coating **OR** Powder coat, **as directed**.
   c. Stainless-Steel Sheet: 0.050 inch (1.27 mm) **OR** 1.3 mm, **as directed**.
      1) Finish: No. 2B **OR** No. 4 **OR** No. 6 **OR** No. 7 **OR** No. 8, **as directed**.
   d. Bronze Sheet: 0.051 inch (1.29 mm).

1) Finish: Buffed finish, lacquered **OR** Hand-rubbed finish, lacquered **OR** Statuary conversion coating over satin finish, **as directed**.

2. Weld seams at end closures.
   OR
   Braze seams at end closures.
3. Apply sound-deadening insulation **OR** mastic, **as directed**, to underside of window stools.

R. General Finish Requirements
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Complete mechanical finishes of flat sheet metal surfaces before fabrication where possible. After fabrication, finish all joints, bends, abrasions, and other surface blemishes to match sheet finish.
3. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
4. Apply organic and anodic finishes to formed metal after fabrication unless otherwise indicated.
5. Finish items indicated on Drawings after assembly.
6. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

S. Aluminum Finishes
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
3. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
   a. Color: Champagne **OR** Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As selected from full range of industry colors and color densities, **as directed**.
4. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
5. Siliconized Polyester Finish: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
6. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 **OR** AAMA 2605, **as directed**, and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

   OR

   High-Performance Organic Finish: Three **OR** Four, **as directed**,-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   b. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

T. Galvanized-Steel Sheet Finishes
1. Preparing Galvanized Items for Factory Priming: Thoroughly clean galvanized decorative formed metal of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.
2. Preparing Galvanized Items for Factory Finishing: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it.
3. Repairing Galvanized Surfaces: Clean welds and abraded areas and repair galvanizing to comply with ASTM A 780.
4. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply shop primer to prepared surfaces of items unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
5. Factory-Painted Finish: Comply with Division 09 Section(s) "Exterior Painting" OR "High-performance Coatings", **as directed**.
   a. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
6. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil (0.025 mm) for topcoat. Comply with paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils (0.05 mm).
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
7. Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils (0.04 mm). Prepare, treat, and coat metal to comply with resin manufacturer's written instructions.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
8. Siliconized-Polyester Coating: Immediately after cleaning and pretreating, apply manufacturer's standard epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
9. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 **OR** AAMA 2605, **as directed**, and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

   OR

   High-Performance Organic Finish: Three **OR** Four, **as directed**,-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

U. Steel Sheet Finishes
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."
2. Pretreatment: Immediately after cleaning, apply a conversion coating of type suited to organic coating applied over it.

3. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply shop primer to prepared surfaces of items unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
4. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils (0.05 mm).
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
5. Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils (0.04 mm). Prepare, treat, and coat metal to comply with resin manufacturer's written instructions.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

V. Stainless-Steel Finishes
1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
   a. Run grain of directional finishes with long dimension of each piece.
3. Bright, Cold-Rolled, Unpolished Finish: No. 2B.
4. Directional Satin Finish: No. 4.
5. Dull Satin Finish: No. 6.
6. Satin, Reflective, Directional Polish: No. 7.
7. Mirrorlike Reflective, Nondirectional Polish: No. 8 finish.
8. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

W. Copper-Alloy Finishes
1. Finish designations for copper alloys comply with the system established for designating copper-alloy finish systems defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products."
2. Buffed Finish: M21 (Mechanical Finish: buffed, smooth specular).
3. Hand-Rubbed Finish: M31-M34 (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed).
4. Medium-Satin Finish: M32 (Mechanical Finish: directionally textured, medium satin).
5. Fine-Matte Finish: M42 (Mechanical Finish: nondirectional finish, fine matte).
6. Buffed Finish, Lacquered: M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear organic, air drying, as specified below).
   a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
7. Hand-Rubbed Finish, Lacquered: M31-M34-O6x (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed; Coating: clear organic, air drying, as specified below).
   a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
8. Medium-Satin Finish, Lacquered: M32-O6x (Mechanical Finish: directionally textured, medium satin; Coating: clear organic, air drying, as specified below).
   a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
9. Fine-Matte Finish, Lacquered: M42-O6x (Mechanical Finish: nondirectional finish, fine matte; Coating: clear organic, air drying, as specified below).

a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).

10. Statuary Conversion Coating over Satin Finish: M31-C55 (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide), with color matching the Owner's sample.
11. Statuary Conversion Coating over Satin Finish, Lacquered: M31-C55-O6x (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide; Coating: clear, organic, air drying, as specified below) , with color matching the Owner's sample:
    a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).

X. Titanium Finishes
1. General: Fabricate items from finished titanium sheet, taking care not to damage finish during fabrication. Protect finish as needed during fabrication by applying a strippable, temporary protective covering.
2. Dull Matte Finish: Pickled and annealed.
3. Bright Matte Finish: Vacuum annealed.

1.3 EXECUTION

A. Examination
1. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of decorative formed metal.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Installation
1. Locate and place decorative formed metal items level and plumb and in alignment with adjacent construction. Perform cutting, drilling, and fitting required to install decorative formed metal.
    a. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.
2. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where needed to protect metal surfaces and to make a weathertight connection.
3. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers as indicated.
4. Install concealed gaskets, joint fillers, insulation, sealants, and flashings, as the Work progresses, to make exterior decorative formed metal items weatherproof.
5. Install concealed gaskets, joint fillers, sealants, and insulation, as the Work progresses, to make interior decorative formed metal items soundproof or lightproof as applicable to type of fabrication indicated.
6. Corrosion Protection: Apply bituminous paint or other permanent separation materials on concealed surfaces where metals would otherwise be in direct contact with substrate materials that are incompatible or could result in corrosion or deterioration of either material or finish.
7. Install decorative-formed-metal-clad doors and frames to comply with requirements specified in Division 08 Section "Steel Doors And Frames".
8. Apply joint treatment at joints of spackled-seam-type metal column covers. Comply with requirements in Division 09 Section "Gypsum Board".

C. Adjusting And Cleaning
1. Unless otherwise indicated, clean metals by washing thoroughly with clean water and soap, rinsing with clean water, and drying with soft cloths.

2. Clean copper alloys according to metal finisher's written instructions in a manner that leaves an undamaged and uniform finish matching approved Sample.
3. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
   a. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.
4. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 07 OR Division 09 Section(s) "High-performance Coatings" **OR** Division 07 AND Division 09 Section(s) "High-performance Coatings", **as directed**.
5. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit or provide new units.

D. Protection
1. Protect finishes of decorative formed metal items from damage during construction period. Remove temporary protective coverings at time of Substantial Completion.

END OF SECTION 05730

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Task	Specification	Specification Description
05730	05720	Ornamental Metal
05735	05720	Ornamental Metal
05735	05730	Ornamental Formed Metal

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SECTION 05805 - ARCHITECTURAL JOINT SYSTEMS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for architectural joint systems. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.
2. See Division 03 Section "Cast-in-place Concrete" for cast-in architectural-joint-system frames furnished, but not installed, in this Section.

B. Definitions
1. Maximum Joint Width: Widest linear gap a joint system tolerates and in which it performs its designed function without damaging its functional capabilities.
2. Minimum Joint Width: Narrowest linear gap a joint system tolerates and in which it performs its designed function without damaging its functional capabilities.
3. Movement Capability: Value obtained from the difference between widest and narrowest widths of a joint opening typically expressed in numerical values (mm or inches) or a percentage (plus or minus) of nominal value of joint width.
4. Nominal Joint Width: The width of the linear opening specified in practice and in which the joint system is installed.

C. Submittals
1. Shop Drawings: Provide placement drawings, including line diagrams and details, and a tabular schedule of architectural joint systems.

D. Quality Assurance
1. Accessibility Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines (ADAAG)" and ICC A117.1.
2. Fire-Test-Response Characteristics: Where indicated, provide architectural joint system and fire-barrier assemblies identical to those of assemblies tested for fire resistance per UL 2079 or ASTM E 1966 by a testing and inspecting agency acceptable to authorities having jurisdiction.
   a. Hose Stream Test: Wall-to-wall and wall-to-ceiling assemblies shall be subjected to hose stream testing.

1.2 PRODUCTS

A. Materials
1. Aluminum: ASTM B 221 (ASTM B 221M), Alloy 6063-T5 for extrusions; ASTM B 209 (ASTM B 209M), Alloy 6061-T6 for sheet and plate.
   a. Apply manufacturer's standard protective coating on aluminum surfaces to be placed in contact with cementitious materials.
   b. Mill Finish.
   c. Clear Anodic Finish: Class II, clear anodic coating **OR** Class I, clear anodic coating, **as directed**, complying with AAMA 611.
   d. Color Anodic Finish: Class II, color anodic coating **OR** Class I, color anodic coating, **as directed**, complying with AAMA 611.
   e. High-Performance Organic Finish (Two-Coat Fluoropolymer): Comply with AAMA 2604 and with coating and resin manufacturers' written instructions.
2. Stainless Steel: ASTM A 666, Type 304 for plates, sheet, and strips.
3. Brass: ASTM B 36/B 36M, UNS Alloy C26000 for half hard sheet and coil.

4. Bronze: ASTM B 455, Alloy C38500 for extrusions; Alloy C23000 red brass for plates.
5. Moisture Barrier: PVC , minimum 30 mils thick **OR** EPDM, minimum 45 mils thick **OR** Santoprene, **as directed**.
6. Elastomeric Seals: Preformed elastomeric membranes or extrusions to be installed in metal frames.
7. Compression Seals: ASTM E 1612; preformed rectangular elastomeric extrusions having internal baffle system and designed to function under compression.
8. Strip Seals: ASTM E 1783; preformed elastomeric membrane or tubular extrusions having an internal baffle system and secured in or over a joint by a metal locking rail.
9. Cellular Foam Seals: Extruded, compressible foam designed to function under compression.
10. Elastomeric Concrete: Modified epoxy or polyurethane extended into a prepackaged aggregate blend, specifically designed for bonding to concrete substrates.
11. Fire Barriers: Any material or material combination, when fire tested after cycling, designated to resist the passage of flame and hot gases through a movement joint and to meet performance criteria for required rating period.
12. Accessories: Manufacturer's standard anchors, fasteners, and other accessories as required for complete installations.

B. Architectural Joint Systems, General
   1. General: Provide joint systems of design indicated.
      a. Furnish in longest practicable lengths to minimize splicing. Install with hairline mitered corners where joint changes direction.
      b. Include factory-fabricated closure materials and transition pieces to provide continuous joint systems.
   2. Design architectural joint systems for the following size and movement characteristics:
      a. Nominal Joint Width: As indicated on Drawings **OR** As scheduled, **as directed**.
      b. Movement Capability: Plus or minus 25 percent **OR** Plus or minus 50 percent **OR** Plus or minus 100 percent **OR** As indicated on Drawings **OR** As scheduled, **as directed**.
      c. Type of Movement: As indicated on Drawings **OR** As scheduled **OR** Thermal **OR** Seismic **OR** Wind sway, **as directed**.

C. Architectural Joint Systems For Building Interiors
   1. Floor-to-Floor and Floor-to-Wall Joint Systems:
      a. Type: Cover plate **OR** Center plate **OR** Glide plate **OR** Hidden sightline **OR** Pan **OR** Surface mounted, **as directed**.
         1) Exposed Metal: Aluminum **OR** Stainless steel **OR** Bronze **OR** Brass, **as directed**.
            a) Finish: Manufacturer's standard finish **OR** Mill **OR** Class I, clear anodic **OR** Class II, clear anodic **OR** No. 2B **OR** No, 4, **as directed**.
            b) Color: As selected from manufacturer's full range.
      b. Type: Elastomeric **OR** Dual elastomeric, **as directed**, seal.
         1) Exposed Metal: Aluminum **OR** Stainless steel **OR** Bronze **OR** Brass, **as directed**.
            a) Finish: Manufacturer's standard finish **OR** Mill **OR** Class I, clear anodic **OR** Class II, clear anodic **OR** No. 2B **OR** No, 4, **as directed**.
            b) Color: As selected from manufacturer's full range.
         2) Seal Material: Santoprene.
            a) Color: As selected from manufacturer's full range.
      c. Cover-Plate Design:
         1) Plain **OR** Serrated **OR** Abrasive filled, **as directed**.
         2) Recessed to accept field-applied finish materials.
            a) Recess Depth: To accommodate adjacent flooring.
      d. Attachment Method: Mechanical anchors **OR** Cast in, **as directed**.
      e. Load Capacity: Standard **OR** Heavy **OR** Extra heavy, **as directed**, duty.
      f. Fire-Resistance Rating: Match adjacent construction.
      g. Moisture Barrier: Manufacturer's standard.
   2. Wall-to-Wall and Wall Corner Joint Systems:

a. Type: Vertical cover plate **OR** Glide plate **OR** Hidden sightline **OR** Snap-on cover **OR** Clip-in cover, **as directed**.
   1) Exposed Metal: Aluminum **OR** Stainless steel **OR** Bronze **OR** Brass, **as directed**.
      a) Finish: Manufacturer's standard finish **OR** Mill **OR** Class I, clear anodic **OR** Class II, clear anodic **OR** No. 2B **OR** No, 4, **as directed**.
      b) Color: As selected from manufacturer's full range.

b. Type: Elastomeric seal **OR** Dual elastomeric seal **OR** Accordion, **as directed**.
   1) Exposed Metal: Aluminum **OR** Stainless steel **OR** Bronze **OR** Brass, **as directed**.
      a) Finish: Manufacturer's standard finish **OR** Mill **OR** Class I, clear anodic **OR** Class II, clear anodic **OR** No. 2B **OR** No, 4, **as directed**.
      b) Color: As selected from manufacturer's full range.
   2) Seal Material: Santoprene **OR** PVC, **as directed**.
      a) Color: As selected from manufacturer's full range.

c. Type: Flat seal.
   1) Seal Material: Santoprene.
      a) Color: As selected from manufacturer's full range.

d. Fire-Resistance Rating: Match adjacent construction.

e. Moisture Barrier: Manufacturer's standard.

3. Wall-to-Ceiling and Ceiling-to-Ceiling Joint Systems:

a. Type: Cover plate **OR** Glide plate **OR** Snap-on cover **OR** Clip-in cover, **as directed**.
   1) Exposed Metal: Aluminum **OR** Stainless steel **OR** Bronze **OR** Brass, **as directed**.
      a) Finish: Manufacturer's standard finish **OR** Mill **OR** Class I, clear anodic **OR** Class II, clear anodic **OR** No. 2B **OR** No, 4, **as directed**.
      b) Color: As selected from manufacturer's full range.

b. Type: Elastomeric seal **OR** Dual elastomeric seal **OR** Accordion, **as directed**.
   1) Exposed Metal: Aluminum **OR** Stainless steel **OR** Bronze **OR** Brass, **as directed**.
      a) Finish: Manufacturer's standard finish **OR** Mill **OR** Class I, clear Color: As selected from manufacturer's full range.
      b) Seal Material: Santoprene **OR** PVC, **as directed**.
      c) Color: As selected from manufacturer's full range.

c. Type: Flat seal.
   1) Seal Material: Santoprene.
      a) Color: As selected from manufacturer's full range.

d. Fire-Resistance Rating: Match adjacent construction.

e. Moisture Barrier: Manufacturer's standard.

D. Architectural Joint Systems For Building Exteriors

1. Architectural Joint Systems for Exterior Walls and Soffits:

a. Type: Vertical cover-plate.
   1) Exposed Metal: Aluminum **OR** Stainless steel, **as directed**.
      a) Finish: Manufacturer's standard finish **OR** Mill **OR** Class I, clear anodic **OR** Class II, clear anodic **OR** Class I, color anodic **OR** Class II, color anodic **OR** High-performance organic **OR** No. 2B **OR** No. 4, **as directed**.
      b) Color: As selected from full range of industry colors and color densities.
   2) Secondary Seal: Manufacturer's standard extruded-elastomeric seal designed to prevent water and moisture infiltration.

b. Type: Flat seal.
   1) Seal Material: Santoprene.
      a) Color: As selected from manufacturer's full range.
   2) Secondary Seal: Manufacturer's standard extruded-elastomeric seal designed to prevent water and moisture infiltration.
   3) Pantograph Mechanism: Manufacturer's standard nylon pantographic wind-load support mechanism with stainless-steel fasteners.

c. Type: Preformed cellular foam.

1) Foam Material: Manufacturer's standard **OR** Non-extruded, low-density, crosslinked, nitrogen-blown, ethylene-vinyl-acetate copolymer **OR** Polyurethane, **as directed**.
a) Color: As selected from manufacturer's full range.

d. Fire-Resistance Rating: Match adjacent construction.

E. Architectural Joint Systems For Open-Air Structures

1. Slab-to-Slab Joint Systems for Parking Structures **OR** Plaza Decks **OR** Stadiums, **as directed**:
a. Type: Metal plate.
1) Exposed Metal: Aluminum **OR** Stainless steel, **as directed**.
a) Finish: Manufacturer's standard finish **OR** Mill **OR** Class I, clear anodic **OR** Class II, clear anodic **OR** Class I, color anodic **OR** Class II, color anodic **OR** High-performance organic **OR** No. 2B **OR** No. 4, **as directed**.
b) Color: As selected from full range of industry colors and color densities.
b. Type: Sealant T-joint **OR** Rubber pad **OR** Compression seal **OR** Strip seal **OR** Winged seal **OR** Epoxy-bonded seal **OR** Split-slab membrane, **as directed**.
1) Seal Material: Santoprene **OR** Neoprene **OR** Silicone **OR** EPDM **OR** PVC **OR** Manufacturer's standard, **as directed**.
a) Color: As selected from manufacturer's full range.
c. Attachment Method: Mechanical anchors **OR** Cast in **OR** Elastomeric concrete header **OR** Compressed, epoxy adhered **OR** Compressed, lubricant adhesive adhered, **as directed**.
d. Load Capacity: Heavy **OR** Extra heavy, **as directed**, duty.
e. Fire-Resistance Rating: Match adjacent construction.
f. Gutter: Flexible, fabric-reinforced neoprene gutter system with drain tubes.

2. Slab-to-Wall Joint Systems for Parking Structures **OR** Plaza Decks **OR** Stadiums, **as directed**:
a. Type: Metal plate.
1) Exposed Metal: Aluminum **OR** Stainless steel, **as directed**.
a) Finish: Manufacturer's standard finish **OR** Mill **OR** Class I, clear anodic **OR** Class II, clear anodic **OR** Class I, color anodic **OR** Class II, color anodic **OR** High-performance organic **OR** No. 2B **OR** No. 4, **as directed**.
b) Color: As selected from full range of industry colors and color densities.
b. Type: Sealant T-joint **OR** Rubber pad **OR** Compression seal **OR** Strip seal **OR** Winged seal **OR** Epoxy-bonded seal **OR** Split-slab membrane, **as directed**.
1) Seal Material: Santoprene **OR** Neoprene **OR** Silicone **OR** EPDM **OR** PVC **OR** Manufacturer's standard, **as directed**.
a) Color: As selected from manufacturer's full range.
c. Attachment Method: Mechanical anchors **OR** Cast in **OR** Elastomeric concrete header **OR** Compressed, epoxy adhered **OR** Compressed, lubricant adhesive adhered, **as directed**.
d. Fire-Resistance Rating: Match adjacent construction.
e. Gutter: Flexible, fabric reinforced neoprene gutter system with drain tubes.

3. Wall-to-Wall Joint Systems for Parking Structures **OR** Plaza Decks **OR** Stadiums, **as directed**:
a. Type: Compression seal.
1) Seal Material: Santoprene **OR** Neoprene **OR** Silicone **OR** EPDM **OR** PVC **OR** Manufacturer's standard, **as directed**.
a) Color: As selected from manufacturer's full range.
b. Type: Preformed cellular foam.
1) Foam Material: Manufacturer's standard **OR** Non-extruded, low-density, crosslinked, nitrogen-blown, ethylene-vinyl-acetate copolymer **OR** Polyurethane, **as directed**.
a) Color: As selected from manufacturer's full range.
c. Attachment Method: Mechanical anchors **OR** Cast in **OR** Compressed, epoxy adhered **OR** Compressed, lubricant adhesive adhered, **as directed**.
d. Fire-Resistance Rating: Match adjacent construction.

F. Finishes

1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Appearance of Finished Work: Noticeable variations in same piece are not acceptable.

1.3 EXECUTION

A. Installation
1. Comply with manufacturer's written instructions for storing, handling, and installing architectural joint assemblies and materials unless more stringent requirements are indicated.
2. Metal Frames: Perform cutting, drilling, and fitting required to install joint systems.
   a. Install in true alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.
   b. Adjust for differences between actual structural gap and nominal design gap due to ambient temperature at time of installation.
   c. Cut and fit ends to accommodate thermal expansion and contraction of metal without buckling of frames.
   d. Locate in continuous contact with adjacent surfaces.
   e. Support underside of frames continuously to prevent vertical deflection when in service.
   f. Locate anchors at interval recommended by manufacturer, but not less than 3 inches (75 mm) from each end and not more than 24 inches (600 mm) o.c.
3. Seals in Metal Frames: Install elastomeric seals in frames to comply with manufacturer's written instructions. Install with minimum number of end joints.
   a. Provide in continuous lengths for straight sections.
   b. Seal transitions according to manufacturer's written instructions.
4. Compression Seals: Apply adhesive or lubricant adhesive as recommended by manufacturer to both frame interfaces **OR** sides of slabs, **as directed**, before installing compression seals.
5. Foam Seals: Install with adhesive recommended by manufacturer.
6. Epoxy-Bonded Seals: Pressurize seal for time period and to pressure recommended by manufacturer. Do not overpressurize.
7. Terminate exposed ends of joint assemblies with field- or factory-fabricated termination devices.
8. Fire-Resistance-Rated Assemblies: Coordinate so complete assemblies comply with assembly performance requirements.
   a. Fire Barriers: Install fire barriers to provide continuous, uninterrupted fire resistance throughout length of joint, including transitions and field splices.
9. Water Barrier: Provide water barrier at exterior joints and where called for on Drawings.

B. Protection
1. Do not remove protective covering until finish work in adjacent areas is complete.
2. Protect the installation from damage by work of other Sections.

END OF SECTION 05805

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NEW YORK CITY DEPARTMENT OF DESIGN + CONSTRUCTION

JOB ORDER CONTRACT

Technical Specifications

VOLUME II of V
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SECTION 06110 - ROUGH CARPENTRY

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for rough carpentry. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
   a. Framing with dimension lumber.
   b. Framing with timber.
   c. Framing with engineered wood products.
   d. Rooftop equipment bases and support curbs.
   e. Wood blocking, cants, and nailers.
   f. Wood furring and grounds.
   g. Wood sleepers.
   h. Utility shelving.
   i. Plywood backing panels.

C. Definitions
1. Exposed Framing: Framing not concealed by other construction.
2. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) or greater but less than 5 inches nominal (114 mm actual) in least dimension.
3. Timber: Lumber of 5 inches nominal (114 mm actual) or greater in least dimension.
4. Lumber grading agencies, and the abbreviations used to reference them, include the following:
   a. NeLMA: Northeastern Lumber Manufacturers' Association.
   b. NLGA: National Lumber Grades Authority.
   c. RIS: Redwood Inspection Service.
   d. SPIB: The Southern Pine Inspection Bureau.
   e. WCLIB: West Coast Lumber Inspection Bureau.
   f. WWPA: Western Wood Products Association.

D. Submittals
1. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
   a. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
   b. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
   c. For fire-retardant treatments specified to be High-Temperature (HT) type, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
   d. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
   e. Include copies of warranties from chemical treatment manufacturers for each type of treatment.
2. LEED Submittals:

a. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content.
b. Product Data for Credit EQ 4.4: For composite-wood products, documentation indicating that product contains no urea formaldehyde.
c. Certificates for Credit MR 7: Chain-of-custody certificates certifying that products specified to be made from certified wood comply with forest certification requirements. Include evidence that mill is certified for chain of custody by an FSC-accredited certification body.
1) Include statement indicating costs for each certified wood product.

3. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
4. Research/Evaluation Reports: For the following, showing compliance with building code in effect for Project:
a. Wood-preservative-treated wood.
b. Fire-retardant-treated wood.
c. Engineered wood products.
d. Power-driven fasteners.
e. Powder-actuated fasteners.
f. Expansion anchors.
g. Metal framing anchors.

E. Quality Assurance
1. Forest Certification: For the following wood products, provide materials produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship":
a. Dimension lumber framing.
b. Timber.
c. Laminated-veneer lumber.
d. Parallel-strand lumber.
e. Prefabricated wood I-joists.
f. Rim boards.
g. Miscellaneous lumber.

F. Delivery, Storage, And Handling
1. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

1.2 PRODUCTS

A. Wood Products, General
1. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
a. Factory mark each piece of lumber with grade stamp of grading agency.
b. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.
c. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
d. Provide dressed lumber, S4S, unless otherwise indicated.

2. Engineered Wood Products: Provide engineered wood products acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.
   a. Allowable Design Stresses: Provide engineered wood products with allowable design stresses, as published by manufacturer, that meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

B. Wood-Preservative-Treated Lumber
   1. Preservative Treatment by Pressure Process: AWPA C2, except that lumber that is not in contact with the ground and is continuously protected from liquid water may be treated according to AWPA C31 with inorganic boron (SBX).
      a. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
      b. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.
   2. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
   3. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
      a. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
   4. Application: Treat all rough carpentry, unless otherwise indicated, **OR** items indicated on Drawings, and the following, **as directed**:
      a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
      b. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
      c. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
      d. Wood framing members that are less than 18 inches (460 mm) above the ground in crawlspaces or unexcavated areas.
      e. Wood floor plates that are installed over concrete slabs-on-grade.

C. Fire-Retardant-Treated Materials
   1. General: Comply with performance requirements in AWPA C20 (lumber) and AWPA C27 (plywood).
      a. Use Exterior type for exterior locations and where indicated.
      b. Use Interior Type A, High Temperature (HT) for enclosed roof framing, framing in attic spaces, and where indicated.
      c. Use Interior Type A, unless otherwise indicated.
   2. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
      a. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
   3. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.
   4. Application: Treat all rough carpentry, unless otherwise indicated, **OR** items indicated on Drawings, and the following, **as directed**:
      a. Framing for raised platforms.
      b. Concealed blocking.
      c. Framing for non-load-bearing partitions.

d. Framing for non-load-bearing exterior walls.
e. Roof construction.
f. Plywood backing panels.

D. Dimension Lumber Framing
1. Maximum Moisture Content: 15 percent **OR** 19 percent **OR** 15 percent for 2-inch nominal (38-mm actual) thickness or less, 19 percent for more than 2-inch nominal (38-mm actual) thickness **OR** 15 percent for 2-inch nominal (38-mm actual) thickness or less, no limit for more than 2-inch nominal (38-mm actual) thickness **OR** 19 percent for 2-inch nominal (38-mm actual) thickness or less, no limit for more than 2-inch nominal (38-mm actual) thickness, **as directed**.
2. Non-Load-Bearing Interior Partitions: Construction or No. 2 **OR** Construction, Stud, or No. 3 **OR** Standard, Stud, or No. 3, **as directed**, grade of any species.
3. Exterior and Load-Bearing Walls **OR** Framing Other Than Non-Load-Bearing Interior Partitions **OR** Framing Other Than Interior Partitions, **as directed**: Any species and grade with a modulus of elasticity of at least 1,500,000 psi (10 350 MPa) **OR** 1,300,000 psi (8970 MPa) **OR** 1,100,000 psi (7590 MPa) **OR** 1,000,000 psi (6900 MPa) **OR** 900,000 psi (6210 MPa), **as directed**, and an extreme fiber stress in bending of at least 1000 psi (6.9 MPa) **OR** 850 psi (5.86 MPa) **OR** 700 psi (4.83 MPa) **OR** 600 psi (4.14 MPa) **OR** 500 psi (3.45 MPa), **as directed**, for 2-inch nominal (38-mm actual) thickness and 12-inch nominal (286-mm actual) width for single-member use.
4. Ceiling Joists (Non-Load-Bearing): Construction or No. 2 **OR** Construction, Stud, or No. 3 **OR** Standard, Stud, or No. 3, **as directed**, grade of any species.
5. Joists, Rafters, and Other Framing Not Listed Above: Any species and grade with a modulus of elasticity of at least 1,500,000 psi (10 350 MPa) **OR** 1,300,000 psi (8970 MPa) **OR** 1,100,000 psi (7590 MPa) **OR** 1,000,000 psi (6900 MPa) **OR** 900,000 psi (6210 MPa), **as directed**, and an extreme fiber stress in bending of at least 1000 psi (6.9 MPa) **OR** 850 psi (5.86 MPa) **OR** 700 psi (4.83 MPa) **OR** 600 psi (4.14 MPa) **OR** 500 psi (3.45 MPa), **as directed**, for 2-inch nominal (38-mm actual) thickness and 12-inch nominal (286-mm actual) width for single-member use.
6. Exposed Exterior **OR** Interior, **as directed**, Framing Indicated to Receive a Stained or Natural Finish: Provide material hand-selected for uniformity of appearance and freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot-holes, shake, splits, torn grain, and wane.
   a. Species and Grade: As indicated above for load-bearing construction of same type.
   b. Species and Grade: Hem-fir (north), Select Structural **OR** No. 1, **as directed**, grade; NLGA.
   c. Species and Grade: Southern pine, Select Structural **OR** No. 1 **OR** No. 2, **as directed**, grade; SPIB.
   d. Species and Grade: Douglas fir-larch; Select Structural **OR** No. 1, **as directed**, grade; WCLIB, or WWPA.
   e. Species and Grade: Mixed southern pine, Select Structural **OR** No. 1 **OR** No. 2, **as directed**, grade; SPIB.
   f. Species and Grade: Spruce-pine-fir, Select Structural **OR** No. 1, **as directed**, grade; NLGA.
   g. Species and Grade: Douglas fir-south; Select Structural **OR** No. 1, **as directed**, grade; WWPA.
   h. Species and Grade: Hem-fir; Select Structural **OR** No. 1, **as directed**, grade; WCLIB, or WWPA.
   i. Species and Grade: Douglas fir-larch (north); Select Structural **OR** No. 1, **as directed**, grade; NLGA.
   j. Species and Grade: Spruce-pine-fir (south), Select Structural **OR** No. 1, **as directed**, grade; NeLMA, WCLIB, or WWPA.
   k. Species and Grade: Eastern hemlock-balsam fir or eastern hemlock-tamarack; Select Structural **OR** No. 1, **as directed**, grade; NeLMA.
   l. Species and Grade: Beech-birch-hickory, Select Structural **OR** No. 1, **as directed**, grade; NeLMA.

m. Species and Grade: Northern red oak, Select Structural **OR** No. 1, **as directed**, grade; NeLMA.
n. Species and Grade: Redwood, Clear Heart Structural **OR** Clear Structural **OR** Select Structural **OR** No. 1, **as directed**, grade; RIS.
o. Species and Grade: Mixed oak, Select Structural **OR** No. 1, **as directed**, grade; NeLMA.
p. Species and Grade: Mixed maple, Select Structural **OR** No. 1, **as directed**, grade; NeLMA.
q. Species and Grade: Western cedars, Select Structural **OR** No. 1, **as directed**, grade; WCLIB, or WWPA.

E. Timber Framing
1. Provide timber framing complying with the following requirements, according to grading rules of grading agency indicated:
a. Species and Grade: Douglas fir-larch, Douglas fir-larch (north), or Douglas fir-south; Select Structural **OR** No. 1, **as directed**, grade; NLGA, WCLIB, or WWPA.
b. Species and Grade: Eastern hemlock, eastern hemlock-tamarack, or eastern hemlock-tamarack (north); Select Structural **OR** No. 1, **as directed**, grade; NeLMA or NLGA.
c. Species and Grade: Hem-fir or hem-fir (north), Select Structural **OR** No. 1, **as directed**, grade; NLGA, WCLIB, or WWPA.
d. Species and Grade: Mixed maple, Select Structural **OR** No. 1, **as directed**, grade; NeLMA.
e. Species and Grade: Mixed oak, Select Structural **OR** No. 1, **as directed**, grade; NeLMA.
f. Species and Grade: Southern pine, Select Structural **OR** No. 1, **as directed**, grade; SPIB.
g. Maximum Moisture Content: 20 **OR** 23, **as directed**, percent.
h. Additional Restriction: Free of heart centers.

F. Engineered Wood Products
1. Laminated-Veneer Lumber: Structural composite lumber made from wood veneers with grain primarily parallel to member lengths, evaluated and monitored according to ASTM D 5456 and manufactured with an exterior-type adhesive complying with ASTM D 2559 and containing no urea formaldehyde.
a. Extreme Fiber Stress in Bending, Edgewise: 3100 psi (21.3 MPa) **OR** 2900 psi (20.0 MPa) **OR** 2600 psi (17.9 MPa) **OR** 2250 psi (15.5 MPa), **as directed**, for 12-inch nominal- (286-mm actual-) depth members.
b. Modulus of Elasticity, Edgewise: 2,000,000 psi (13 700 MPa) **OR** 1,800,000 psi (12 400 MPa) **OR** 1,500,000 psi (10 300 MPa), **as directed**.
2. Parallel-Strand Lumber: Structural composite lumber made from wood strand elements with grain primarily parallel to member lengths, evaluated and monitored according to ASTM D 5456 and manufactured with an exterior-type adhesive complying with ASTM D 2559 and containing no urea formaldehyde.
a. Extreme Fiber Stress in Bending, Edgewise: 2900 psi (20 MPa) for 12-inch nominal- (286-mm actual-) depth members.
b. Modulus of Elasticity, Edgewise: 2,200,000 psi (15 100 MPa).
3. Wood I-Joists: Prefabricated units, I-shaped in cross section, made with solid or structural composite lumber flanges and wood-based structural panel webs, let into and bonded to flanges. Provide units complying with material requirements of and with structural capacities established and monitored according to ASTM D 5055.
a. Provide I-joists manufactured without urea formaldehyde.
b. Web Material: Either oriented strand board or plywood, complying with DOC PS 1 or DOC PS 2, Exposure 1 **OR** Plywood, complying with DOC PS 1 or DOC PS 2, Exposure 1 **OR** Plywood, complying with DOC PS 1, Exterior grade, **as directed**.
c. Structural Properties: Provide units with depths and design values not less than those indicated.
d. Provide units complying with APA PRI-400, factory marked with APA trademark indicating nominal joist depth, joist class, span ratings, mill identification, and compliance with APA standard.

4. Rim Boards: Product designed to be used as a load-bearing member and to brace wood I-joists at bearing ends, complying with research/evaluation report for I-joists.
   a. Manufacturer: Provide products by same manufacturer as I-joists.
   b. Material: All-veneer product **OR** glued-laminated wood **OR** product made from any combination solid lumber, wood strands, and veneers, **as directed**. Provide rim boards made without urea formaldehyde.
   c. Thickness: 1 inch (25 mm) **OR** 1-1/8 inches (28 mm) **OR** 1-1/4 inches (32 mm), **as directed**.
   d. Provide performance-rated product complying with APA PRR-401, rim board **OR** rim board plus, **as directed**, grade, factory marked with APA trademark indicating thickness, grade, and compliance with APA standard.

G. Miscellaneous Lumber
1. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
   a. Blocking.
   b. Nailers.
   c. Rooftop equipment bases and support curbs.
   d. Cants.
   e. Furring.
   f. Grounds.
   g. Utility shelving.
2. For items of dimension lumber size, provide Construction or No. 2 **OR** Standard, Stud, or No. 3, **as directed,** grade lumber with 15 **OR** 19, **as directed,** percent maximum moisture content of any species.
3. For items of dimension lumber size, provide Construction or No. 2 **OR** Standard, Stud, or No. 3, **as directed**, grade lumber with 15 **OR** 19, **as directed,** percent maximum moisture content and any of the following species:
   a. Hem-fir (north); NLGA.
   b. Mixed southern pine; SPIB.
   c. Spruce-pine-fir; NLGA.
   d. Hem-fir; WCLIB, or WWPA.
   e. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.
   f. Western woods; WCLIB or WWPA.
   g. Northern species; NLGA.
   h. Eastern softwoods; NeLMA.
4. For exposed boards, provide lumber with 15 **OR** 19, **as directed,** percent maximum moisture content and any of the following species and grades:
   a. Eastern white pine, Idaho white, lodgepole, ponderosa, or sugar pine; Premium or 2 Common (Sterling) **OR** Standard or No. 3 Common, **as directed,** grade; NeLMA, NLGA, WCLIB, or WWPA.
   b. Mixed southern pine, No. 1 **OR** 2, **as directed,** grade; SPIB.
   c. Hem-fir or hem-fir (north), Select Merchantable or No. 1 Common **OR** Construction or No. 2 Common, **as directed**, grade; NLGA, WCLIB, or WWPA.
   d. Spruce-pine-fir (south) or spruce-pine-fir, Select Merchantable or No. 1 Common **OR** Construction or No. 2 Common, **as directed**, grade; NeLMA, NLGA, WCLIB, or WWPA.
5. For concealed boards, provide lumber with 15 **OR** 19, **as directed,** percent maximum moisture content and any of the following species and grades:
   a. Mixed southern pine, No. 2 **OR** 3, **as directed,** grade; SPIB.
   b. Hem-fir or hem-fir (north), Construction or 2 Common **OR** Standard or 3 Common, **as directed,** grade; NLGA, WCLIB, or WWPA.
   c. Spruce-pine-fir (south) or spruce-pine-fir, Construction or 2 Common **OR** Standard or 3 Common, **as directed,** grade; NeLMA, NLGA, WCLIB, or WWPA.
   d. Eastern softwoods, No. 2 **OR** 3, **as directed,** Common grade; NeLMA.
   e. Northern species, No. 2 **OR** 3, **as directed,** Common grade; NLGA.

f. Western woods, Construction or No. 2 Common **OR** Standard or No. 3 Common, **as directed,** grade; WCLIB or WWPA.

6. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
7. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.
8. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

H. Plywood Backing Panels
1. Telephone and Electrical Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated**, as directed**, in thickness indicated or, if not indicated, not less than 1/2-inch (13-mm) nominal thickness.

I. Fasteners
1. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
   a. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M **OR** of Type 304 stainless steel, **as directed**.
2. Nails, Brads, and Staples: ASTM F 1667.
3. Power-Driven Fasteners: NES NER-272.
4. Wood Screws: ASME B18.6.1.
5. Lag Bolts: ASME B18.2.1 (ASME B18.2.3.8M).
6. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.
7. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
   a. Material:
      1) Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
         OR
         Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Grade A1 or A4).

J. Metal Framing Anchors
1. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those indicated **OR** of basis-of-design products, **as directed**. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.
2. Galvanized Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 (Z180) coating designation.
   a. Use for interior locations where stainless steel is not indicated.
3. Stainless-Steel Sheet: ASTM A 666, Type 304 **OR** 316, **as directed**.
   a. Use for exterior locations and where indicated.
4. Joist Hangers: U-shaped joist hangers with 2-inch- (50-mm-) long seat and 1-1/4-inch- (32-mm-) wide nailing flanges at least 85 percent of joist depth.
5. I-Joist Hangers: U-shaped joist hangers with 2-inch- (50-mm-) long seat and 1-1/4-inch- (32-mm-) wide nailing flanges full depth of joist. Nailing flanges provide lateral support at joist top chord.
6. Top Flange Hangers: U-shaped joist hangers, full depth of joist, formed from metal strap with tabs bent to extend over and be fastened to supporting member.
7. Bridging: Rigid, V-section, nailless type, 0.050 inch (1.3 mm) thick, length to suit joist size and spacing.

8. Post Bases: Adjustable-socket type for bolting in place with standoff plate to raise post 1 inch (25 mm) above base and with 2-inch- (50-mm-) minimum side cover, socket 0.062 inch (1.6 mm) thick, and standoff and adjustment plates 0.108 inch (2.8 mm) thick.
9. Joist Ties: Flat straps, with holes for fasteners, for tying joists together over supports.
10. Rafter Tie-Downs: Bent strap tie for fastening rafters or roof trusses to wall studs below, 1-1/2 inches (38 mm) wide by 0.050 inch (1.3 mm) thick. Tie fastens to side of rafter or truss, face of top plates, and side of stud below.
11. Rafter Tie-Downs (Hurricane or Seismic Ties): Bent strap tie for fastening rafters or roof trusses to wall studs below, 2-1/4 inches (57 mm) wide by 0.062 inch (1.6 mm) thick. Tie fits over top of rafter or truss and fastens to both sides of rafter or truss, face of top plates, and side of stud below.
12. Floor-to-Floor Ties: Flat straps, with holes for fasteners, for tying upper floor wall studs to band joists and lower floor studs, 1-1/4 inches (32 mm) wide by 0.050 inch (1.3 mm) thick by 36 inches (914 mm) long.
13. Hold-Downs: Brackets for bolting to wall studs and securing to foundation walls with anchor bolts or to other hold-downs with threaded rods and designed with first of two bolts placed seven bolt diameters from reinforced base.
14. Wall Bracing:
    a. T-shaped bracing made for letting into studs in saw kerf, 1-1/8 inches (29 mm) wide by 9/16 inch (14 mm) deep by 0.034 inch (0.85 mm) thick with hemmed edges.
       OR
       Wall Bracing: Angle bracing made for letting into studs in saw kerf, 15/16 by 15/16 by 0.040 inch (24 by 24 by 1 mm) thick with hemmed edges.

K. Miscellaneous Materials
1. Sill-Sealer Gaskets:
    a. Glass-fiber-resilient insulation, fabricated in strip form, for use as a sill sealer; 1-inch (25-mm) nominal thickness, compressible to 1/32 inch (0.8 mm); selected from manufacturer's standard widths to suit width of sill members indicated.
       OR
       Closed-cell neoprene foam, 1/4 inch (6.4 mm) thick, selected from manufacturer's standard widths to suit width of sill members indicated.
2. Adhesives for Gluing Furring and Sleepers to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.
    a. Use adhesives that have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Water-Repellent Preservative: NWWDA-tested and -accepted formulation containing 3-iodo-2-propynyl butyl carbamate, combined with an insecticide containing chloropyrifos as its active ingredient.

1.3 EXECUTION

A. Installation, General
1. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.
2. Framing Standard: Comply with AF&PA's "Details for Conventional Wood Frame Construction," unless otherwise indicated.
3. Framing with Engineered Wood Products: Install engineered wood products to comply with manufacturer's written instructions.
4. Metal Framing Anchors: Install metal framing to comply with manufacturer's written instructions.
5. Do not splice structural members between supports, unless otherwise indicated.

6. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
   a. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches (406 mm) o.c.
7. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:
   a. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches (2438 mm) o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
   b. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than 96 inches (2438 mm) o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-inch nominal- (38-mm actual-) thickness.
   c. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than 100 sq. ft. (9.3 sq. m) and to solidly fill space below partitions.
   d. Fire block concealed spaces behind combustible cornices and exterior trim at not more than 20 feet (6 m) o.c.
8. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
9. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
   a. Use inorganic boron for items that are continuously protected from liquid water.
   b. Use copper naphthenate for items not continuously protected from liquid water.
10. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
    a. NES NER-272 for power-driven fasteners.
    b. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
    c. Table 23-II-B-1, "Nailing Schedule," and Table 23-II-B-2, "Wood Structural Panel Roof Sheathing Nailing Schedule," in ICBO's Uniform Building Code.
    d. Table 2305.2, "Fastening Schedule," in BOCA's BOCA National Building Code.
    e. Table 2306.1, "Fastening Schedule," in SBCCI's Standard Building Code.
    f. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
    g. Table 602.3(1), "Fastener Schedule for Structural Members," and Table 602.3(2), "Alternate Attachments," in ICC's International One- and Two-Family Dwelling Code.
11. Use common wire nails, unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; do not countersink nail heads, unless otherwise indicated.
12. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced, and with adjacent rows staggered.
    a. Comply with approved **OR** indicated, **as directed,** fastener patterns where applicable. Before fastening, mark fastener locations, using a template made of sheet metal, plastic, or cardboard.
    b. Use finishing nails, unless otherwise indicated. Do not countersink nail heads **OR** Countersink nail heads and fill holes with wood filler, **as directed**.

B. Wood Ground, Sleeper, Blocking, And Nailer Installation
   1. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

2. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.
3. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches (38 mm) wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

C. Wood Furring Installation
1. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
2. Furring to Receive Plywood or Hardboard Paneling: Install 1-by-3-inch nominal- (19-by-63-mm actual-) size furring horizontally **OR** vertically **OR** horizontally and vertically, **as directed,** at 24 inches (610 mm) **OR** 600 mm, **as directed,** o.c.
3. Furring to Receive Gypsum Board **OR** Plaster Lath, **as directed**: Install 1-by-2-inch nominal- (19-by-38-mm actual-) size furring vertically at 16 inches (406 mm) **OR** 400 mm, **as directed,** o.c.

D. Wall And Partition Framing Installation
1. General: Provide single bottom plate and double top plates using members of 2-inch nominal (38-mm actual) thickness whose widths equal that of studs, except single top plate may be used for non-load-bearing partitions and for load-bearing partitions where framing members bearing on partition are located directly over studs. Fasten plates to supporting construction, unless otherwise indicated.
   a. For exterior walls, provide 2-by-6-inch nominal- (38-by-140-mm actual-) **OR** 2-by-4-inch nominal- (38-by-89-mm actual-), **as directed,** size wood studs spaced 24 inches (610 mm) **OR** 16 inches (406 mm) **OR** 600 mm **OR** 400 mm, **as directed**, o.c., unless otherwise indicated.
   b. For interior partitions and walls, provide 2-by-6-inch nominal- (38-by-140-mm actual-) **OR** 2-by-4-inch nominal- (38-by-89-mm actual-) **OR** 2-by-3-inch nominal- (38-by-64-mm actual-), **as directed**, size wood studs spaced 24 inches (610 mm) **OR** 16 inches (406 mm) **OR** 600 mm **OR** 400 mm, **as directed**, o.c., unless otherwise indicated.
   c. Provide continuous horizontal blocking at midheight of partitions more than 96 inches (2438 mm) high, using members of 2-inch nominal (38-mm actual) thickness and of same width as wall or partitions.
2. Construct corners and intersections with three or more studs, except that two studs may be used for interior non-load-bearing partitions.
3. Frame openings with multiple studs and headers. Provide nailed header members of thickness equal to width of studs. Support headers on jamb studs.
   a. For non-load-bearing partitions, provide double-jamb studs and headers not less than 4-inch nominal (89-mm actual) depth for openings 48 inches (1200 mm) and less in width, 6-inch nominal (140-mm actual) depth for openings 48 to 72 inches (1200 to 1800 mm) in width, 8-inch nominal (184-mm actual) depth for openings 72 to 120 inches (1800 to 3000 mm) in width, and not less than 10-inch nominal (235-mm actual) depth for openings 10 to 12 feet (3 to 3.6 m) in width.
   b. For load-bearing walls, provide double-jamb studs for openings 60 inches (1500 mm) and less in width, and triple-jamb studs for wider openings. Provide headers of depth indicated or, if not indicated, according to Table R502.5(1) or Table R502.5(2), as applicable, in ICC's International Residential Code for One- and Two-Family Dwellings.
4. Provide diagonal bracing in exterior walls, at both walls of each external corner **OR** walls, at locations indicated, **as directed**, at 45-degree angle, full-story height, unless otherwise indicated. Use 1-by-4-inch nominal- (19-by-89-mm actual-) size boards, let-in flush with faces of studs **OR** metal wall bracing, let into studs in saw kerf, **as directed**.

E. Floor Joist Framing Installation
1. General: Install floor joists with crown edge up and support ends of each member with not less than 1-1/2 inches (38 mm) of bearing on wood or metal, or 3 inches (76 mm) on masonry. Attach floor joists as follows:

a. Where supported on wood members, by toe nailing or by using metal framing anchors.
b. Where framed into wood supporting members, by using wood ledgers as indicated or, if not indicated, by using metal joist hangers.

2. Fire Cuts: At joists built into masonry, bevel cut ends 3 inches (76 mm) and do not embed more than 4 inches (102 mm).
3. Frame openings with headers and trimmers supported by metal joist hangers; double headers and trimmers where span of header exceeds 48 inches (1200 mm).
4. Do not notch in middle third of joists; limit notches to one-sixth depth of joist, one-third at ends. Do not bore holes larger than 1/3 depth of joist; do not locate closer than 2 inches (50 mm) from top or bottom.
5. Provide solid blocking of 2-inch nominal (38-mm actual) thickness by depth of joist at ends of joists unless nailed to header or band.
6. Lap members framing from opposite sides of beams, girders, or partitions not less than 4 inches (102 mm) or securely tie opposing members together. Provide solid blocking of 2-inch nominal (38-mm actual) thickness by depth of joist over supports.
7. Anchor members paralleling masonry with 1/4-by-1-1/4-inch (6.4-by-32-mm) metal strap anchors spaced not more than 96 inches (2438 mm) o.c., extending over and fastening to 3 joists. Embed anchors at least 4 inches (102 mm) into grouted masonry with ends bent at right angles and extending 4 inches (102 mm) beyond bend.
8. Provide solid blocking between joists under jamb studs for openings.
9. Under non-load-bearing partitions, provide double joists separated by solid blocking equal to depth of studs above.
   a. Provide triple joists separated as above, under partitions receiving ceramic tile and similar heavy finishes or fixtures.
10. Provide bridging of type indicated below, at intervals of 96 inches (2438 mm) o.c., between joists.
    a. Diagonal wood bridging formed from bevel-cut, 1-by-3-inch nominal- (19-by-64-mm actual-) size lumber, double-crossed and nailed at both ends to joists.
    b. Steel bridging installed to comply with bridging manufacturer's written instructions.

F. Ceiling Joist And Rafter Framing Installation

1. Ceiling Joists: Install ceiling joists with crown edge up and complying with requirements specified above for floor joists. Face nail to ends of parallel rafters.
   a. Where ceiling joists are at right angles to rafters, provide additional short joists parallel to rafters from wall plate to first joist; nail to ends of rafters and to top plate and nail to first joist or anchor with framing anchors or metal straps. Provide 1-by-8-inch nominal- (19-by-184-mm actual-) size or 2-by-4-inch nominal- (38-by-89-mm actual-) size stringers spaced 48 inches (1200 mm) o.c. crosswise over main ceiling joists.
2. Rafters: Notch to fit exterior wall plates and toe nail or use metal framing anchors. Double rafters to form headers and trimmers at openings in roof framing, if any, and support with metal hangers. Where rafters abut at ridge, place directly opposite each other and nail to ridge member or use metal ridge hangers.
   a. At valleys, provide double-valley rafters of size indicated or, if not indicated, of same thickness as regular rafters and 2 inches (50 mm) deeper. Bevel ends of jack rafters for full bearing against valley rafters.
   b. At hips, provide hip rafter of size indicated or, if not indicated, of same thickness as regular rafters and 2 inches (50 mm) deeper. Bevel ends of jack rafters for full bearing against hip rafter.
3. Provide collar beams (ties) as indicated or, if not indicated, provide 1-by-6-inch nominal- (19-by-140-mm actual-) size boards between every third pair of rafters, but not more than 48 inches (1219 mm) o.c. Locate below ridge member, at third point of rafter span. Cut ends to fit roof slope and nail to rafters.
4. Provide special framing as indicated for eaves, overhangs, dormers, and similar conditions, if any.

G. Timber Framing Installation

1. Install timber with crown edge up and provide not less than 4 inches (102 mm) of bearing on supports. Provide continuous members, unless otherwise indicated; tie together over supports as indicated if not continuous.
2. Where beams or girders are framed into pockets of exterior concrete or masonry walls, provide 1/2-inch (13-mm) air space at sides and ends of wood members.
3. Install wood posts using metal anchors indicated.
4. Treat ends of timber beams and posts exposed to weather by dipping in water-repellent preservative for 15 minutes.

H. Stair Framing Installation
1. Provide stair framing members of size, space, and configuration indicated or, if not indicated, to comply with the following requirements:
   a. Stringer Size: 2-by-12-inch nominal- (38-by-286-mm actual-) size, minimum.
   b. Stringer Material: Laminated-veneer lumber **OR** parallel-strand lumber **OR** solid lumber, **as directed**.
   c. Notching: Notch stringers to receive treads, risers, and supports; leave at least 3-1/2 inches (89 mm) of effective depth.
   d. Stringer Spacing: At least 3 stringers for each 36-inch (914-mm) clear width of stair.
2. Provide stair framing with no more than 3/16-inch (4.7-mm) variation between adjacent treads and risers and no more than 3/8-inch (9.5-mm) variation between largest and smallest treads and risers within each flight.

I. Protection
1. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
2. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 06110

SECTION 06110a - MISCELLANEOUS CARPENTRY

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for miscellaneous carpentry. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
   a. Framing with dimension lumber.
   b. Rooftop equipment bases and support curbs.
   c. Wood blocking, cants, and nailers.
   d. Wood furring and grounds.
   e. Wood sleepers.
   f. Interior wood trim.
   g. Wood shelving and clothes rods.
   h. Plywood backing panels.

C. Definitions
1. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) or greater but less than 5 inches nominal (114 mm actual) in least dimension.
2. Lumber grading agencies, and the abbreviations used to reference them, include the following:
   a. NeLMA: Northeastern Lumber Manufacturers' Association.
   b. NHLA: National Hardwood Lumber Association.
   c. NLGA: National Lumber Grades Authority.
   d. SPIB: The Southern Pine Inspection Bureau.
   e. WCLIB: West Coast Lumber Inspection Bureau.
   f. WWPA: Western Wood Products Association.

D. Submittals
1. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
   a. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
   b. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
   c. For fire-retardant treatments specified to be High-Temperature (HT) type include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
   d. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
   e. Include copies of warranties from chemical treatment manufacturers for each type of treatment.
2. LEED Submittals:
   a. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content.
   b. Product Data for Credit EQ 4.4: For composite-wood products, documentation indicating that product contains no urea formaldehyde.

c. Certificates for Credit MR 7: Chain-of-custody certificates certifying that products specified to be made from certified wood comply with forest certification requirements. Include evidence that mill is certified for chain of custody by an FSC-accredited certification body.
   1) Include statement indicating costs for each certified wood product.

3. Research/Evaluation Reports: For the following, showing compliance with building code in effect for Project:
   a. Preservative-treated wood.
   b. Fire-retardant-treated wood.
   c. Power-driven fasteners.
   d. Powder-actuated fasteners.
   e. Expansion anchors.
   f. Metal framing anchors.

E. Quality Assurance
1. Forest Certification: For the following wood products, provide materials produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship":
   a. Dimension lumber framing.
   b. Miscellaneous lumber.
   c. Interior wood trim.
   d. Shelving and clothes rods.

F. Delivery, Storage, And Handling
1. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.
2. Deliver interior wood materials that are to be exposed to view only after building is enclosed and weatherproof, wet work other than painting is dry, and HVAC system is operating and maintaining temperature and humidity at occupancy levels.

1.2 PRODUCTS

A. Wood Products, General
1. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
   a. Factory mark each piece of lumber with grade stamp of grading agency.
   b. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.
   c. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
   d. Provide dressed lumber, S4S, unless otherwise indicated.

B. Wood-Preservative-Treated Materials
1. Preservative Treatment by Pressure Process: AWPA C2, except that lumber that is not in contact with the ground and is continuously protected from liquid water may be treated according to AWPA C31 with inorganic boron (SBX).
   a. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
   b. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.

2. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
3. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
    a. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
4. Application: Treat all miscellaneous carpentry, unless otherwise indicated **OR** items indicated on Drawings, and the following, **as directed**:
    a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
    b. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
    c. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
    d. Wood framing members that are less than 18 inches (460 mm) above the ground in crawl spaces or unexcavated areas.
    e. Wood floor plates that are installed over concrete slabs-on-grade.

C. Fire-Retardant-Treated Materials
1. General: Comply with performance requirements in AWPA C20 (lumber) and AWPA C27 (plywood).
    a. Use treatment that does not promote corrosion of metal fasteners.
    b. Use Exterior type for exterior locations and where indicated.
    c. Use Interior Type A, High Temperature (HT) for enclosed roof framing, framing in attic spaces, and where indicated.
    d. Use Interior Type A, unless otherwise indicated.
2. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
    a. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
3. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.
4. Application: Treat all miscellaneous carpentry, unless otherwise indicated **OR** items indicated on Drawings, and the following, **as directed**:
    a. Framing for raised platforms.
    b. Concealed blocking.
    c. Roof construction.
    d. Plywood backing panels.

D. Dimension Lumber Framing
1. Maximum Moisture Content: 15 percent **OR** 19 percent **OR** 15 percent for 2-inch nominal (38-mm actual) thickness or less, 19 percent for more than 2-inch nominal (38-mm actual) thickness, **as directed**.
2. Non-Load-Bearing Interior Partitions: Construction or No. 2 **OR** Construction, Stud, or No. 3 **OR** Standard, Stud, or No. 3, **as directed**, grade of any species.
3. Other Framing: No. 2 **OR** Construction or No. 2 **OR** Construction, Stud, or No., **as directed**, grade and any of the following species:
    a. Hem-fir (north); NLGA.
    b. Southern pine; SPIB.
    c. Douglas fir-larch; WCLIB or WWPA.
    d. Mixed southern pine; SPIB.
    e. Spruce-pine-fir; NLGA.
    f. Douglas fir-south; WWPA.
    g. Hem-fir; WCLIB or WWPA.

h. Douglas fir-larch (north); NLGA.
i. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.

E. Miscellaneous Lumber
1. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
a. Blocking.
b. Nailers.
c. Rooftop equipment bases and support curbs.
d. Cants.
e. Furring.
f. Grounds.
g. Utility shelving.
2. For items of dimension lumber size, provide Construction or No. 2 **OR** Standard, Stud, or No. 3, **as directed**, grade lumber with 15 **OR** 19, **as directed**, percent maximum moisture content of any species.
3. For exposed boards, provide lumber with 15 **OR** 19, **as directed**, percent maximum moisture content and any of the following species and grades:
a. Eastern white pine, Idaho white, lodgepole, ponderosa, or sugar pine; Premium or 2 Common (Sterling) **OR** Standard or No. 3 Common, **as directed**, grade; NeLMA, NLGA, WCLIB, or WWPA.
b. Mixed southern pine, No. 1 **OR** 2, **as directed**, grade; SPIB.
c. Hem-fir or hem-fir (north), Select Merchantable or No. 1 Common **OR** Construction or No. 2 Common, **as directed**, grade; NLGA, WCLIB, or WWPA.
d. Spruce-pine-fir (south) or spruce-pine-fir, Select Merchantable or No. 1 Common **OR** Construction or No. 2 Common, **as directed**, grade; NeLMA, NLGA, WCLIB, or WWPA.
4. For concealed boards, provide lumber with 15 **OR** 19, **as directed**, percent maximum moisture content and any of the following species and grades:
a. Mixed southern pine, No. 2 **OR** 3, **as directed**, grade; SPIB.
b. Hem-fir or hem-fir (north), Construction or 2 Common **OR** Standard or 3 Common, **as directed**, grade; NLGA, WCLIB, or WWPA.
c. Spruce-pine-fir (south) or spruce-pine-fir, Construction or 2 Common **OR** Standard or 3 Common, **as directed**, grade; NeLMA, NLGA, WCLIB, or WWPA.
d. Eastern softwoods, No. 2 **OR** 3, **as directed**, Common grade; NELMA.
e. Northern species, No. 2 **OR** 3, **as directed**, Common grade; NLGA.
f. Western woods, Construction or No. 2 Common **OR** Standard or No. 3 Common, **as directed**, grade; WCLIB or WWPA.
5. For blocking not used for attachment of other construction Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
6. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.
7. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

F. Interior Wood Trim
1. General: Provide kiln-dried finished (surfaced) material without finger-jointing, unless otherwise indicated.
2. Softwood Lumber Trim for Transparent (Stain or Clear) Finish: Provide one of the following species and grade:
a. Grade C Select **OR** D Select **OR** Finish **OR** Premium, **as directed**, eastern white pine; NeLMA or NLGA.
b. Grade C Select (Choice) **OR** D Select (Quality) **OR** 1 Common (Colonial) **OR** 2 Common (Sterling), **as directed**, Idaho white, lodgepole, ponderosa, or sugar pine; NLGA or WWPA.

c. Grade Superior or C & Btr **OR** Prime or D, **as directed**, Finish Douglas fir-larch or Douglas fir-south; NLGA, WCLIB, or WWPA.
d. Clear Heart **OR** Grade A **OR** Grade B, **as directed**, western red cedar; NLGA, WCLIB, or WWPA.

3. Hardwood Lumber Trim for Transparent (Stain or Clear) Finish: Clear red oak **OR** white maple, **as directed**, selected for compatible grain and color, **as directed**.
4. Lumber Trim for Opaque (Painted) Finish: Either finger-jointed or solid lumber, of one of the following species and grades:
   a. Grade D Select **OR** Finish **OR** Premium, **as directed**, eastern white pine; NeLMA or NLGA.
   b. Grade D Select (Quality) **OR** 1 Common (Colonial) **OR** 2 Common (Sterling), **as directed**, Idaho white, lodgepole, ponderosa, or sugar pine; NLGA or WWPA.
   c. Grade A **OR** B, **as directed**, Finish aspen, basswood, cottonwood, gum, magnolia, red alder, soft maple, sycamore, tupelo, or yellow poplar; NHLA.
5. Moldings: Made to patterns included in WMMPA WM 7 and graded according to WMMPA WM 4.
   a. Moldings for Transparent (Stain or Clear) Finish: N-grade eastern white, Idaho white, lodgepole, ponderosa, or sugar pine **OR** western red cedar **OR** Douglas fir **OR** red oak **OR** white maple, **as directed**, selected for compatible grain and color.
   b. Moldings for Opaque (Painted) Finish: P-grade eastern white, Idaho white, lodgepole, ponderosa, or sugar pine **OR** aspen, basswood, cottonwood, gum, magnolia, soft maple, tupelo, or yellow poplar **OR** primed medium-density fiberboard, **as directed**.

G. Shelving And Clothes Rods
1. Shelving: Made from one of the following materials, 3/4-inch (19-mm) thick. Do not use particleboard or medium-density fiberboard that contains urea formaldehyde.
   a. Melamine-faced particleboard with radiused and filled front edge.
   b. Particleboard with radiused and filled **OR** solid-wood, **as directed**, front edge.
   c. Medium-density fiberboard with radiused **OR** solid-wood, **as directed**, front edge.
   d. Wood boards of same species and grade indicated above for interior lumber trim for opaque **OR** transparent, **as directed**, finish.
2. Shelf Cleats: 3/4-by-3-1/2-inch (19-by-89-mm) boards **OR** 3/4-by-5-1/2-inch (19-by-140-mm) boards with hole and notch to receive clothes rods, **as directed**, of same species and grade indicated above for interior lumber trim for opaque finish.
3. Shelf Brackets: Prime-painted formed steel with provision to support clothes rod where rod is indicated.
4. Clothes Rods:
   a. 1-1/2-inch- (38-mm-) diameter, clear, kiln-dried hardwood rods **OR** clear, kiln-dried softwood rods; either Douglas fir or southern pine **OR** aluminum tubes, **as directed**.
      OR
      1-1/4-inch- (32-mm-) diameter, chrome-plated steel **OR** stainless-steel, **as directed**, tubes.
5. Rod Flanges: Clear, kiln-dried hardwood turnings **OR** Clear, kiln-dried softwood turnings **OR** Aluminum **OR** Chrome-plated steel **OR** Stainless steel, **as directed**.

H. Plywood Backing Panels
1. Telephone and Electrical Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, **as directed**, in thickness indicated or, if not indicated, not less than 1/2-inch (13-mm) nominal thickness.

I. Fasteners
1. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
   a. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M **OR** of Type 304 stainless steel, **as directed**.
2. Nails, Brads, and Staples: ASTM F 1667.
3. Power-Driven Fasteners: NES NER-272.

4. Wood Screws: ASME B18.6.1.
5. Screws for Fastening to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.
6. Lag Bolts: ASME B18.2.1 (ASME B18.2.3.8M).
7. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.
8. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
   a. Material:
      1) Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
         OR
         Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Grade A1 or A4).

J. Metal Framing Anchors
1. Galvanized Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 (Z180) coating designation.
   a. Use for interior locations where stainless steel is not indicated.
2. Stainless-Steel Sheet: ASTM A 666, Type 304 **OR** 316, **as directed**.
   a. Use for exterior locations and where indicated.

K. Miscellaneous Materials
1. Adhesives for Gluing Furring and Sleepers to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.
   a. Use adhesives that have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1.3 EXECUTION

A. Installation, General
1. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.
2. Framing Standard: Comply with AF&PA's "Details for Conventional Wood Frame Construction," unless otherwise indicated.
3. Metal Framing Anchors: Install metal framing to comply with manufacturer's written instructions.
4. Do not splice structural members between supports, unless otherwise indicated.
5. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
   a. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches (406 mm) o.c.
6. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:
   a. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches (2438 mm) o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
   b. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than 96 inches (2438 mm) o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-inch nominal- (38-mm actual-) thickness.

c. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than 100 sq. ft. (9.3 sq. m) and to solidly fill space below partitions.
d. Fire block concealed spaces behind combustible cornices and exterior trim at not more than 20 feet (6 m) o.c.

7. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
8. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
   a. Use inorganic boron for items that are continuously protected from liquid water.
   b. Use copper naphthenate for items not continuously protected from liquid water.
9. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
   a. NES NER-272 for power-driven fasteners.
   b. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
   c. Table 23-II-B-1, "Nailing Schedule," and Table 23-II-B-2, "Wood Structural Panel Roof Sheathing Nailing Schedule," in ICBO's Uniform Building Code.
   d. Table 2305.2, "Fastening Schedule," in BOCA's BOCA National Building Code.
   e. Table 2306.1, "Fastening Schedule," in SBCCI's Standard Building Code.
   f. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
   g. Table 602.3(1), "Fastener Schedule for Structural Members," and Table 602.3(2), "Alternate Attachments," in ICC's International One- and Two-Family Dwelling Code.
10. Use common wire nails, unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; do not countersink nail heads, unless otherwise indicated.

B. Wood Ground, Sleeper, Blocking, And Nailer Installation
1. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
2. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.
3. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches (38 mm) wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

C. Wood Furring Installation
1. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
2. Furring to Receive Plywood or Hardboard Paneling: Install 1-by-3-inch nominal- (19-by-63-mm actual-) size furring horizontally **OR** vertically **OR** horizontally and vertically, **as directed**, at 24 inches (610 mm) **OR** 600 mm, **as directed**, o.c.
3. Furring to Receive Gypsum Board **OR** Plaster Lath, **as directed**: Install 1-by-2-inch nominal- (19-by-38-mm actual-) size furring vertically at 16 inches (406 mm) **OR** 400 mm, **as directed**, o.c.

D. Wood Trim Installation
1. Install with minimum number of joints practical, using full-length pieces from maximum lengths of lumber available. Do not use pieces less than 24 inches (610 mm) long except where necessary. Stagger joints in adjacent and related standing and running trim. Cope at returns and miter at corners to produce tight-fitting joints with full-surface contact throughout length of joint. Use scarf joints for end-to-end joints.
   a. Match color and grain pattern across joints.

b. Install trim after gypsum board joint-finishing operations are completed.
c. Drill pilot holes in hardwood before fastening to prevent splitting. Fasten to prevent movement or warping. Countersink fastener heads and fill holes.
d. Install to tolerance of 1/8 inch in 96 inches (3 mm in 2438 mm) for level and plumb. Install adjoining finish carpentry with 1/32-inch (0.8-mm) maximum offset for flush installation and 1/16-inch (1.6-mm) maximum offset for reveal installation.

E. Protection
1. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
2. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 06110a

Task	Specification	Specification Description
06110	01352	No Specification Required

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SECTION 06130 - HEAVY TIMBER CONSTRUCTION

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for heavy timber construction. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes framing using timbers and round wood poles.

C. Definitions
1. Timbers: Lumber of 5 inches nominal (114 mm actual) or greater in least dimension.
2. Poles: Round wood members, called either "poles" or "posts" in the referenced standards.
3. Inspection agencies, and the abbreviations used to reference them, include the following:
   a. NeLMA - Northeastern Lumber Manufacturers Association.
   b. NHLA - National Hardwood Lumber Association.
   c. NLGA - National Lumber Grades Authority.
   d. SPIB - Southern Pine Inspection Bureau.
   e. WCLIB - West Coast Lumber Inspection Bureau.
   f. WWPA - Western Wood Products Association.

D. Submittals
1. Product Data: For preservative-treated wood products and timber connectors.
   a. For preservative-treated wood products, include chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.
   b. For timber connectors, include installation instructions.
2. LEED Submittals:
   a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that wood products comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
      1) Include statement indicating costs for each certified wood product.
3. Shop Drawings: For heavy timber construction. Show layout, dimensions of each member, and details of connections.
4. Certificates of Inspection: Issued by lumber grading agency for exposed timber not marked with grade stamp.

E. Quality Assurance
1. Timber Standard: Comply with AITC 108, "Standard for Heavy Timber Construction."
2. Forest Certification: Provide wood products obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

F. Delivery, Storage, And Handling
1. Schedule delivery of heavy timber construction to avoid extended on-site storage and to avoid delaying the Work.
2. Store materials under cover and protected from weather and contact with damp or wet surfaces. Provide for air circulation within and around stacks and under temporary coverings.

1.2 PRODUCTS

A. Timber
1. General: Comply with DOC PS 20 and with grading rules of lumber grading agencies certified by ALSC's Board of Review as applicable.
a. Factory mark each item of timber with grade stamp of grading agency.
b. For exposed timber indicated to receive a stained or natural finish, apply grade stamps to surfaces that will not be exposed to view, or omit grade stamps and provide certificates of grade compliance issued by grading agency.
2. Timber Species and Grade: Any species and grade that, for moisture content provided, complies with required structural properties.
a. Allowable Stress Ratings for 12-Inch Nominal (286-mm Actual) Depth: Fb 1500 psi (10.3 MPa) and E 1,500,000 psi (10 340 MPa) **OR** Fb 1300 psi (9.0 MPa) and E 1,300,000 psi (8 960 MPa) **OR** As indicated on Drawings, **as directed**.
3. Moisture Content: Provide timber with 19 percent maximum moisture content at time of dressing or provide timber that is unseasoned at time of dressing but with 19 percent maximum moisture content at time of installation, **as directed**.
4. Dressing: Provide dressed timber (S4S) **OR** timber that is rough sawn (Rgh), **as directed**, unless otherwise indicated.
5. End Sealer: Manufacturer's standard, transparent, colorless wood sealer that is effective in retarding the transmission of moisture at cross-grain cuts and is compatible with indicated finish.
6. Penetrating Sealer: Manufacturer's standard, transparent, penetrating wood sealer that is compatible with indicated finish.

B. Round Wood Poles
1. Round Wood Poles: Clean-peeled wood poles complying with ASTM D 3200; with at least 80 percent of inner bark removed and with knots and limbs cut flush with the surface.

C. Preservative Treatment
1. Pressure treat timber with waterborne preservative according to AWPA C15 requirements for "sawn building poles and posts as structural members."
a. Timber that is not in contact with the ground and is continuously protected from liquid water may be treated with inorganic boron (SBX) according to AWPA C31 instead of AWPA C15.
b. Treatment with CCA shall include post-treatment fixation process.
2. Pressure treat poles with waterborne preservative to comply with AWPA C4.
a. Treatment with CCA shall include post-treatment fixation process.
3. Preservative Chemicals: Acceptable to authorities having jurisdiction.
a. Do not use chemicals containing arsenic or chromium except for marine (saltwater) applications.
4. Use process that includes water-repellent treatment.
5. Use process that does not include water repellents or other substances that might interfere with application of indicated finishes.
6. After treatment, redry timber and poles to 19 percent maximum moisture content.
7. Mark treated timber and poles with treatment quality mark of an inspection agency approved by ALSC's Board of Review.
a. For exposed items indicated to receive a stained or natural finish, mark each piece on surface that will not be exposed or omit marking and provide certificates of treatment compliance issued by inspection agency.
8. Application: Treat all heavy timber construction unless otherwise indicated **OR** Treat items indicated on Drawings and the following, **as directed**:
a. Sills and similar members in contact with masonry or concrete.
b. Timber framing members less than 18 inches (460 mm) above grade.

D. Timber Connectors
1. General: Unless otherwise indicated, fabricate from the following materials:

a. Structural-steel shapes, plates, and flat bars complying with ASTM A 36/A 36M.
b. Round steel bars complying with ASTM A 575, Grade M 1020.
c. Hot-rolled steel sheet complying with ASTM A 1011/A 1011M, Structural Steel, Type SS, Grade 33.
d. Stainless-steel plate and flat bars complying with ASTM A 666, Type 304 **OR** Type 316, **as directed**.
e. Stainless-steel bars and shapes complying with ASTM A 276, Type 304 **OR** Type 316, **as directed**.
f. Stainless-steel sheet complying with ASTM A 666, Type 304 **OR** Type 316, **as directed**.

2. Fabricate beam seats from steel **OR** stainless steel, **as directed**, with 0.239-inch (6-mm) **OR** 3/16-inch (8-mm) **OR** 3/8-inch (9.5-mm), **as directed**, bearing plates, 3/4-inch- (19-mm-) diameter-by-12-inch- (300-mm-) long deformed bar anchors, and 0.239-inch (6-mm) side plates.
3. Fabricate beam hangers from steel **OR** stainless steel, **as directed**, with 0.179-inch (4.6-mm) stirrups and 0.239-inch (6-mm) top plates.
4. Fabricate strap ties from steel **OR** stainless steel, **as directed**, 2-1/2 inches (63 mm) wide by 0.179 inch (4.6 mm) **OR** 3 inches (75 mm) wide by 0.239 inch (6 mm), **as directed**, thick.
5. Fabricate tie rods from round steel bars with upset threads connected with forged-steel turnbuckles complying with ASTM A 668/A 668M.
6. Provide bolts, 3/4 inch (19 mm) unless otherwise indicated, complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); provide nuts complying with ASTM A 563 (ASTM A 563M); and, where indicated, provide flat washers.
7. Provide shear plates, 2-5/8 inches (66.7 mm) **OR** 4 inches (102 mm), **as directed**, in diameter, complying with ASTM D 5933.
8. Finish steel assemblies and fasteners with rust-inhibitive primer, 2-mil (0.05-mm) dry film thickness.
9. Hot-dip galvanize steel assemblies and fasteners after fabrication to comply with ASTM A 123/A 123M or ASTM A 153/A 153M.

E. Fabrication
1. Camber: Fabricate horizontal members and inclined members with a slope of less than 1:1, with natural convex bow (crown) up, to provide camber.
2. Shop fabricate members by cutting and restoring exposed surfaces to match specified surfacing. Finish exposed surfaces to remove planing or surfacing marks, and to provide a finish equivalent to that produced by machine sanding with No. 120 grit sandpaper.
3. Predrill for fasteners and assembly of units.
4. Where preservative-treated members are indicated, fabricate (cut, drill, surface, and sand) before treatment to greatest extent possible. Where fabrication must be done after treatment, apply a field-treatment preservative to comply with AWPA M4.
   a. Use inorganic boron (SBX) treatment for members not in contact with the ground and continuously protected from liquid water.
   b. Use copper naphthenate treatment for members in contact with the ground or not continuously protected from liquid water.
5. Coat crosscuts with end sealer.
6. Seal Coat: After fabricating and surfacing each unit, apply a saturation coat of penetrating sealer on surfaces of each unit except for treated wood where the treatment included a water repellent.

1.3 EXECUTION

A. Installation
1. General: Erect heavy timber construction true and plumb. Provide temporary bracing to maintain lines and levels until permanent supporting members are in place.
   a. Install heavy timber construction to comply with Shop Drawings.
   b. Install horizontal and sloping members with crown edge up and provide not less than 4 inches (102 mm) of bearing on supports. Provide continuous members unless otherwise indicated; tie together over supports if not continuous.

c. Handle and temporarily support heavy timber construction to prevent surface damage, compression, and other effects that might interfere with indicated finish.

2. Framing Built into Masonry: Provide 1/2-inch (13-mm) clearance at tops, sides, and ends of members built into masonry, bevel cut ends 3 inches (76 mm); do not embed more than 4 inches (102 mm) unless otherwise indicated.

3. Cutting: Avoid extra cutting after fabrication. Where field fitting is unavoidable, comply with requirements for shop fabrication.

OR

Fit members by cutting and restoring exposed surfaces to match specified surfacing. Predrill for fasteners and assembly of units.

a. Finish exposed surfaces to remove planing or surfacing marks, and to provide a finish equivalent to that produced by machine sanding with No. 120 grit sandpaper.

b. Coat crosscuts with end sealer.

c. Where preservative-treated members must be cut during erection, apply a field-treatment preservative to comply with AWPA M4.

1) Use inorganic boron (SBX) treatment for members not in contact with the ground and continuously protected from liquid water.

2) Use copper naphthenate treatment for members in contact with the ground or not continuously protected from liquid water.

4. Install timber connectors as indicated.

a. Unless otherwise indicated, install bolts with same orientation within each connection and in similar connections.

b. Install bolts with orientation as indicated or, if not indicated, as directed by the Owner.

B. Adjusting

1. Repair damaged surfaces and finishes after completing erection. Replace damaged heavy timber construction if repairs are not approved by the Owner.

END OF SECTION 06130

SECTION 06150 - EXTERIOR ROUGH CARPENTRY

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for exterior rough carpentry. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Elevated decks including wood decking, plastic decking, stairs, railings, and support framing.
   b. Wood benches.

C. Definitions
1. Boards: Lumber of less than 2 inches nominal (38 mm actual) in thickness and 2 inches nominal (38 mm actual) or greater width.
2. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) or greater but less than 5 inches nominal (114 mm actual) in least dimension.
3. Timber: Lumber of 5 inches nominal (114 mm actual) or greater in least dimension.
4. Lumber grading agencies, and the abbreviations used to reference them, include the following:
   a. NeLMA: Northeastern Lumber Manufacturers' Association.
   b. NLGA: National Lumber Grades Authority.
   c. RIS: Redwood Inspection Service.
   d. SPIB: The Southern Pine Inspection Bureau.
   e. WCLIB: West Coast Lumber Inspection Bureau.
   f. WWPA: Western Wood Products Association.

D. Submittals
1. Product Data: For preservative-treated wood products, plastic decking, and metal framing anchors.
2. LEED Submittal:
   a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that wood products comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
3. Material Certificates:
   a. For lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by ALSC's Board of Review.
   b. For preservative-treated wood products. Indicate type of preservative used and net amount of preservative retained.
4. Evaluation Reports: For the following, from an approved organization/model code, as directed by the Owner:
   a. Preservative-treated wood products.
   b. Plastic decking.
   c. Expansion anchors.
   d. Metal framing anchors.
   e. Decking fasteners.

E. Quality Assurance
1. Forest Certification: Provide wood products obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

F. Delivery, Storage, And Handling
1. Store materials under cover and protected from weather and contact with damp or wet surfaces. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.
2. Handle and store plastic lumber to comply with manufacturer's written instructions.

1.2 PRODUCTS

A. Lumber, General
1. Lumber: Comply with DOC PS 20 and with applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by ALSC's Board of Review. Provide lumber graded by an agency certified by ALSC's Board of Review to inspect and grade lumber under the rules indicated.
a. Factory mark each item with grade stamp of grading agency.
b. For items that are exposed to view in the completed Work, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.
c. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry wood products.
d. Provide dressed lumber, S4S, unless otherwise indicated.

B. Dimension Lumber
1. Maximum Moisture Content: 15 percent **OR** 19 percent **OR** 15 percent for 2-inch nominal (38-mm actual) thickness or less; 19 percent for more than 2-inch nominal (38-mm actual) thickness **OR** 15 percent for 2-inch nominal (38-mm actual) thickness or less; no limit for more than 2-inch nominal (38-mm actual) thickness **OR** 19 percent for 2-inch nominal (38-mm actual) thickness or less; no limit for more than 2-inch nominal (38-mm actual) thickness, **as directed**.
2. Deck and Stair Framing: Select Structural **OR** No. 1 **OR** No. 2 **OR** Construction or No. 2 **OR** Construction, Stud, or No. 3, **as directed**, grade and as selected from the following species:
a. Hem-fir (North); NLGA.
b. Southern pine; SPIB.
c. Douglas fir-larch; WCLIB or WWPA.
d. Mixed southern pine; SPIB.
e. Spruce-pine-fir; NLGA.
f. Douglas fir-south; WWPA.
g. Hem-fir; WCLIB or WWPA.
h. Douglas fir-larch (North); NLGA.
i. Spruce-pine-fir (South); NeLMA, WCLIB, or WWPA.

OR

Deck and Stair Framing: Any species and grade with a modulus of elasticity of at least 1,500,000 psi (10 350 MPa) **OR** 1,300,000 psi (8970 MPa) **OR** 1,100,000 psi (7590 MPa) **OR** 1,000,000 psi (6900 MPa) **OR** 900,000 psi (6210 MPa), **as directed**, and an extreme fiber stress in bending of at least 1000 psi (6.9 MPa) **OR** 850 psi (5.86 MPa) **OR** 700 psi (4.83 MPa) **OR** 600 psi (4.14 MPa) **OR** 500 psi (3.45 MPa), **as directed**, for 2-inch nominal (38-mm actual) thickness and 12-inch nominal (286-mm actual) width for single-member use.
3. Dimension Lumber Posts: No. 2 **OR** Construction or No. 2 **OR** Construction, Stud, or No. 3, **as directed**, grade and as selected from the following species:
a. Hem-fir or hem-fir (North); NLGA, WCLIB, or WWPA.
b. Douglas fir-larch, Douglas fir-larch (North), or Douglas fir-south; NLGA, WCLIB, or WWPA.
c. Mixed southern pine; SPIB.
d. Spruce-pine-fir or spruce-pine-fir (South); NeLMA, NLGA, WCLIB, or WWPA.
e. Northern species; NLGA.
f. Eastern softwoods; NeLMA.

g. Western woods; WCLIB or WWPA.

4. Dimension Lumber Decking and Stair Treads: No. 2 **OR** Construction or No. 2, **as directed**, grade and as selected from the following species:
   a. Hem-fir or hem-fir (North); NLGA, WCLIB, or WWPA.
   b. Douglas fir-larch, Douglas fir-larch (North), or Douglas fir-south; NLGA, WCLIB, or WWPA.
   c. Mixed southern pine; SPIB.
   d. Redwood; RIS.

   OR

   Dimension Lumber Decking and Stair Treads: Deck Heart or Construction Heart **OR** Deck Common or Construction Common, **as directed**, redwood; RIS.
5. Dimension Lumber Railing Members: Select Structural **OR** No. 1 **OR** No. 2 **OR** Construction or No. 2, **as directed**, grade and as selected from the following species:
   a. Hem-fir or hem-fir (North); NLGA, WCLIB, or WWPA.
   b. Douglas fir-larch, Douglas fir-larch (North), or Douglas fir-south; NLGA, WCLIB, or WWPA.
   c. Mixed southern pine; SPIB.
   d. Redwood; RIS.
   e. Spruce-pine-fir or spruce-pine-fir (South); NeLMA, NLGA, WCLIB, or WWPA.

   OR

   Dimension Lumber Railing Members: Heart Clear **OR** Heart B or Select Heart, **as directed**, redwood; RIS.
6. Dimension Lumber for Benches: Select Structural **OR** No. 1, **as directed**, grade and as selected from the following species:
   a. Hem-fir or hem-fir (North); NLGA, WCLIB, or WWPA.
   b. Douglas fir-larch, Douglas fir-larch (North), or Douglas fir-south; NLGA, WCLIB, or WWPA.
   c. Mixed southern pine; SPIB.
   d. Redwood; RIS.
   e. Spruce-pine-fir or spruce-pine-fir (South); NeLMA, NLGA, WCLIB, or WWPA.

   OR

   Dimension Lumber for Benches: Heart Clear **OR** Heart B or Select Heart, **as directed**, redwood; RIS.

C. Boards
1. Maximum Moisture Content: 15 **OR** 19, **as directed**, percent.
2. Board Decking and Stair Treads: 1-1/4-inch- (32-mm-) thick radius-edged decking of any of the following species and grades:
   a. Douglas fir-larch or Douglas fir-south, Patio 1 **OR** Patio 2, **as directed**, WWPA.
   b. Douglas fir-larch, Select Dex **OR** Commercial Dex, **as directed**, WCLIB.
   c. Douglas fir-larch (North), Select Patio **OR** Commercial Patio, **as directed**, NLGA.
   d. Hem-fir, Patio 1 **OR** Patio 2, **as directed**, WWPA.
   e. Hem-fir, Select Dex **OR** Commercial Dex, **as directed**, WCLIB.
   f. Hem-fir (North), Select Patio **OR** Commercial Patio, **as directed**, NLGA.
   g. Redwood, Heart Clear **OR** Heart B or Select Heart, **as directed**; RIS.
   h. Southern pine, Premium **OR** Standard, **as directed**, SPIB.
   i. Western red cedar, Patio 1 **OR** Patio 2, **as directed**, WWPA.
   j. Western red cedar, Select Dex **OR** Commercial Dex, **as directed**, WCLIB.
   k. Western red cedar (North), Select Patio **OR** Commercial Patio, **as directed**, NLGA.
3. Railing Boards: Any of the following species and grades:
   a. Douglas fir, C & Btr finish or C Select; NLGA, WCLIB, or WWPA.
   b. Hem-fir, C & Btr finish or C Select; NLGA, WCLIB, or WWPA.
   c. Redwood, Heart Clear **OR** Heart B or Select Heart, **as directed**; RIS.
   d. Southern pine, B & B finish; SPIB.
4. Boards for Benches: Any of the following species and grades:
   a. Douglas fir, C & Btr finish or C Select; NLGA, WCLIB, or WWPA.
   b. Hem-fir, C & Btr finish or C Select; NLGA, WCLIB, or WWPA.
   c. Redwood, Heart Clear **OR** Heart B or Select Heart, **as directed**; RIS.

d. Southern pine, Edge Grain B & B finish **OR** Near Rift B & B finish **OR** B & B finish, **as directed**; SPIB.

D. Timber
1. Maximum Moisture Content: 19 percent **OR** No limit, **as directed**.
2. Dressing: Provide dressed timber (S4S) or timber that is rough sawn (Rgh) unless otherwise indicated.
3. Timber Posts:
   a. Balsam fir, Douglas fir-larch, Douglas fir-larch (North), eastern hemlock tamarack (North), hem-fir, southern pine, western hemlock, or western hemlock (North); No. 1 **OR** No. 2, **as directed**, NeLMA, NLGA, SPIB, WCLIB, or WWPA.
   b. Alaska cedar; No. 1 **OR** No. 2, **as directed**, WCLIB.
   c. Southern pine; No. 1 **OR** No. 2, **as directed**, SPIB.

E. Round Wood Poles
1. Round Wood Poles: Clean-peeled wood poles complying with ASTM D 3200; with at least 80 percent of inner bark removed and with knots and limbs cut flush with the surface.
2. Species: as directed by the Owner.

F. Preservative Treatment
1. Pressure treat boards and dimension lumber with waterborne preservative according to AWPA C2.
2. Pressure treat timber with waterborne preservative according to AWPA C15 requirements for "sawn building poles and posts as structural members."
   a. Treatment with CCA shall include post-treatment fixation process.
3. Pressure treat poles with waterborne preservative to comply with AWPA C4.
   a. Treatment with CCA shall include post-treatment fixation process.
4. Preservative Chemicals: Acceptable to authorities having jurisdiction.
   a. Do not use chemicals containing arsenic or chromium except for timber posts **OR** except for poles, **as directed**.
5. Use process that includes water-repellent treatment.
   OR
   Use process that does not include water repellents or other substances that might interfere with application of indicated finishes.
6. After treatment, redry boards**,** dimension lumber, timber, and poles to 19 percent maximum moisture content.
7. Mark treated wood with treatment quality mark of an inspection agency approved by ALSC's Board of Review.
   a. For items indicated to receive a stained or natural finish, mark each piece on surface that will not be exposed or omit marking and provide certificates of treatment compliance issued by inspection agency.
8. Application: Treat all exterior rough carpentry unless otherwise indicated **OR** Treat items indicated on Drawings and the following, **as directed**:
   a. Framing members less than 18 inches (460 mm) above grade.
   b. Sills and ledgers.
   c. Members in contact with masonry or concrete.
   d. Posts.
   e. Round wood poles.
   f. Decking.
   g. Stair treads.

G. Plastic Decking
1. Plastic Lumber, General: Products acceptable to authorities having jurisdiction and for which current model code evaluation reports exist that show compliance with building code in effect for Project for indicated occupancy and type of construction.

a. Allowable loads and spans, as documented in evaluation reports or in information referenced in evaluation reports, shall not be less than design loads and spans indicated.

2. Composite Plastic Lumber: Solid or hollow shapes made from a mixture of cellulose fiber and polyethylene or polypropylene.
   a. Configuration: Provide product with grooved edges designed for fastening with concealed splines.
   b. Surface Texture: Woodgrain **OR** Smooth **OR** Manufacturer's standard, **as directed**.
   c. Color: As selected from manufacturer's full range.
3. All-Plastic Lumber: Solid or hollow shapes made from high-density polyethylene (HDPE) **OR** PVC **OR** polystyrene **OR** cellular PVC, **as directed**, with no cellulose fiber.
   a. Configuration: Provide product with grooved edges designed for fastening with concealed splines **OR** tongue-and-groove edges designed for concealed fastening, **as directed**.
   b. Surface Texture: Woodgrain **OR** Smooth **OR** Manufacturer's standard, **as directed**.
   c. Color: As selected from manufacturer's full range.

H. Fasteners
1. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than 1-1/2 inches (38 mm) into wood substrate.
   a. Use stainless steel **OR** fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M or ASTM F 2329, **as directed**, unless otherwise indicated.
   b. For pressure-preservative-treated wood, use stainless-steel fasteners.
   c. For plastic **OR** wood, **as directed**, decking, use stainless-steel fasteners where fasteners are exposed to view.
   d. For redwood, use brass/bronze **OR** stainless-steel **OR** hot-dip galvanized-steel, **as directed**, fasteners.
2. Nails: ASTM F 1667.
3. Power-Driven Fasteners: NES NER-272.
4. Wood Screws: ASME B18.6.1.
5. Lag Screws: ASME B18.2.1 (ASME B18.2.3.8M).
6. Carbon-Steel Bolts: ASTM A 307 (ASTM F 568M) with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers all hot-dip zinc coated.
7. Stainless-Steel Bolts: ASTM F 593, Alloy Group 1 or 2 (ASTM F 738M, Grade A1 or A4); with ASTM F 594, Alloy Group 1 or 2 (ASTM F 836M, Grade A1 or A4) hex nuts and, where indicated, flat washers.
8. Postinstalled Anchors: Stainless-steel, chemical or torque-controlled expansion anchors with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry assemblies and equal to four times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
   a. Stainless-steel bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Grade A1 or A4).

I. Metal Framing Anchors
1. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those indicated on Drawings **OR** of basis-of-design products, **as directed**. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.
2. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 (Z180) **OR** G90 (Z270) **OR** G185 (Z550), **as directed**, coating designation.
3. Stainless-Steel Sheet: ASTM A 666, Type 304 **OR** Type 316, **as directed**.
4. Joist Hangers: U-shaped, with 2-inch- (50-mm-) long seat and 1-1/4-inch- (32-mm-) wide nailing flanges at least 85 percent of joist depth.
5. Top Flange Hangers: U-shaped joist hangers, full depth of joist, formed from metal strap with tabs bent to extend over and be fastened to supporting member.

6. Post Bases: Adjustable-socket type for bolting in place with standoff plate to raise post 1 inch (25 mm) above base and with 2-inch- (50-mm-) minimum side cover, socket 0.062 inch (1.6 mm) thick, and standoff and adjustment plates 0.108 inch (2.8 mm) thick.
7. Joist Ties: Flat straps, with holes for fasteners, for tying joists together over supports.

J. Concealed Decking Fasteners
1. Deck Splines: Plastic splines designed to fit in grooves routed into the sides of decking material and be fastened to deck framing with screws. Splines provide uniform spacing of decking material. Splines are made from UV-resistant polypropylene.
2. Deck Clips: Black oxide coated stainless-steel clips designed to be fastened to deck framing with screws, and to secure decking material with teeth that also provide uniform spacing of decking material.
3. Deck Tracks: Formed metal strips designed to be fastened to deck framing and to secure decking material from underside with screws. Made from epoxy powder-coated, hot-dip galvanized steel **OR** stainless steel, **as directed**.

1.3 EXECUTION

A. Preparation
1. Clean substrates of projections and substances detrimental to application.
2. Prime lumber to be painted, including both faces and edges. Cut to required lengths and prime ends. Comply with requirements in Division 09 Section "Exterior Painting".

B. Installation, General
1. Set exterior rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit exterior rough carpentry to other construction; scribe and cope as needed for accurate fit.
2. Framing Standard: Comply with AF&PA's "Details for Conventional Wood Frame Construction" unless otherwise indicated.
3. Install wood decking and stair treads with crown up (bark side down).
4. Install plastic lumber to comply with manufacturer's written instructions.
5. Secure decking to framing with concealed decking fasteners.
6. Install metal framing anchors to comply with manufacturer's written instructions.
7. Do not splice structural members between supports unless otherwise indicated.
8. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
9. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
10. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
    a. Use inorganic boron (SBX) for items that are continuously protected from liquid water.
    b. Use copper naphthenate for items not continuously protected from liquid water.
11. Securely attach exterior rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
    a. NES NER-272 for power-driven fasteners.
    b. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
    c. Table 23-II-B-1, "Nailing Schedule," in ICBO's Uniform Building Code.
    d. Table 2305.2, "Fastening Schedule," in BOCA's BOCA National Building Code.
    e. Table 2306.1, "Fastening Schedule," in SBCCI's Standard Building Code.
    f. Table R602.3(1), "Fastener Schedule for Structural Members" and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.

12. Use common wire nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view. Make tight connections between members. Install fasteners without splitting wood; do not countersink nail heads unless otherwise indicated.
13. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced, and with adjacent rows staggered.

C. Elevated Deck Joist Framing Installation
1. General: Install joists with crown edge up and support ends of each member with not less than 1-1/2 inches (38 mm) of bearing on wood or metal, or 3 inches (76 mm) on masonry. Attach floor joists where framed into wood supporting members by using wood ledgers as indicated or, if not indicated, by using metal joist hangers. Do not notch joists.
2. Frame openings with headers and trimmers supported by metal joist hangers; double headers and trimmers where span of header exceeds 48 inches (1200 mm).
3. Lap members framing from opposite sides of beams or girders not less than 4 inches (102 mm) or securely tie opposing members together. Provide solid blocking of 2-inch nominal (38-mm actual) thickness by depth of joist over supports.
4. Provide solid blocking of 2-inch nominal (38-mm actual) thickness by depth of joist at intervals of 96 inches (2438 mm) o.c., between joists.

D. Stair Installation
1. Provide stair framing members of size, space, and configuration indicated or, if not indicated, to comply with the following requirements:
   a. Stringer Size: 2 by 12 inches nominal (38 by 286 mm actual), minimum.
   b. Notching: Notch stringers to receive treads, risers, and supports; leave at least 3-1/2 inches (89 mm) of effective depth.
   c. Stringer Spacing: At least three stringers for each 36-inch (914-mm) clear width of stair.
2. Provide stair framing with no more than 3/16-inch (4.7-mm) variation between adjacent treads and risers and no more than 3/8-inch (9.5-mm) variation between largest and smallest treads and risers within each flight.
3. Treads and Risers: Secure by gluing and nailing **OR** screwing, **as directed**, to carriages. Countersink fastener heads, fill flush, and sand filler. Extend treads over carriages and finish with bullnose edge.

E. Railing Installation
1. Balusters: Fit to railings, glue, and nail **OR** screw, **as directed**, in place. Countersink fastener heads, fill flush, and sand filler.
2. Newel Posts: Secure to stringers and risers with through bolts **OR** lag screws **OR** countersunk-head wood screws and glue, **as directed**.
3. Railings: Secure wall rails with metal brackets. Fasten freestanding railings to newel posts and to trim at walls with countersunk-head wood screws or rail bolts and glue.

END OF SECTION 06150

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SECTION 06150a - WOOD DECKING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for wood decking. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Solid-sawn wood roof and floor decking.
b. Glued-laminated wood roof and floor decking.

C. Submittals
1. Product Data: For each type of product indicated.
a. For glued-laminated wood decking, include installation instructions and data on lumber, adhesives, and fabrication.
b. For preservative-treated wood products, include chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.
2. LEED Submittals:
a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that wood used for decking complies with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
1) Include statement indicating costs for each certified wood product.
b. Product Data for Credit EQ 4.1: For sealants and installation adhesives, including printed statement of VOC content.
c. Product Data for Credit EQ 4.4: For laminating adhesive used for glued-laminated decking, indicating that product contains no urea formaldehyde.

D. Quality Assurance
1. Standard for Solid-Sawn Wood Decking: Comply with AITC 112.
2. Forest Certification: Provide wood decking produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

E. Delivery, Storage, And Handling
1. Schedule delivery of wood decking to avoid extended on-site storage and to avoid delaying the Work.
2. Store materials under cover and protected from weather and contact with damp or wet surfaces. Provide for air circulation within and around stacks and under temporary coverings. Stack wood decking with surfaces that are to be exposed in the final Work protected from exposure to sunlight.

1.2 PRODUCTS

A. Wood Decking, General
1. General: Comply with DOC PS 20 and with applicable grading rules of inspection agencies certified by ALSC's Board of Review.
2. Moisture Content: Provide wood decking with 15 **OR** 19, **as directed**, percent maximum moisture content at time of dressing.

B. Solid-Sawn Wood Decking
1. Decking Species: Alaska cedar **OR** Balsam fir **OR** Douglas fir-larch or Douglas fir-larch (North) **OR** Eastern spruce **OR** Hem-fir or hem-fir (North) **OR** Southern pine, **as directed**.
2. Decking Nominal Size: 2x6 **OR** 2x8 **OR** 3x6 **OR** 4x6, **as directed**.
3. Decking Grade:
   a. Select(ed) **OR** Commercial, **as directed**, Decking.
      OR
      Dense Standard **OR** Dense Select **OR** Select **OR** Dense Commercial **OR** Commercial, **as directed**, Decking.
      OR
      Select(ed) Decking or Select Dex **OR** Commercial Decking or Commercial Dex, **as directed**.
4. Grade Stamps: Factory mark each item with grade stamp of grading agency. Apply grade stamp to surfaces that will not be exposed to view.
5. Face Surface: Rough sanded or wire brushed **OR** Saw textured **OR** Smooth, **as directed**.
6. Edge Pattern: Beaded edge **OR** Bullnosed **OR** Channel grooved **OR** Vee grooved, **as directed**.
7. Preservative Treatment: Pressure treat solid-sawn wood decking according to AWPA C31 with inorganic boron (SBX) and redry wood to 15 **OR** 19, **as directed**, percent maximum moisture content.

C. Glued-Laminated Wood Decking
1. Face Species: Alaska cedar **OR** Douglas fir-larch or Douglas fir-larch (North) **OR** Ponderosa pine **OR** Southern pine **OR** Western cedars or western cedars (North), **as directed**.
2. Decking Nominal Size: 2x6 **OR** 2x8 **OR** 3x6 **OR** 3x8 **OR** 4x6 **OR** 4x8 **OR** 5x6 **OR** 5x8, **as directed**.
3. Decking Configuration: For glued-laminated wood decking indicated to be of diaphragm design and construction, provide tongue-and-groove configuration that complies with research/evaluation report.
4. Face Grade:
   a. Custom or Supreme: Clear face is required. Occasional pieces may contain a small knot or minor characteristic that does not detract from the overall appearance.
      OR
      Decorative: Sound knots and natural characteristics are allowed, including chipped edge knots, short end splits, seasoning checks, and some pin holes. Face knot holes, stain, end slits, skip, roller split, and planer burn are not allowed.
      OR
      Service: Face knot holes, stain, end splits, skip, roller split, planer burn, and other nonstrength-reducing characteristics are allowed. Strength-reducing characteristics are not allowed.
5. Face Surface: Rough sanded or wire brushed **OR** Saw textured **OR** Smooth, **as directed**.
6. Edge Pattern: Beaded edge **OR** Bullnosed **OR** Channel grooved **OR** Vee grooved, **as directed**.
7. Laminating Adhesive: Wet-use type complying with ASTM D 2559.
   a. Use adhesive that contains no urea-formaldehyde resins.
8. Preservative Treatment: Pressure treat lumber before gluing according to AWPA C28 for aboveground use.
   a. Use oxine copper (copper-8-quinolinolate) in a light petroleum solvent.
      OR
      Use copper naphthenate in a light petroleum solvent.
      OR
      Use waterborne preservative that is acceptable to authorities having jurisdiction and that contains no arsenic or chromium. After treating, redry wood to 15 **OR** 19, **as directed**, percent maximum moisture content.
      OR
      Use preservative solution without water repellents or substances that might interfere with application of indicated finishes.

OR

After dressing and fabricating decking, apply copper naphthenate according to AWPA M4 to surfaces cut to a depth of more than 1/16 inch (1.5 mm).

D. Accessory Materials

1. Fasteners for Solid-Sawn Decking: Provide fastener size and type complying with decking standard for thickness of deck used.
2. Fasteners for Glued-Laminated Decking: Provide fastener size and type complying with requirements in "Installation" Article for installing laminated decking.
3. Nails: Common; complying with ASTM F 1667, Type I, Style 10.
4. Spikes: Round; complying with ASTM F 1667, Type III, Style 3.
5. Fastener Material: Hot-dip galvanized **OR** Stainless, **as directed**, steel.
6. Bolts for Anchoring Decking to Walls:
   a. Carbon steel; complying with ASTM A 307 (ASTM F 568M) with ASTM A 563/A 563M hex nuts and, where indicated, flat washers, all hot-dip zinc coated, **as directed**.

      OR

      Stainless steel; complying with ASTM F 593, Alloy Group 1 or 2 (ASTM F 738M, Grade A1 or A4); with ASTM F 594, Alloy Group 1 or 2 (ASTM F 836M, Grade A1 or A4) hex nuts and, where indicated, flat washers.
7. Installation Adhesive: For glued-laminated wood decking indicated to be of diaphragm design and construction, provide adhesive that complies with research/evaluation report.
   a. Use adhesive that has a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
8. Sealant: Latex sealant compatible with substrates **OR** Elastomeric joint sealant complying with requirements in Division 07 Section "Joint Sealants" for Use NT (nontraffic) and for Uses M, G, A, and, as applicable to joint substrates indicated, O joint substrates, **as directed**.
   a. Use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. Penetrating Sealer: Clear sanding sealer complying with Division 09 Section "Wood Stains And Transparent Finishes" and compatible with topcoats specified for use over it.

E. Fabrication

1. Shop Fabrication: Where preservative-treated decking is indicated, complete cutting, trimming, surfacing, and sanding before treating.
2. Predrill decking for lateral spiking to adjacent units to comply with referenced decking standard.
3. Seal Coat: After fabricating and surfacing decking, apply a saturation coat of penetrating sealer in fabrication shop, **as directed**.

1.3 EXECUTION

A. Installation

1. Install solid-sawn wood decking to comply with referenced decking standard.
   a. Locate end joints for two-span continuous lay-up **OR** combination simple and two-span continuous lay-up **OR** controlled random lay-up **OR** lay-up indicated, **as directed**.
2. Install laminated wood decking to comply with manufacturer's written instructions.
   a. Locate end joints for two-span continuous lay-up **OR** combination simple and two-span continuous lay-up **OR** controlled random lay-up **OR** lay-up indicated, **as directed**.
   b. Nail each course of glued-laminated wood decking at each support with one nail slant nailed above the tongue and one nail straight nailed through the face.
      1) Use 12d nails for 2x6 and 2x8 decking.
      2) Use 30d nails for 3x6 and 3x8 decking.
      3) Use 60d nails for 4x6 and 4x8 decking. Predrill decking to prevent splitting.
      4) Use 30d tongue nails in bottom tongue and 3/8-inch (10-mm) face spikes for 5x6 and 5x8 decking. Predrill decking at spikes to prevent splitting.

c. Slant nail each course of glued-laminated wood decking to the tongue of the adjacent course at 30 inches (750 mm) o.c. and within 12 inches (300 mm) of the end of each unit. Stagger nailing in adjacent courses 15 inches (380 mm).
   1) Use 6d nails for 2x6 and 2x8 decking.
   2) Use 8d nails for 3x6 and 3x8 decking.
   3) Use 10d nails for 4x6 and 4x8 decking.
   4) Use 16d nails for 5x6 and 5x8 decking.

d. Glue adjoining decking courses together by applying a 3/8-inch (10-mm) bead of adhesive on the top of tongues according to research/evaluation report.

3. Anchor wood roof decking, where supported on walls, with bolts as indicated.
4. Where preservative-treated decking must be cut during erection, apply a field-treatment preservative to comply with AWPA M4.
   a. For solid-sawn decking, use inorganic boron (SBX).
   b. For laminated decking, use copper naphthenate.
5. Apply joint sealant to seal roof decking at exterior walls at the following locations:
   a. Between decking and supports located at exterior walls.
   b. Between decking and exterior walls that butt against underside of decking.
   c. Between tongues and grooves of decking over exterior walls and supports at exterior walls.

B. Adjusting
1. Repair damaged surfaces and finishes after completing erection. Replace damaged decking if repairs are not approved by the Owner.

C. Protection
1. Provide temporary waterproof covering as the Work progresses to protect roof decking until roofing is applied.

END OF SECTION 06150a

SECTION 06150b - ROUGH CARPENTRY RENOVATION

1.1 DESCRIPTION OF WORK

A. This specification covers the furnishing and installation of materials for rough carpentry renovation. Products shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 GENERAL

A. Quality Assurance
   1. Regulatory Requirements:
      a. Fire Retardant Treated Lumber and Plywood: Bear UL FR-S classification label.
      b. Preservative Treated Wood: Provide all heart redwood, cedar, or cyprus; or preservative-treated wood at following conditions in accordance with applicable building code:
         1) Wood framing, woodwork, and plywood up to and including subflooring at first-floor level of structures having crawl spaces, when bottoms of such items are 150 mm (6 inches) or less from earth underneath.
         2) Exterior wood steps, platforms, and railings.
         3) Wood sills, soles, plates, furring, and sleepers that are less than 150 mm (6 inches) from earth, furring and nailers that are set into or in contact with concrete or masonry.
         4) Nailers, edge strips, crickets, curbs, and cants for roof decks.
         5) Furring strips used on walls or partitions below grade and exterior walls above grade.
         6) Wood members used for rough framing of openings in exterior concrete or masonry walls.

B. Delivery, Storage, And Handling
   1. General: Deliver material to site, off-load, and handle in manner that will not damage material. Store material off ground and cover with waterproof covering. Provide adequate ventilation.
      a. Interior Fire-Retardant Treated Wood: Keep dry at all times. Replace material that has become wet. Store off ground, in building, or covered with unbroken water-tight cover in storage yard, during transit, and at job site. Keep ventilated to avoid moisture condensation.

C. Project Conditions
   1. Environmental Requirements: Execute demolition and renovation in manner to limit unnecessary dust and noise, and in compliance with applicable codes and federal or state requirements. Burning of materials on site not allowed.
   2. Existing Conditions: See Detailed Scope of Work. Do not interfere with use of occupied buildings or portions of buildings. Maintain free and safe passage to and from occupied areas.
   3. Protection:
      a. Provide necessary temporary shoring and bracing to support and protect portions of existing buildings during demolition operations. Leave such shoring in place until permanent supports have been installed. Be solely responsible for design, safety, and adequacy of temporary shoring and bracing and its ability to carry load for which intended.
      b. Contractor: Protect grounds, plantings, buildings, and any other facilities or property from damage caused by construction operations.
   4. Safety: Cease operations at endangered area, and notify the Owner immediately if safety of structure appears to be endangered. Take precautions to properly support structure. Do not resume work in endangered area until safety is restored.

D. Scheduling And Sequencing

1. Scheduling and Completion: Comply with requirements of Detailed Scope of Work.

1.3 PRODUCTS

A. Materials
1. Materials for Patching, Extending, and Matching:
   a. Provide same products or types of construction as in existing structure, as needed to patch, extend, or match existing work.
      1) Generally, Contract Documents will not define products or standards of workmanship present in existing construction. Determine products by inspection and testing as ecessary, and required workmanship by reference to existing as sample of comparison.
      2) Patching, extending, and matching existing work and systems shall result in complete, finished system.
   b. Presence of product, finish, or type of construction requires that patching, extending, or matching be performed as necessary to make work complete and consistent.
2. Lumber: Each Piece of Lumber: Grade stamped by recognized association or independent inspection agency certified by American Lumber Standards Committee's Board of Review.
   a. New Replacement Studs and Joists: Match existing and complies with Reference Standards.
   b. Wood Studs and Joists: No. 2 Grade or better.
   c. Sill Plates on Concrete: All heart redwood, cedar, or cyprus: or preservative-treated wood.
   d. Blocking and Furring: Standard Grade or Better.
   e. Preservative-Treated: AWPB LP-2, pressure-treated with waterborne preservative. Penta or creosote not allowed.
      1) Treat drilled holes and cuts across grain in accordance with AWPA M4.
   f. Fire-Retardant Treated:
      1) Lumber: AWPA C20 Interior Type A.
      2) Plywood: AWPA C27 Interior Type A.
      3) Bear UL FR-S classification label.
   g. Pressure-Treated Lumber: Bear AWPA Quality Mark C-2.
   h. Seasoning: Kiln dry to following (including treated material):
   i. Lumber Up to 50 mm (2 inches): 19 percent or less moisture content.
   j. Preservative- and Fire-Retardant Treated Material: Mill or rip material parallel to grain prior to treatment.
3. Plywood: PS-1: Each panel identified with APA grade trademark.
   a. Subfloor: APA Rated Sheathing, Tongue and groove, Exposure 1 (interior with exterior glue).
      1) Span Rating: Not less than spacing of framing members.
      2) Thickness: In accordance with APA Recommendations.
   b. Roof Sheathing: APA Rated Sheathing, Exposure 1 (interior with exterior glue).
      1) Span Rating: Not less than spacing of framing members.
      2) Thickness: In accordance with APA Recommendations.
   c. Wall Sheathing: APA CD, Exposure 1 (Interior with exterior glue).
      1) Span Rating: Not less than spacing of framing members.
      2) Thickness: As indicated.
   d. Panel Edge Clips: Extruded aluminum or hot-dipped galvanized steel, H-shaped clips to prevent differential deflection of roof sheathing.
   e. Fire-Retardant Treated Plywood: Bear UL FR-S classification label.
      1) Interior Plywood Fire Retardant Treatment: AWPA C27 Interior Type A.
      2) Exterior Plywood Fire Retardant Treatment: AWPA C27 Exterior Type.
   f. Seasoning: Kiln dry plywood to 15 percent or less moisture content.
      1) Pressure Treated Plywood: Kiln dry lumber after treatment.
   g. Nails: Type and size as recommended by APA.

4. Metal Framing Anchors: Punched and formed for nailing so that nails will be stressed in shear only.
   a. General: Provide with nails and bolts according to manufacturers requirements.
      1) Nails: Zinc coated.
   b. Types: As indicated and as required to accommodate framing.
   c. Sizes: Of sufficient size and strength to develop full strength of supported member in accordance with applicable building code.
   d. Metal Bridging: Minimum No. 16 U.S. Standard gage.
   e. Finish: Hot-dipped galvanized.
5. Anchor Bolts: Furnish anchors to be built into concrete and masonry for anchorage of wood.
6. Rough Hardware: Provide necessary bolts, screws, nails, clips, plates, straps, hangers, etc., necessary for completion of renovation work. Provide correct material of proper size and strength for purpose intended, conforming to Reference Standards and applicable building codes.
   a. Exterior Locations and for Fire-Retardant- and Preservative-Treated Wood: Provide galvanized rough hardware.
7. Vapor Barrier at Crawl Spaces: ASTM D 2103, 0.15 mm (6 mil) polyethylene sheeting.
8. Insulation: Type and R-value to comply with applicable codes and regulations.
   a. Blanket Insulation: ASTM C 665 fiberglass blankets. Exposed insulation shall be foil-faced with flame-spread rating of 25 or less in accordance with ASTM E 84, where required by applicable codes and regulations.

1.4 EXECUTION

A. Examination
   1. Units, Spaces, and Areas to be Renovated: Comply with Detailed Scope of Work.
      a. Verify that surfaces to receive rough carpentry are prepared to require grades and dimensions.

B. Preparation
   1. Dust Protection: Comply with Detailed Scope of Work.
   2. Building Occupation: Carry out demolition and renovation work to cause as little inconvenience to occupants as possible. See Detailed Scope of Work.
   3. Protection: See Detailed Scope of Work.
   4. Selective Demolition: Comply with Detailed Scope of Work.

C. Laying Out Work
   1. Discrepancies: Verify dimensions and elevations indicated in layout of existing work.
      a. Prior to commencing work, carefully compare and check Drawings (if any) for discrepancies in locations or elevations of work to be executed.
      b. Refer discrepancies among Drawings (if any), Specifications, and existing conditions to the Owner for adjustment before work affected is performed.
         1) Failure to make such notification shall place responsibility on Contractor to carry out work in satisfactory, workmanlike manner.
   2. Contractor: Responsible for location and elevation of construction contemplated by Construction Documents.

D. Performance
   1. Patching: Patch and extend existing work using skilled mechanics who are capable of matching existing quality of workmanship.
      a. Quality of Patched or Extended Work: Not less than specified for new work. If similar new work is not specified, equal to existing work.
   2. General: Perform in accordance with AF&PA National Design Specification for Wood Construction, latest Edition.
      a. Framing: Erect plumb, level and true and rigidly anchor in place. Cut framing square on bearings, closely fit, accurately set to required lines and levels.

b. Nail or spike members in accordance with applicable codes.
c. Framing: 400 mm (16 inches) OC unless otherwise indicated.
d. Shims: Do not use shims for leveling on wood or metal bearings. Use steel or slate shims with full bearing on masonry or concrete.
e. Do not splice framing members between bearing points.
f. Metal Framing Anchors: Install where required for proper connections in accordance with manufacturer recommendations. Drive nail in each nail hole provided in anchor.

3. Wood Framing:
   a. Openings: Frame members for passage of pipes and ducts to avoid cutting structural members. Do not cut, notch, or bore framing members for passage of pipes or conduits without the Owner's permission. Reinforce framing members as directed where damaged by cuffing.
   b. Firestopping: Firestop concealed spaces in framing. No shutoff by framing members to prevent drafts from one space to another. Use 50 mm (2 inch) nominal thick accurately fit wood blocking to fill opening.
   c. Joists and Beams: Sizes and spacing as indicated.
      1) Set crown edge-up with 90 mm (3-1/2 inch) bearing unless noted otherwise.
      2) Toe nail joists to wood sills with 16d nails both sides or secure with metal connectors. Lap and spike joists over supports.
      3) Double joists to form headers and trimmers at openings over 1,200 mm (4 feet) and support with metal joist hangers.
      4) Provide joist hangers at joists framing into flush wood beams.
   d. Provide blocking or suitable edge support between members as necessary to support edges of sheathing.
   e. Replace warped lumber in walls and joists prior to installation of finish surface.
4. Anchors: Unless otherwise indicated, bolt plates firmly to concrete or masonry with anchor bolts in accordance with applicable code.
   a. In Masonry: Embed anchor bolts minimum 400 mm (16 inches) and provide each with nut and 50 mm (2 inch) diameter washer at bottom end. Grout bolts with mortar.
   b. In Concrete: Embed anchor bolts minimum 200 mm (8 inches) and provide each with nut and 50 mm (2 inch) diameter washer at bottom end. 90 degree bent end may be substituted for nut and washer.
5. Wood Studs: Install at 400 mm (16 inches) OC with single bottom plate and double top plate with joints staggered.
   a. Double studs at openings and triple at corners and intersections. Double headers with double trimmers over openings.
6. Plywood Sheathing: Install in accordance with APA Recommendations.
   a. Provide space at end and side joints as recommended by APA.
   b. Install panels with face grain perpendicular to supports with end-joints supported. Stagger ends of adjacent sheets 1 200 mm (4 feet) where possible.
   c. Where support spacing exceeds maximum span for unsupported edge, provide adequate blocking, tongue and groove edges, or panel edge clips, in accordance with APA E30-L.
   d. Nail in accordance with APA's Recommendations.
7. Preservative- and Fire-Retardant Material: Milling or ripping material parallel to grain not allowed unless material is treated after milling or ripping.
   a. Preservative-Treated Material: Treat drilled holes and cuts across grain in accordance with AWPA M4.

E. Flooring Work
1. Defective Joists and Subfloor: Remove defective joists and subfloor which no longer satisfy structural requirements with now material to fulfill their structural function.
   a. Remove ceiling, subfloor, and joists in safe manner and at minimum inconvenience to residents.
   b. Splice, strengthen, support, or replace rotted or otherwise defective joists to fulfill their anticipated structural function.

c. New Replacement Joists: Comply with requirements of appropriate section specifying new flooring, including flooring manufacturer's recommendations.
d. Ceiling Replacement: Include removal and replacement of ceiling finish to match existing.
1) Glue and screw new ceiling material to bottom of joists.
2) Paint entire ceiling of space affected by replacement matching color of existing walls in accordance with Division 9 Section "Painting."
e. Crawl-Space Insulation: Replace insulation damaged by or removed during construction operations. If there is no existing insulation, provide new insulation, where required.
1) Insulation: Type and R-value to comply with applicable codes and regulations.
f. New Replacement Subfloor: Install in accordance with APA Recommendations and with requirements of appropriate section specifying new flooring, including flooring manufacturer's recommendations.
1) Glue and nail new subfloor to joists.
2) Nail in accordance with APA's Recommendations and sufficiently to avoid squeaking floors.
g. Base at walls: Replace wood base (including coves and corner rounds) with new wood base to match existing.

2. Above-Grade Floors to Receive Resilient Flooring: Examine to ensure that vapor-barrier sheet is laid over ground, sheets lapped, edge joints sealed and sufficient cross ventilation exists to insure dryness.
a. If vapor barrier does not cover ground in crawl space, install vapor barrier in accordance with applicable codes and regulations.
1) Completely cover ground at crawl spaces with minimum 150 mm (6 inch) lapped joints.
2) Tape all lapped joints with water-resistive tape in accordance with manufacturer's recommendations.
3) Protect vapor barrier from puncture and displacement. Lay heavy objects such as pieces of masonry at intervals not over 1 200 mm (4 feet) OC at lapped joints to hold in place. If punctures occur in vapor barrier, repair by placing patches of vapor-barrier material over punctures and taping all lapped joints.
b. If crawl space does not have enough ventilation, install additional vents in accordance with applicable codes and regulations.

3. Floors Damaged by Construction Operations: Patch floor damage to match existing floor surfaces, and comply with requirements for new flooring.

F. Roofing Work
1. Removal of Existing Roofing: Roofing may contain asbestos fibers. Comply with applicable codes, laws, and regulations regarding asbestos materials.
2. Defective Rafters and Sheathing: Remove defective rafters and sheathing which no longer satisfy structural requirements with new material to match existing.
a. Remove sheathing and rafters in safe manner and at minimum inconvenience to residents.
b. Splice, strengthen, support, or replace rotted or otherwise defective rafters to fulfill their anticipated structural function.
c. New Replacement Sheathing: Install in accordance with APA Recommendations and with requirements of applicable Division 7 roofing Sections.
1) Nail in accordance with APA s Recommendations.

G. Blocking And Furring
1. Blocking: Install wood blocking as required for proper support of hardware, bath accessories, cabinets, and other wall-mounted hems.
a. Set true to line, level, or plumb, well-secured in stud wall and flush with back of drywall or other wall finish.
b. Coordinate exact locations with other sections.
2. Rough Wood Bucks: Set true and plumb and anchor to concrete or masonry with steel straps extending into wall minimum 200 mm (8 inches). Place anchors near top and bottom of buck and space uniformly at maximum 600 mm (24 inches) OC. Provide nominal 50 mm (2 inch) thick if not indicated.

3. Wood Furring: Install wood furring on masonry or concrete walls in sizes and spacing as indicated on Drawings (if any). Provide minimum 25 mm by 75-mm (1 inch by 3 inch) nominal furring strips spaced at maximum of 400 mm (16 inches) OC if not indicated.
   a. Securely fasten wood furring at maximum 900 mm (3 feet) OC with toggle or expansion bolts, cut concrete nails or ramset anchors as required. Do not use wood plugs.
   b. Install furring around openings and at corners.
   c. Erect furring plumb and level, and shim out as required to provide true, even plane with surfaces suitable to receive required finish.

END OF SECTION 06150b

Task	Specification	Specification Description
06150	06110	Rough Carpentry
06150	06110a	Miscellaneous Carpentry
06155	06110a	Miscellaneous Carpentry

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SECTION 06160 - SHEATHING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for sheathing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Wall sheathing.
b. Roof sheathing.
c. Composite nail base insulated roof sheathing.
d. Subflooring.
e. Underlayment.
f. Building paper.
g. Building wrap.
h. Sheathing joint-and-penetration treatment.
i. Flexible flashing at openings in sheathing.

C. Submittals
1. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
a. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Indicate type of preservative used and net amount of preservative retained.
b. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Include physical properties of treated materials.
c. For fire-retardant treatments specified to be High-Temperature (HT) type, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5516.
d. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
e. Include copies of warranties from chemical treatment manufacturers for each type of treatment.
f. For building wrap, include data on air-/moisture-infiltration protection based on testing according to referenced standards.
2. LEED Submittals:
a. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content.
b. Product Data for Credit EQ 4.4: For composite-wood products, documentation indicating that product contains no urea formaldehyde.
c. Certificates for Credit MR 7: Chain-of-custody certificates certifying that products specified to be made from certified wood comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
1) Include statement indicating costs for each certified wood product.
3. Research/Evaluation Reports: For the following, showing compliance with building code in effect for Project:
a. Preservative-treated plywood.
b. Fire-retardant-treated plywood.

c. Foam-plastic sheathing.
d. Building wrap.

D. Quality Assurance
1. Fire-Test-Response Characteristics: For assemblies with fire-resistance ratings, provide materials and construction identical to those of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.
2. Forest Certification: For the following wood products, provide materials produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship":
a. Plywood.
b. Oriented strand board.
c. Fiberboard wall sheathing.
d. Particleboard underlayment.
e. Hardboard underlayment.

E. Delivery, Storage, And Handling
1. Stack plywood and other panels flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

1.2 PRODUCTS

A. Wood Panel Products, General
1. Plywood: DOC PS 1 **OR** Either DOC PS 1 or DOC PS 2, unless otherwise indicated, **as directed**.
2. Oriented Strand Board: DOC PS 2.
3. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.
4. Factory mark panels to indicate compliance with applicable standard.

B. Preservative-Treated Plywood
1. Preservative Treatment by Pressure Process: AWPA C9.
a. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
2. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.
3. Application: Treat all plywood, unless otherwise indicated **OR** Treat items indicated on Drawings, **as directed**, and plywood in contact with masonry or concrete or used with roofing, flashing, vapor barriers, and waterproofing.

C. Fire-Retardant-Treated Plywood
1. General: Comply with performance requirements in AWPA C27.
a. Use treatment that does not promote corrosion of metal fasteners.
b. Use Exterior type for exterior locations and where indicated.
c. Use Interior Type A, High Temperature (HT) for roof sheathing and where indicated.
d. Use Interior Type A, unless otherwise indicated.
2. Kiln-dry material after treatment to a maximum moisture content of 15 percent. Do not use material that is warped or does not comply with requirements for untreated material.
3. Identify fire-retardant-treated plywood with appropriate classification marking of UL, U.S. Testing, Timber Products Inspection, or another testing and inspecting agency acceptable to authorities having jurisdiction.
4. Application: Treat all plywood, unless otherwise indicated **OR** Treat plywood indicated on Drawings, and the following, **as directed**:
a. Roof and wall sheathing within 48 inches (1220 mm) of fire **OR** party, **as directed**, walls.

b. Roof sheathing.
c. Subflooring and underlayment for raised platforms.

D. Wall Sheathing
1. Plywood Wall Sheathing: Exterior, Structural I **OR** Exterior **OR** Exposure 1, Structural I **OR** Exposure 1, **as directed**, sheathing.
2. Oriented-Strand-Board Wall Sheathing: Exposure 1, Structural I **OR** Exposure 1, **as directed**, sheathing.
3. Paper-Surfaced Gypsum Wall Sheathing: ASTM C 79/C 79M or ASTM C 1396/C 1396M, gypsum sheathing; with water-resistant-treated core and with water-repellent paper bonded to core's face, back, and long edges.
   a. Type and Thickness: Regular, 1/2 inch (13 mm) **OR** Type X, 5/8 inch (15.9 mm), **as directed**, thick.
4. Glass-Mat Gypsum Wall Sheathing: ASTM C 1177/1177M.
   a. Type and Thickness: Regular, 1/2 inch (13 mm) **OR** Type X, 5/8 inch (15.9 mm), **as directed**, thick.
5. Cellulose Fiber-Reinforced Gypsum Sheathing: ASTM C 1278/C 1278M, gypsum sheathing.
   a. Type and Thickness: Regular, 1/2 inch (13 mm) **OR** Type X, 5/8 inch (15.9 mm), **as directed**, thick.
6. Fiberboard Wall Sheathing: ASTM C 208, Type IV, Grade 1 (Regular) **OR** 2 (Structural), **as directed**, cellulosic fiberboard sheathing with square edges, 1/2 inch (13 mm) **OR** 25/32 inch (20 mm), **as directed**, thick.
7. Extruded-Polystyrene-Foam Wall Sheathing: ASTM C 578, Type IV, in manufacturer's standard lengths and widths with tongue-and-groove or shiplap long edges as standard with manufacturer.
   a. Thickness: 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** As indicated, **as directed**.
8. Foil-Faced, Polyisocyanurate-Foam Wall Sheathing: ASTM C 1289, Type I, Class 2, aluminum-foil-faced, glass-fiber-reinforced, rigid, cellular, polyisocyanurate thermal insulation. Foam-plastic core and facings shall have a flame-spread index of 25 or less when tested individually.
   a. Thickness: 7/16 inch (11.1 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (15.9 mm) **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** As indicated, **as directed**.

E. Roof Sheathing
1. Plywood Roof Sheathing: Exterior, Structural I **OR** Exterior **OR** Exposure 1, Structural I **OR** Exposure 1, **as directed**, sheathing.
2. Oriented-Strand-Board Roof Sheathing: Exposure 1, Structural I **OR** Exposure 1, **as directed**, sheathing.

F. Composite Nail Base Insulated Roof Sheathing
1. Oriented-Strand-Board-Surfaced, Polyisocyanurate-Foam Sheathing: Rigid, cellular, polyisocyanurate thermal insulation with oriented strand board laminated to one face complying with ASTM C 1289, Type V.
2. Vented, Oriented-Strand-Board-Surfaced, Polyisocyanurate-Foam Sheathing:
   a. Rigid, cellular, polyisocyanurate thermal insulation complying with ASTM C 1289, Type II, Class 1, with oriented strand board adhered to spacers on one face.

      OR

      Rigid, cellular, polyisocyanurate thermal insulation with oriented strand board laminated to one face complying with ASTM C 1289, Type V. Oriented-strand-board face has a second layer of oriented strand board adhered to it with spacers between.
      1) Polyisocyanurate-Foam Thickness: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 2-1/2 inches (64 mm) **OR** 3 inches (76 mm) **OR** 3-1/2 inches (89 mm) **OR** 4 inches (102 mm), **as directed**.
      2) Oriented-Strand-Board Nominal Thickness: 7/16 inch (11.1 mm) **OR** 5/8 inch (15.9 mm), **as directed**.
      3) Spacers: Wood furring strips or blocks not less than 3/4 inch (19 mm) thick and spaced not more than 12 inches (300 mm) **OR** 16 inches (400 mm) **OR** 24 inches (600 mm), **as directed**, o.c.

G. Subflooring And Underlayment
1. Plywood Combination Subfloor-Underlayment: DOC PS 1, Exterior, Structural I, C-C Plugged **OR** Exterior, C-C Plugged **OR** Exposure 1, Structural I, Underlayment **OR** Exposure 1, Underlayment, **as directed**, single-floor panels.
2. Oriented-Stand-Board Combination Subfloor-Underlayment: Exposure 1 single-floor panels.
3. Plywood Subflooring: Exterior, Structural I **OR** Exterior **OR** Exposure 1, Structural I **OR** Exposure 1, **as directed**, single-floor panels or sheathing.
4. Oriented-Strand-Board Subflooring: Exposure 1, Structural I sheathing **OR** single-floor panels or sheathing, **as directed**.
5. Underlayment, General: Provide underlayment in nominal thicknesses indicated or, if not indicated, not less than 1/4 inch (6.4 mm) over smooth subfloors and not less than 3/8 inch (9.5 mm) over board or uneven subfloors.
6. Plywood Underlayment for Resilient Flooring: DOC PS 1, Exterior A-C **OR** Exterior B-C **OR** Exterior, C-C Plugged **OR** Exposure 1 Underlayment, **as directed**, with fully sanded face.
7. Plywood Underlayment for Ceramic Tile: DOC PS 1, Exterior, C-C Plugged, not less than 5/8-inch (15.9-mm) nominal thickness, for ceramic tile set in organic **OR** epoxy, **as directed**, adhesive.
8. Plywood Underlayment for Carpet: DOC PS 1, Exterior, C-C Plugged **OR** Exposure 1, Underlayment **OR** Interior, Underlayment, **as directed**.
9. Particleboard Underlayment: ANSI A208.1, Grade PBU **OR** M-2, Exterior Glue, complying with dimensional tolerances and thickness swell requirements of Grade PBU, **as directed**.
10. Hardboard Underlayment: AHA A135.4, Class 4 (Service), Surface S1S; with back side sanded.

H. Fasteners
1. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
   a. For roof and wall, **as directed**, sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M **OR** of Type 304 stainless steel, **as directed**.
2. Nails, Brads, and Staples: ASTM F 1667.
3. Power-Driven Fasteners: NES NER-272.
4. Wood Screws: ASME B18.6.1.
5. Screws for Fastening Wood Structural Panels to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.
   a. For wall and roof sheathing panels, provide screws with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.
6. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing board to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.
   a. For steel framing less than 0.0329 inch (0.835 mm) thick, attach sheathing to comply with ASTM C 1002.
   b. For steel framing from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick, attach sheathing to comply with ASTM C 954.
7. Screws for Fastening Oriented-Strand-Board-Surfaced, Polyisocyanurate-Foam Sheathing to Metal Roof Deck: Steel drill screws, in type and length recommended by sheathing manufacturer for thickness of sheathing board to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117. Provide washers or plates if recommended by sheathing manufacturer.

I. Weather-Resistant Sheathing Paper
1. Building Paper:
   a. ASTM D 226, Type 1 (No. 15 asphalt-saturated organic felt), unperforated.
      OR

UBC Standard 14-1, Grade D (water-vapor-permeable, kraft building paper), except that water resistance shall be not less than 1 hour and water-vapor transmission shall be not less than 75 g/sq. m x 24 h.

2. Building Wrap: ASTM E 1677, Type I air retarder; with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, when tested according to ASTM E 84; UV stabilized; and acceptable to authorities having jurisdiction.
   a. Water-Vapor Permeance: Not less than 535 **OR** 152 **OR** 125 **OR** 63, **as directed**, g through 1 sq. m of surface in 24 hours per ASTM E 96, Desiccant Method (Procedure A).
   b. Allowable UV Exposure Time: Not less than three months.
3. Building-Wrap Tape: Pressure-sensitive plastic tape recommended by building-wrap manufacturer for sealing joints and penetrations in building wrap.

J. Sheathing Joint-And-Penetration Treatment Materials
1. Sealant for Paper-Surfaced **OR** Glass-Mat, **as directed**, Gypsum Sheathing Board:
   a. Elastomeric, medium-modulus, neutral-curing silicone joint sealant compatible with joint substrates formed by gypsum sheathing and other materials, recommended by sheathing manufacturer for application indicated, and complying with requirements for elastomeric sealants specified in Division 07 Section "Joint Sealants".
   OR
   Silicone emulsion sealant complying with ASTM C 834, compatible with sheathing tape and sheathing, and recommended by tape and sheathing manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.
2. Sheathing Tape for Glass-Mat Gypsum Sheathing Board: Self-adhering glass-fiber tape, minimum 2 inches (50 mm) wide, 10 by 10 or 10 by 20 threads/inch (390 by 390 or 390 by 780 threads/m), of type recommended by sheathing and tape manufacturers for use with silicone emulsion sealant in sealing joints in glass-mat gypsum sheathing board and with a history of successful in-service use.
3. Sheathing Tape for Foam-Plastic Sheathing: Pressure-sensitive plastic tape recommended by sheathing manufacturer for sealing joints and penetrations in sheathing.

K. Miscellaneous Materials
1. Adhesives for Field Gluing Panels to Framing: Formulation complying with APA AFG-01 **OR** ASTM D 3498, **as directed**, that is approved for use with type of construction panel indicated by manufacturers of both adhesives and panels.
   a. Use adhesives that have a VOC content of 50 **OR** 70, **as directed**, g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.025 inch (0.6 mm) **OR** 0.030 inch (0.8 mm) **OR** 0.040 inch (1.0 mm), **as directed**.
3. Primer for Flexible Flashing: Product recommended by manufacturer of flexible flashing for substrate.

1.3 EXECUTION

A. Installation, General
1. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
2. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction, unless otherwise indicated.
3. Securely attach to substrate by fastening as indicated, complying with the following:
   a. NES NER-272 for power-driven fasteners.
   b. Table 2304.9.1, "Fastening Schedule," in ICC's "International Building Code."
   c. Table 23-II-B-1, "Nailing Schedule," and Table 23-II-B-2, "Wood Structural Panel Roof Sheathing Nailing Schedule," in ICBO's "Uniform Building Code."

d. Table 2305.2, "Fastening Schedule," in BOCA's "BOCA National Building Code."
e. Table 2306.1, "Fastening Schedule," in SBCCI's "Standard Building Code."
f. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's "International Residential Code for One- and Two-Family Dwellings."
g. Table 602.3(1), "Fastener Schedule for Structural Members," and Table 602.3(2), "Alternate Attachments," in ICC's "International One- and Two-Family Dwelling Code."

4. Use common wire nails, unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.
5. Coordinate wall and roof sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.
6. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.
7. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

B. Wood Structural Panel Installation
1. General: Comply with applicable recommendations in APA Form No. E30S, "Engineered Wood Construction Guide," for types of structural-use panels and applications indicated.
2. Fastening Methods: Fasten panels as indicated below:
a. Combination Subfloor-Underlayment:
1) Glue and nail **OR** Nail, **as directed**, to wood framing.
2) Screw to cold-formed metal framing.
3) Space panels 1/8 inch (3 mm) apart at edges and ends.
b. Subflooring:
1) Glue and nail **OR** Nail **OR** Nail or staple, **as directed**, to wood framing.
2) Screw to cold-formed metal framing.
3) Space panels 1/8 inch (3 mm) apart at edges and ends.
c. Wall and Roof Sheathing:
1) Nail **OR** Nail or staple, **as directed**, to wood framing. Apply a continuous bead of glue to framing members at edges of wall sheathing panels.
2) Screw to cold-formed metal framing.
3) Space panels 1/8 inch (3 mm) apart at edges and ends.
d. Underlayment:
1) Nail **OR** Nail or staple, **as directed**, to subflooring.
2) Space panels 1/32 inch (0.8 mm) apart at edges and ends.
3) Fill and sand edge joints of underlayment receiving resilient flooring right before installing flooring.

C. Gypsum Sheathing Installation
1. Comply with GA-253 and with manufacturer's written instructions.
a. Fasten gypsum sheathing to wood framing with nails **OR** screws, **as directed**.
b. Fasten gypsum sheathing to cold-formed metal framing with screws.
c. Install boards with a 3/8-inch (9.5-mm) gap where non-load-bearing construction abuts structural elements.
d. Install boards with a 1/4-inch (6.4-mm) gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.
2. Apply fasteners so heads bear tightly against face of sheathing boards but do not cut into facing.
3. Horizontal Installation: Install sheathing with V-grooved edge down and tongue edge up. Interlock tongue with groove to bring long edges in contact with edges of adjacent boards without forcing. Abut ends of boards over centers of studs, and stagger end joints of adjacent boards not

less than one stud spacing. Attach boards at perimeter and within field of board to each steel stud.

a. Space fasteners approximately 8 inches (200 mm) o.c. and set back a minimum of 3/8 inch (9.5 mm) from edges and ends of boards.
b. For sheathing under stucco cladding, boards may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.

4. Vertical Installation: Install board vertical edges centered over studs. Abut ends and edges of each board with those of adjacent boards. Attach boards at perimeter and within field of board to each stud.
   a. Space fasteners approximately 8 inches (200 mm) o.c. and set back a minimum of 3/8 inch (9.5 mm) from edges and ends of boards.
   b. For sheathing under stucco cladding, boards may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.

D. Fiberboard Sheathing Installation
1. Comply with ASTM C 846 and with manufacturer's written instructions.
2. Fasten fiberboard sheathing panels to intermediate supports and then at edges and ends. Use galvanized roofing nails or galvanized staples, **as directed**; comply with manufacturer's recommended spacing and referenced fastening schedule. Drive fasteners flush with surface of sheathing and locate perimeter fasteners at least 3/8 inch (9.5 mm) from edges and ends.
3. Install sheathing vertically with long edges parallel to, and centered over, studs. Install solid wood blocking where end joints do not occur over framing. Allow 1/8-inch (3-mm) open space between edges and ends of adjacent units. Stagger horizontal joints if any.
4. Cover sheathing as soon as practical after installation to prevent deterioration from wetting.

E. Foam-Plastic Sheathing Installation
1. Comply with manufacturer's written instructions.
2. Foam-Plastic Wall Sheathing: Install vapor-relief strips or equivalent for permitting escape of moisture vapor that otherwise would be trapped in stud cavity behind sheathing.

F. Particleboard Underlayment Installation
1. Comply with the National Particleboard Association's recommendations for type of subfloor indicated. Fill and sand gouges, gaps, and chipped edges. Sand uneven joints flush.
   a. Fastening Method: Glue and nail **OR** Nail **OR** Nail or staple, **as directed**, underlayment to subflooring.

G. Hardboard Underlayment Installation
1. Comply with AHA's "Application Instructions for Basic Hardboard Products" and with hardboard manufacturer's written instructions for preparing and applying hardboard underlayment.
   a. Fastening Method: Nail **OR** Nail or staple, **as directed**, underlayment to subflooring.

H. Weather-Resistant Sheathing-Paper Installation
1. General: Cover sheathing with weather-resistant sheathing paper as follows:
   a. Cut back barrier 1/2 inch (13 mm) on each side of the break in supporting members at expansion- or control-joint locations.
   b. Apply barrier to cover vertical flashing with a minimum 4-inch (100-mm) overlap, unless otherwise indicated.
2. Building Paper: Apply horizontally with a 2-inch (50-mm) overlap and a 6-inch (150-mm) end lap; fasten to sheathing with galvanized staples or roofing nails.
3. Building Wrap: Comply with manufacturer's written instructions.
   a. Seal seams, edges, fasteners, and penetrations with tape.
   b. Extend into jambs of openings and seal corners with tape.

I. Sheathing Joint-And-Penetration Treatment

1. Seal sheathing joints according to sheathing manufacturer's written instructions.
   a. Apply elastomeric sealant to joints and fasteners and trowel flat. Apply sufficient quantity of sealant to completely cover joints and fasteners after troweling. Seal other penetrations and openings.
   b. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing board joints, and apply and trowel silicone emulsion sealant to embed entire face of tape in sealant. Apply sealant to exposed fasteners with a trowel so fasteners are completely covered. Seal other penetrations and openings.
   c. Apply sheathing tape to joints between foam-plastic sheathing panels and at items penetrating sheathing. Apply at upstanding flashing to overlap both flashing and sheathing.

J. Flexible Flashing Installation
   1. Apply flexible flashing where indicated to comply with manufacturers written instructions.
      a. Prime substrates as recommended by flashing manufacturer.
      b. Lap seams and junctures with other materials at least 4 inches (100 mm), except that at flashing flanges of other construction, laps need not exceed flange width.
      c. Lap flashing over weather-resistant building paper at bottom and sides of openings.
      d. Lap weather-resistant building paper over flashing at heads of openings.
      e. After flashing has been applied, roll surfaces with a hard rubber or metal roller to ensure that flashing is completely adhered to substrates.

K. Protection
   1. Paper-Surfaced Gypsum Sheathing: Protect sheathing by covering exposed exterior surface of sheathing with weather-resistant sheathing paper securely fastened to framing. Apply covering immediately after sheathing is installed.

END OF SECTION 06160

Task	Specification	Specification Description
06160	06110	Rough Carpentry
06160	06110a	Miscellaneous Carpentry
06160	06150b	Rough Carpentry Renovation

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SECTION 06170 - METAL-PLATE-CONNECTED WOOD TRUSSES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for metal-plate-connected wood trusses. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
   a. Wood roof trusses.
   b. Wood floor trusses.
   c. Wood girder trusses.
   d. Wood truss bracing.
   e. Metal truss accessories.

C. Definitions
1. Metal-Plate-Connected Wood Trusses: Planar structural units consisting of metal-plate-connected members fabricated from dimension lumber and cut and assembled before delivery to Project site.
2. TPI: Truss Plate Institute, Inc.
3. Lumber grading agencies, and the abbreviations used to reference them, include the following:
   a. NeLMA: Northeastern Lumber Manufacturers' Association.
   b. NLGA: National Lumber Grades Authority.
   c. SPIB: The Southern Pine Inspection Bureau.
   d. WCLIB: West Coast Lumber Inspection Bureau.
   e. WWPA: Western Wood Products Association.

D. Performance Requirements
1. Structural Performance: Provide metal-plate-connected wood trusses capable of withstanding design loads within limits and under conditions indicated. Comply with requirements in TPI 1 unless more stringent requirements are specified below.
   a. Design Loads: As indicated.
   b. Maximum Deflection Under Design Loads:
      1) Roof Trusses: Vertical deflection of 1/180 **OR** 1/240 **OR** 1/360, **as directed**, of span.
      2) Floor Trusses: Vertical deflection of 1/360 **OR** 1/480 **OR** 1/600, **as directed**, of span.

E. Submittals
1. Product Data: For wood-preservative-treated lumber, fire-retardant treated lumber, metal-plate connectors, metal truss accessories, and fasteners.
   a. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
   b. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
   c. For fire-retardant treatments specified to be High-Temperature (HT) type, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.

d. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to truss fabricator.
e. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

2. Shop Drawings: Prepared by or under the supervision of a qualified professional engineer. Show fabrication and installation details for trusses.
   a. Show location, pitch, span, camber, configuration, and spacing for each type of truss required.
   b. Indicate sizes, stress grades, and species of lumber.
   c. Indicate locations of permanent bracing required to prevent buckling of individual truss members due to design loads.
   d. Indicate type, size, material, finish, design values, orientation, and location of metal connector plates.
   e. Show splice details and bearing details.
   f. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
3. LEED Submittal:
   a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that wood used to produce metal-plate-connected wood trusses complies with forest certification requirements. Include evidence that mill is certified for chain of custody by an FSC-accredited certification body.
      1) Include statement indicating costs for each certified wood product.
4. Qualification Data: For metal-plate manufacturer, professional engineer, fabricator, and Installer.
5. Research/Evaluation Reports: For the following, showing compliance with building code in effect for Project:
   a. Wood-preservative-treated lumber.
   b. Fire-retardant-treated wood.
   c. Metal-plate connectors.
   d. Metal truss accessories.

F. Quality Assurance
1. Metal Connector-Plate Manufacturer Qualifications: A manufacturer that is a member of TPI and that complies with quality-control procedures in TPI 1 for manufacture of connector plates.
   a. Manufacturer's responsibilities include providing professional engineering services needed to assume engineering responsibility.
   b. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.
2. Fabricator Qualifications: Shop that participates in a recognized quality-assurance program that complies with quality-control procedures in TPI 1 and that involves third-party inspection by an independent testing and inspecting agency acceptable to the Owner and authorities having jurisdiction.
3. Comply with applicable requirements and recommendations of the following publications:
   a. TPI 1, "National Design Standard for Metal Plate Connected Wood Truss Construction."
   b. TPI DSB, "Recommended Design Specification for Temporary Bracing of Metal Plate Connected Wood Trusses."
   c. TPI HIB, "Commentary and Recommendations for Handling, Installing & Bracing Metal Plate Connected Wood Trusses."
4. Wood Structural Design Standard: Comply with applicable requirements in AF&PA's "National Design Specifications for Wood Construction" and its "Supplement."
5. Forest Certification: Provide metal-plate-connected wood trusses produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

G. Delivery, Storage, And Handling

1. Handle and store trusses to comply with recommendations of TPI HIB, "Commentary and Recommendations for Handling, Installing & Bracing Metal Plate Connected Wood Trusses."
   a. Store trusses flat, off of ground, and adequately supported to prevent lateral bending.
   b. Protect trusses from weather by covering with waterproof sheeting, securely anchored.
   c. Provide for air circulation around stacks and under coverings.
2. Inspect trusses showing discoloration, corrosion, or other evidence of deterioration. Discard and replace trusses that are damaged or defective.

1.2 PRODUCTS

A. Dimension Lumber
   1. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
      a. Factory mark each piece of lumber with grade stamp of grading agency.
      b. For exposed lumber indicated to receive a stained or natural finish, omit grade stamp and provide certificates of grade compliance issued by grading agency.
      c. Provide dressed lumber, S4S.
      d. Provide dry lumber with 19 **OR** 15, **as directed**, percent maximum moisture content at time of dressing.
   2. Grade and Species: For truss chord and web members, provide dimension lumber of any species, graded visually or mechanically, and capable of supporting required loads without exceeding allowable design values according to AF&PA's "National Design Specifications for Wood Construction" and its "Supplement."
   3. Permanent Bracing: Provide wood bracing that complies with requirements for miscellaneous lumber in Division 06 Section(s) "Rough Carpentry" OR "Miscellaneous Carpentry", **as directed**.

B. Wood-Preservative-Treated Lumber
   1. Preservative Treatment by Pressure Process: AWPA C2, except that trusses that are not in contact with the ground and are continuously protected from liquid water may be made from lumber treated according to AWPA C31 with inorganic boron (SBX).
      a. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
      b. For exposed trusses indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.
   2. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
   3. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
      a. For exposed trusses indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
   4. Application: Treat all trusses, unless otherwise indicated **OR** trusses where indicated on Drawings, **as directed**.

C. Fire-Retardant-Treated Wood
   1. General: Comply with performance requirements in AWPA C20.
      a. Use Exterior type for exterior locations and where indicated.
      b. Use Interior Type A, High Temperature (HT) for enclosed roof trusses and where indicated.
      c. Use Interior Type A, unless otherwise indicated.
   2. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.

a. For exposed trusses and bracing indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.

3. For exposed trusses indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.
4. Application: Treat all trusses, unless otherwise indicated **OR** items indicated on Drawings, and the following, **as directed**:
   a. Floor trusses for bowling lanes and raised platforms.
   b. Roof trusses.

D. Metal Connector Plates
1. General: Fabricate connector plates to comply with TPI 1.
2. Hot-Dip Galvanized Steel Sheet: ASTM A 653/A 653M; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G60 (Z180) coating designation; and not less than 0.036 inch (0.9 mm) thick.
   a. Use for interior locations where stainless steel is not indicated.
3. Stainless-Steel Sheet: ASTM A 666, Type 304 **OR** 316, **as directed**, and not less than 0.035 inch (0.88 mm) thick.
   a. Use for exterior locations and where indicated.

E. Fasteners
1. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
   a. Where trusses are exposed to weather, in ground contact, made from pressure-preservative treated wood, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M **OR** of Type 304 stainless steel, **as directed**.
2. Nails, Brads, and Staples: ASTM F 1667.
3. Power-Driven Fasteners: NES NER-272.
4. Wood Screws: ASME B18.6.1.
5. Lag Bolts: ASME B18.2.1 (ASME B18.2.3.8M).
6. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.
7. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
   a. Material:
      1) Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
         OR
         Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Grade A1 or A4).

F. Metal Truss Accessories
1. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those \indicated **OR** of basis-of-design products, **as directed**. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.
2. Galvanized Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 (Z180) coating designation.
   a. Use for interior locations where stainless steel is not indicated.
3. Stainless-Steel Sheet: ASTM A 666, Type 304 **OR** 316, **as directed**.
   a. Use for exterior locations and where indicated.

4. Truss Tie-Downs: Bent strap tie for fastening roof trusses to wall studs below, 1-1/2 inches (38 mm) wide by 0.050 inch (1.3 mm) thick. Tie fastens to one side of truss, top plates, and side of stud below.
5. Truss Tie-Downs (Hurricane or Seismic Ties):
   a. Bent strap tie for fastening roof trusses to wall studs below, 2-1/4 inches (57 mm) wide by 0.062 inch (1.6 mm) thick. Tie fits over top of truss and fastens to both sides of truss, top plates, and one side of stud below.
      OR
      Bent strap tie for fastening roof trusses to wall studs below, 2-1/2 inches (63 mm) wide by 0.062 inch (1.6 mm) thick. Tie fits over top of truss and fastens to both sides of truss, inside face of top plates, and both sides of stud below.
6. Roof Truss Clips: Angle clips for bracing bottom chord of roof trusses at non-load-bearing walls, 1-1/4 inches (32 mm) wide by 0.050 inch (1.3 mm) thick. Clip is fastened to truss through slotted holes to allow for truss deflection.
7. Floor Truss Hangers: U-shaped hangers, full depth of floor truss, with 1-3/4-inch- (44-mm-) long seat; formed from metal strap 0.062 inch (1.6 mm) thick with tabs bent to extend over and be fastened to supporting member.
8. Roof Truss Bracing/Spacers: U-shaped channels, 1-1/2 inches (38 mm) wide by 1 inch (25 mm) deep by 0.040 inch (1.0 mm) thick, made to fit between 2 adjacent trusses and accurately space them apart, and with tabs having metal teeth for fastening to trusses.

G. Miscellaneous Materials
1. Galvanizing Repair Paint: SSPC-Paint 20, with dry film containing a minimum of 94 percent zinc dust by weight.
2. Protective Coatings: SSPC-Paint 22, epoxy-polyamide primer **OR** SSPC-Paint 16, coal-tar epoxy-polyamide paint, **as directed**.

H. Fabrication
1. Cut truss members to accurate lengths, angles, and sizes to produce close-fitting joints.
2. Fabricate metal connector plates to sizes, configurations, thicknesses, and anchorage details required to withstand design loads for types of joint designs indicated.
3. Assemble truss members in design configuration indicated; use jigs or other means to ensure uniformity and accuracy of assembly with joints closely fitted to comply with tolerances in TPI 1. Position members to produce design camber indicated.
   a. Fabricate wood trusses within manufacturing tolerances in TPI 1.
4. Connect truss members by metal connector plates located and securely embedded simultaneously in both sides of wood members by air or hydraulic press.

1.3 EXECUTION

A. Installation
1. Install wood trusses only after supporting construction is in place and is braced and secured.
2. If trusses are delivered to Project site in more than one piece, assemble trusses before installing.
3. Hoist trusses in place by lifting equipment suited to sizes and types of trusses required, exercising care not to damage truss members or joints by out-of-plane bending or other causes.
4. Install and brace trusses according to TPI recommendations and as indicated.
5. Install trusses plumb, square, and true to line and securely fasten to supporting construction.
6. Space trusses 16 inches (406 mm) o.c. **OR** 24 inches (610 mm) o.c. **OR** as indicated, **as directed**; adjust and align trusses in location before permanently fastening.
7. Anchor trusses securely at bearing points; use metal truss tie-downs or floor truss hangers as applicable. Install fasteners through each fastener hole in truss accessories according to manufacturer's fastening schedules and written instructions.
8. Securely connect each truss ply required for forming built-up girder trusses.
   a. Anchor trusses to girder trusses as indicated.

9. Install and fasten permanent bracing during truss erection and before construction loads are applied. Anchor ends of permanent bracing where terminating at walls or beams.
   a. Install bracing to comply with Division 06 Section(s) "Rough Carpentry" OR "Miscellaneous Carpentry", **as directed**.
   b. Install and fasten strongback bracing vertically against vertical web of parallel-chord floor trusses at centers indicated.
10. Install wood trusses within installation tolerances in TPI 1.
11. Do not cut or remove truss members.
12. Replace wood trusses that are damaged or do not meet requirements.
    a. Do not alter trusses in field.

B. Repairs And Protection
1. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
2. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
3. Repair damaged galvanized coatings on exposed surfaces with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
4. Protective Coating: Clean and prepare exposed surfaces of metal connector plates. Brush apply primer, when part of coating system, and one coat of protective coating.
   a. Apply materials to provide minimum dry film thickness recommended by coating system manufacturer.

END OF SECTION 06170

SECTION 06180 - TIMBER BRIDGE COMPONENTS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of timber bridge components. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Timber for Bridges shall comply with the specifications for timber bridges contained in the standard specifications of the state in which the work occurs, AASHTO's "Standard Specifications for Highway Bridges," and National Forest Products Association's "National Design Specification for Wood Construction."

B. Preservative Treatment shall comply with the specifications for preservative treatment contained in the standard specifications of the state in which the work occurs, and American Wood-Preservers' Association's "Book of Standards." All timber shall be treated unless specified otherwise.

C. Hardware and Castings:
1. Castings: Cast steel shall comply with ASTM A 27, Grade 70-36, or gray iron castings shall comply with AASHTO M105 Class No. 30, unless otherwise specified.
2. Hardware:
a. Machine Bolts, Drift-Bolts, and Dowels may be either wrought iron or rolled steel. Machine bolts shall have the square heads and nuts unless otherwise specified.
b. Cast Washers shall be made of malleable or gray iron. The outside diameter shall not be less than 3 1/2 times the bolt diameter and its thickness equal to the bolt diameter. Plate washers shall be made of wrought iron or rolled steel. The outside diameter shall not be less than 3 1/2 times the bolt diameter, and they shall not be less than 1/4 inch thick.
c. Nails and Spikes shall be hot-dip zinc coated per ASTM A 153 or of Type 304 stainless steel.
d. Finish: Unless otherwise specified, all hardware for treated timber bridges shall be galvanized or cadmium-plated. Galvanizing shall comply with ASTM A 123 or A 153. Cadmium plating of steel shall comply with ASTM B 766.

D. Timber Connectors shall be ring type or plate type and shall be galvanized in compliance with ASTM A 123 or A 153.
1. Split Ring: Fabricated from hot rolled steel sheet complying with ASTM A 570 (ASTM A 570M), Grade 33 of standard manufacture.
2. Tooth Ring: Stamped cold form 16-gauge steel sheet fabricated from hot rolled steel sheet complying with ASTM A 570 (ASTM A 570M), Grade 33 standard manufacture.
3. Shear-Plate Timber Connectors:
a. Pressed Steel Type shall be fabricated from hot rolled steel sheet complying with ASTM A 570 (ASTM A 570M), Grade 33. Shear plates shall be of standard manufacture.
b. Malleable Iron Type shall be ASTM A 47, Grade No. 32510 (ASTM A 47M, Grade 22010). Casting shall be of standard manufacture.

E. Structural Glue-Laminated Timber shall comply with DOC PS 20, American Structural Lumber Standard, AITC 190.1 and AITC 111. Lumber for laminating shall be of such stress grade as to provide glue-laminated members with allowable stress values of 2,000 psi in bending, 1,600 psi in tension, 1,500 psi in compression parallel to grain, and 385 psi in compression perpendicular to grain for dry condition of service.
   1. Adhesives shall meet requirements for wet condition of service.
   2. Surfaces of Members shall be sealed with a penetration sealer or sealed with a sealer coat.

F. Ties: Fabricate strap ties from hot-rolled steel sheet complying with ASTM A 570 (ASTM A 570M). Hot dip galvanize after fabrication to comply with ASTM A 123 or ASTM A 153 (ASTM A 153M).

G. Asphalt Cement shall comply with ASTM D946 for penetration-graded material.

H. Surface Coarse Aggregate shall be ASTM D 692, except the gradation shall be as follows:

Sieve Percent	Size Passing (Wt.)
1/2 in.	100
3/8 in.	94-100
No. 4	15-45
No. 16	0-4

1.3 EXECUTION

A. Preparation:
   1. Traffic Control: When traffic is maintained on bridge under repair or is directed over a temporary run-around, furnish, erect, and maintain all barricades, flags, torches, lights, guardrails, temporary pavement markings, and traffic control signs required for the protection of the public and for the direction of traffic. Number, type, color, size and placement of all traffic control color, size, and placement of all traffic control devices and the use of a flagman shall comply with USDOT FHA MUTCD "Traffic Controls for Highway Construction and Maintenance Operations." All traffic control devices in advance of the construction limits shall also be the responsibility of the Contractor.
   2. Treated Timber: Give all cuts, abrasions, and holes made after treatment 2 applications of 60 percent creosote oil and 40 percent roofing pitch or brush coat with 2 applications of hot creosote oil and covered with hot roofing pitch. Any unfilled holes, after being treated with preservative oil, shall be plugged with treated plugs.

B. Erection:
   1. Holes:
      a. Drift Bolts and Dowels: Bore holes for round drift bolts and dowels with a bit 1/16 inch less in diameter than the bolt or dowel to be used. The diameter of holes for square drift bolts or dowels shall be equal to the least dimension of the bolt or dowel.
      b. Machine Bolts and Rods: Bore holes for field fabrication with a bit the same diameter as the bolt. Holes for fabrication prior to treatment shall be 1/16 inch larger than the bolt diameter.
      c. Lag Screws: Bore hole with a bit not larger than the body of the screw at the base of the thread.
   2. Nuts and Washers: Use a washer of the size and type specified under all bolt heads and nuts except carriage bolts. The nuts of all bolts shall be locked by scoring threads after they have been finally tightened.
   3. Countersinking: Paint all recesses in treated timber formed for countersinking with hot creosote oil. Fill recesses likely to collect injurious materials with hot pitch.
   4. Framing: All lumber and timber shall be accurately cut and framed to a close fit in such manner that the joints will have even bearing over the entire contact surfaces. Place stringers in position so that knots near edges will be in the top portions of the stringer. Screw type fastenings shall be

screwed into place for the entire length of the fastener. Install the split ring and the shear plate in grooves cut by the Contractor. Force the toothed ring into the contact surfaces of the timbers jointed by means of pressure equipment.

5. Nailing: Nails and spikes shall be driven with just sufficient force to set the heads flush with the surface of the wood.

C. Maintenance and Repair Methods:

1. Timber Deck:
   a. Remove Existing Plank Floor Deck and Fasteners and replace with new planks and fasteners. Lay the floor planks at 45 degrees to centerline of roadway. When more than one length of plank is required, stagger joints between abutting ends at least 3 feet in any two adjacent lines of plank.
   b. Standard Wrought Washers shall be used under the heads of all lag screws and under the heads or nuts of all machine bolts. Where machine bolts are used for fastening the floor plank all nuts used shall be locknuts. Countersink heads of all lag screws and bolts in the surface of the floor. Fill recesses formed for countersinking with hot pitch.
   c. Bituminous Surface Coat: Clean the floor of foreign materials. Apply asphalt cement at a temperature of 275 F to 350 F and at a rate of approximately 1/4 gallon per square yard of surface. The deck shall be dry at the time of bitumen application. Cover the entire surface with a thin coating of aggregate in a sufficient quantity to take up any free bitumen.
2. Hardware: Remove all corrosion by sandblasting or wire brushing. Replace all loose bolts and screws, adding washers as required. Replace deteriorated hardware.
3. Metal Tread Plates: Remove and replace treads as directed. Before installing treads, remove high spots and rough spots in the plank floor so that the treads will be in contact with the floor for their full length and width. Treads shall be laid in a heavy mop coat of asphalt filler. Treads shall be laid with a space of 1/4 inch between adjacent ends and shall be fastened by means of 3/8-inch galvanized bolts. Where bolts cannot be used, use 3/8-inch by 3-inch galvanized lag screws.
4. Timber Railroad Bridge Deck: Remove defective ties and guardrail, including fasteners, and replace with similar ties, guardrail, and fasteners as directed.
5. Repair of Structural Timber Members: Repair, including removal and replacement, shall be as directed.

END OF SECTION 06180

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Task	Specification	Specification Description
06180	06110	Rough Carpentry
06180	06150a	Wood Decking

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SECTION 06220 - EXTERIOR FINISH CARPENTRY

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for exterior finish carpentry. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Exterior standing and running trim.
b. Lumber, Plywood, and Hardboard siding.
c. Plywood and Hardboard soffits.
d. Exterior stairs and railings.
e. Exterior ornamental wood columns.

C. Definitions
1. Lumber grading agencies, and the abbreviations used to reference them, include the following:
a. NeLMA: Northeastern Lumber Manufacturers' Association.
b. NLGA: National Lumber Grades Authority.
c. RIS: Redwood Inspection Service.
d. SPIB: The Southern Pine Inspection Bureau.
e. WCLIB: West Coast Lumber Inspection Bureau.
f. WWPA: Western Wood Products Association.

D. Submittals
1. Product Data: For each type of process and factory-fabricated product.
2. Samples: For each type of siding indicated.
3. LEED Submittal:
a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that products specified to be made from certified wood comply with forest certification requirements. Include evidence that mill is certified for chain of custody by an FSC-accredited certification body.
1) Include statement indicating costs for each certified wood product.
4. Research/Evaluation Reports: For fire-retardant-treated wood.
5. Compliance Certificates:
a. For lumber that is not marked with grade stamp.
b. For preservative-treated wood that is not marked with treatment quality mark.
c. For fire-retardant-treated wood that is not marked with classification marking of testing and inspecting agency.
6. Warranties: Special warranties specified in this Section.

E. Quality Assurance
1. Forest Certification: For the following wood products, provide materials produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship":
a. Exterior standing and running trim.
b. Exterior lumber, plywood, and hardboard siding.
c. Exterior plywood and hardboard soffits.
d. Exterior stairs and railings.
e. Exterior ornamental wood columns.

F. Delivery, Storage, And Handling

1. Protect materials against weather and contact with damp or wet surfaces. Stack lumber, plywood, and other panels flat with spacers between each bundle to provide air circulation. Provide for air circulation within and around stacks and under temporary coverings.

G. Warranty
1. Special Warranty for Cellular PVC Trim: Manufacturer's standard form, signed by manufacturer, Installer, and Contractor, in which manufacturer agrees to repair or replace trim that fails due to defects in manufacturing within 25 years from date of Substantial Completion. Failures include, but are not limited to rotting, corrosion, delamination, and excessive swelling from moisture.
2. Special Warranty for Hardboard Siding and Trim: Manufacturer's standard form, signed by manufacturer, Installer, and Contractor, in which manufacturer agrees to repair or replace siding that fails in materials or workmanship within specified warranty period. Failures include, but are not limited to, deformation or deterioration beyond normal weathering.
   a. Warranty Period for Factory-Applied Finish: Five years from date of Substantial Completion.
   b. Warranty Period for Siding and Trim (Excluding Finish): 25 years from date of Substantial Completion.
3. Special Warranty for Columns: Manufacturer's standard form, signed by manufacturer, Installer, and Contractor, in which manufacturer agrees to repair or replace columns that fail in materials or workmanship within five years from date of Substantial Completion.

1.2 PRODUCTS

A. Materials, General
1. Lumber: DOC PS 20 and applicable grading rules of inspection agencies certified by ALSC's Board of Review.
2. Softwood Plywood: DOC PS 1.
3. Hardboard: AHA A135.4.

B. Wood-Preservative-Treated Materials
1. Water-Repellent Preservative Treatment by Nonpressure Process: AWPA N1 (dip, spray, flood, or vacuum-pressure treatment).
   a. Preservative Chemicals: 3-iodo-2-propynyl butyl carbamate (IPBC), combined with an insecticide containing chloropyrifos (CPF).
   b. Use chemical formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants in solution to distinguish treated material from untreated material.
   c. Application: Items not required to be pressure-preservative treated.
   d. Application: Exterior trim and wood siding.
2. Preservative Treatment by Pressure Process:
   a. Lumber: AWPA C2 except that lumber that is not in contact with the ground and is continuously protected from liquid water may be treated according to AWPA C31 with inorganic boron (SBX). Kiln dry after treatment to a maximum moisture content of 19 percent.
   b. Plywood: AWPA C9. Kiln dry after treatment to a maximum moisture content of 18 percent.
   c. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
   d. For exposed items indicated to receive transparent finish, do not use chemical formulations that contain colorants or that bleed through or otherwise adversely affect finishes.
   e. Do not use material that is warped or does not comply with requirements for untreated material.
   f. Mark lumber with treatment quality mark of an inspection agency approved by ALSC's Board of Review.

1) For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.

g. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.
   1) For exposed plywood indicated to receive a stained or natural finish, mark back of each piece.

h. Application: Where indicated **OR** All exterior lumber and plywood, **as directed**.

C. Fire-Retardant-Treated Materials
1. Lumber: Comply with performance requirements in AWPA C20, Exterior type. Kiln dry after treatment to a maximum moisture content of 19 percent.
2. Plywood: Comply with performance requirements in AWPA C27, Exterior type. Kiln dry after treatment to a maximum moisture content of 15 percent.
3. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not contain colorants and provide materials that do not have marks from spacer sticks on the exposed face.
4. Do not use material that does not comply with requirements for untreated material or is warped or discolored.
5. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
   a. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
   b. For exposed plywood indicated to receive a stained or natural finish, mark back of each piece.
6. Application: Where indicated **OR** All exterior lumber and plywood, **as directed**.

D. Standing And Running Trim
1. Lumber Trim for Semitransparent-Stained Finish **OR** Clear Finish **OR** Unfinished Applications, **as directed**:
   a. Species and Grade: Redwood, Clear All Heart **OR** Hart B **OR** Clear **OR** Grade B, **as directed**; RIS.
   b. Species and Grade: Western red cedar, Clear Heart VG (Vertical Grain) **OR** Clear Heart **OR** Grade A **OR** Grade B, **as directed**; NLGA, WCLIB, or WWPA.
   c. Species and Grade: Hem-fir, pressure-preservative treated; 1 **OR** 2, **as directed**, Common; NLGA, WCLIB, or WWPA.
   d. Species and Grade: Southern pine, pressure-preservative treated; B & B **OR** C & Btr **OR** D, **as directed**; SPIB.
   e. Maximum Moisture Content: 19 **OR** 15, **as directed**, percent with at least 85 percent of shipment at 12 percent or less, **as directed**.
   f. Finger Jointing: Not allowed **OR** Allowed if made with wet-use adhesive complying with ASTM D 5572, **as directed**.
   g. Face Surface: Surfaced (smooth) **OR** Saw textured, **as directed**.
2. Lumber Trim for Opaque-Stained **OR** Painted, **as directed**, Finish:
   a. Species and Grade: Redwood, Clear **OR** Grade B, **as directed**; RIS.
   b. Species and Grade: Western red cedar, Grade A **OR** B, **as directed**; NLGA, WCLIB, or WWPA.
   c. Species and Grade: Hem-fir, Prime or D finish **OR** 1 Common **OR** 2 Common, **as directed**; NLGA, WCLIB, or WWPA.
   d. Species and Grade: Eastern white pine, eastern hemlock-balsam fir-tamarack, eastern spruce, or white woods; D Select (Quality) **OR** Finish or 1 Common (Colonial) **OR** Premium or 2 Common (Sterling), **as directed**; NeLMA, NLGA, WCLIB, or WWPA.
   e. Species and Grade: Northern white cedar, D Select **OR** 1 Common **OR** 2 Common, **as directed**; NeLMA or NLGA.

f. Maximum Moisture Content: 19 **OR** 15, **as directed**, percent with at least 85 percent of shipment at 12 percent or less, **as directed**.
g. Finger Jointing: Not allowed **OR** Allowed if made with wet-use adhesive complying with ASTM D 5572, **as directed**.
h. Face Surface: Surfaced (smooth) **OR** Saw textured, **as directed**.

3. Moldings for Semitransparent-Stained Finish **OR** Clear Finish **OR** Unfinished Applications, **as directed**: WMMPA WM 4, N-grade wood moldings, without finger jointing. Made from kiln-dried stock to patterns included in WMMPA WM 12.
   a. Species: Redwood **OR** Western red cedar **OR** Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine, **as directed**.
   b. Brick-Mold Pattern: WM 180, 1-1/4 by 2 inches (32 by 51 mm).
   c. Drip-Cap Pattern: WM 197, 11/16 by 1-5/8 inches (17 by 41 mm).
   d. Bed-Mold Pattern: WM 75, 9/16 by 1-5/8 inches (14 by 41 mm).
   e. Screen-Bead Pattern: WM 144, 1/4 by 3/4 inch (6 by 19 mm).
4. Moldings for Opaque-Stained **OR** Painted, **as directed**, Finish: WMMPA WM 4, P-grade wood moldings. Made from kiln-dried stock to patterns included in WMMPA WM 12.
   a. Species: Redwood **OR** Western red cedar **OR** Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine, **as directed**.
   b. Finger Jointing: Not allowed **OR** Allowed if made with wet-use adhesive complying with ASTM D 5572, **as directed**.
   c. Brick-Mold Pattern: WM 180, 1-1/4 by 2 inches (32 by 51 mm).
   d. Drip-Cap Pattern: WM 197, 11/16 by 1-5/8 inches (17 by 41 mm).
   e. Bed-Mold Pattern: WM 75, 9/16 by 1-5/8 inches (14 by 41 mm).
   f. Screen-Bead Pattern: WM 144, 1/4 by 3/4 inch (6 by 19 mm).
5. MDO Trim: Exterior Grade B-B, MDO plywood.
6. Cellular PVC Trim: Extruded, expanded PVC with a small-cell microstructure, made from UV- and heat-stabilized, rigid material.
   a. Density: Not less than 31 lb/cu. ft. (500 kg/cu. m).
   b. Heat Deflection Temperature: Not less than 130 deg F (54 deg C), per ASTM D 648.
   c. Coefficient of Thermal Expansion: Not more than 4.5×10^{-5} inches/inch x deg F (8.1×10^{-5} mm/mm x deg C).
   d. Water Absorption: Not more than 1 percent, per ASTM D 570.
   e. Flame-Spread Index: 75 or less, per ASTM E 84.
7. Foam Plastic Moldings: Molded product of shapes indicated, with a tough outer skin on exposed surfaces; factory primed. Exposed surfaces shall not be shaped after molding. Product is recommended by manufacturer for exterior use.
   a. Density: Not less than 20 lb/cu. ft. (320 kg/cu. m).
   b. Flame-Spread Index: Not more than 75 when tested according to ASTM E 84.
   c. Thickness: Not more than 1/2 inch (12.7 mm).
   d. Width: Not more than 8 inches (204 mm).
   e. Patterns: As indicated by manufacturer's designations.

E. Lumber Siding
1. Provide kiln-dried lumber siding complying with DOC PS 20, factory coated with exterior alkyd primer, **as directed**.
2. Species and Grade:
   a. Clear All Heart VG **OR** Clear All Heart **OR** Clear VG (Vertical Grain) **OR** Clear **OR** Grade B, **as directed**, redwood; RIS.
   b. Clear VG (Vertical Grain) Heart **OR** Grade A **OR** Grade B, **as directed** western red cedar; NLGA, WCLIB, or WWPA.
   c. Grade 1 **OR** 2, **as directed**, Common spruce-pine-fir; NeLMA, NLGA, WCLIB, or WWPA.
   d. Grade Prime or D finish **OR** 1 Common **OR** 2 Common, **as directed**, pressure-preservative-treated hem-fir; NLGA, WCLIB, or WWPA.

e. Grade D Select (Quality) **OR** Finish or 1 Common (Colonial) **OR** Premium or 2 Common (Sterling), **as directed**, eastern white pine, eastern hemlock-balsam fir-tamarack, eastern spruce, or white woods; NeLMA, NLGA, WCLIB, or WWPA.
f. Grade D Select **OR** 1 Common **OR** 2 Common, **as directed**, northern white cedar; NeLMA or NLGA.
g. Grade B & B **OR** C & Btr **OR** D **OR** 1 Common **OR** 2 Common, **as directed**, pressure-preservative-treated southern pine; SPIB.

3. Pattern:
   a. Bevel siding, S1S2E, actual overall dimensions of 5-1/2 by 11/16 inch (140 by 17 mm) **OR** 5-1/2 by 3/4 inch (140 by 19 mm) **OR** 7-1/4 by 3/4 inch (184 by 19 mm) **OR** 9-1/4 by 3/4 inch (235 by 19 mm) **OR** 9-1/4 by 1-3/32 inches (235 by 28 mm), **as directed**, measured on the face and thick edge at 19 percent moisture content.
   b. Drop siding, SPIB or WWPA pattern No. 105, actual face width (coverage) and thickness of 4-7/8 by 9/16 inch (124 by 14 mm) **OR** 4-7/8 by 23/32 inch (124 by 18 mm) **OR** 6-5/8 by 23/32 inch (168 by 18 mm) **OR** 8-5/8 by 23/32 inch (219 by 18 mm), **as directed**, measured at 19 percent moisture content.
   c. V-edge, smooth-faced tongue-and-groove pattern with eased edges, actual face width (coverage) and thickness of 3-1/8 by 9/16 inch (79 by 14 mm) **OR** 3-1/8 by 23/32 inch (79 by 18 mm) **OR** 5-1/8 by 23/32 inch (130 by 18 mm) **OR** 6-7/8 by 23/32 inch (175 by 18 mm), **as directed**, measured at 19 percent moisture content.

F. Plywood Siding
1. Plywood Type: APA-rated siding, pressure-preservative treated, **OR** factory coated with exterior acrylic latex stain, **as directed**, in panel sizes indicated.
   a. Face Grade: 303-OC **OR** OL **OR** NR **OR** SR, **as directed**.
   b. Face Grade: 303-6 **OR** 18 **OR** 30, **as directed**-S **OR** W **OR** S/W, **as directed**.
2. Thickness: 11/32 inch (8.7 mm) **OR** 3/8 inch (9.5 mm) **OR** 15/32 inch (11.9 mm) **OR** 1/2 inch (12.7 mm) **OR** 19/32 inch (15.1 mm) **OR** 5/8 inch (15.9 mm) **OR** As indicated, **as directed**.
3. Face Species: Southern pine **OR** Douglas fir **OR** Western red cedar **OR** Redwood, **as directed**.
4. Pattern: Plain **OR** Channel groove; grooves 4 inches (101.6 mm) o.c. **OR** Texture 1-11; grooves 4 inches (101.6 mm) o.c. **OR** Reverse board-and-batten; grooves 12 inches (304.8 mm) o.c., **as directed.**
5. Surface: Smooth **OR** Rough sawn, **as directed**.

G. Hardboard Siding
1. Hardboard Siding: AHA A135.6, primed with manufacturer's standard exterior primer.
   a. Type:
      1) 7/16-inch- (11-mm-) thick-by-6-inch- (152-mm-) **OR** 8-inch- (203-mm-), **as directed**, wide lap siding.
      2) 1/2-inch- (12.7-mm-) thick-by-8-inch- (203-mm-) wide, beaded-edge lap siding.
      3) 7/16-inch- (11-mm-) thick, shiplap-edge panels; with grooves 3-5/8 inches (92 mm) o.c., simulating wood drop siding.
      4) 1/2-inch- (12.7-mm-) thick, shiplap-edge panels; with grooves 5-1/2 inches (140 mm) o.c., simulating wood drop siding.
      5) 7/16-inch- (11-mm-) thick, square-edge flat panels; without grooves.
      6) 7/16-inch- (11-mm-) thick, shiplap-edge panels; channel grooved with grooves 8 inches (203.2 mm) o.c.
   b. Texture: Smooth **OR** Wood grain **OR** Shingle **OR** Stucco, **as directed**.
2. Primed Hardboard Trim: High-temperature-cured, high-resin, wood-fiber composite; factory primed on faces and edges. Recommended by manufacturer for exterior use.
3. Colors, Textures, and Patterns: As selected by the Owner from manufacturer's full range.

H. Plywood Soffits
1. Plywood Type: Exterior, Grade A-C **OR** Grade B-C **OR** Grade C-C, plugged and touch sanded **OR** APA-rated siding, **as directed**.
   a. Face Grade: 303-OC **OR** OL **OR** NR **OR** SR, **as directed**.

b. Face Grade: 303-6 **OR** 18 **OR** 30, **as directed**,-S **OR** W **OR** S/W, **as directed**.

2. Thickness: 11/32 inch (8.7 mm) **OR** 3/8 inch (9.5 mm) **OR** 15/32 inch (11.9 mm) **OR** 1/2 inch (12.7 mm) **OR** 19/32 inch (15.1 mm) **OR** As indicated, **as directed**.
3. Face Species: Southern pine **OR** Douglas fir **OR** Western red cedar **OR** Redwood, **as directed**.
4. Pattern: Plain **OR** Channel groove; grooves 4 inches (101.6 mm) o.c. **OR** Texture 1-11; grooves 4 inches (101.6 mm) o.c., **as directed.**
5. Surface: Smooth **OR** Rough sawn, **as directed**.

I. Hardboard Soffits

1. Hardboard Soffits: Primed hardboard, complying with AHA A135.6, with manufacturer's standard exterior primer.
   a. Type: 7/16-inch- (11-mm-) **OR** 1/2-inch- (12.7-mm-), **as directed**, thick flat panels, smooth **OR** wood-grain textured **OR** stucco textured, **as directed**.
2. Colors, Textures, and Patterns: As selected by the Owner from manufacturer's full range.

J. Stairs And Railings

1. Stairs:
   a. Treads: 1-1/4-inch (32-mm) thick, kiln-dried, pressure-preservative-treated stepping with half-round or rounded edge nosing.
      1) Species and Grade: Douglas fir, C & Btr VG (Vertical Grain) stepping; NLGA, WCLIB, or WWPA **OR** Hem-fir, C & Btr VG (Vertical Grain) stepping; NLGA, WCLIB, or WWPA **OR** Southern pine, B & B stepping; SPIB, **as directed**.
   b. Risers: 3/4-inch (19-mm) thick, kiln-dried, pressure-preservative-treated finish boards.
      1) Species and Grade: Douglas fir, C & Btr or Superior finish; NLGA, WCLIB, or WWPA **OR** Hem-fir, C & Btr or Superior finish; NLGA, WCLIB, or WWPA **OR** Southern pine, B & B; SPIB, **as directed**
2. Railings: Clear, kiln-dried, solid, yellow poplar **OR** pressure-preservative-treated Douglas fir **OR** pressure-preservative-treated southern pine, **as directed**; railing stock of pattern indicated.
3. Balusters: 1-1/16-inch- (27-mm-) square, clear, kiln-dried, solid, yellow poplar **OR** pressure-preservative-treated Douglas fir **OR** pressure-preservative-treated southern pine, **as directed**.
4. Newel Posts: Clear, kiln-dried, yellow poplar **OR** pressure-preservative-treated, Douglas fir **OR** pressure-preservative-treated, southern pine, **as directed**, turned newel posts of pattern and size indicated.
5. Newel Posts: 2-3/4-inch- (70-mm-) square, clear, kiln-dried yellow poplar **OR** pressure-preservative-treated Douglas fir **OR** pressure-preservative-treated southern pine, **as directed**; either solid or laminated.

K. Ornamental Wood Columns

1. Factory fabricate columns from clear stock, either solid or finger jointed, with a moisture content of not more than 15 **OR** 19, **as directed**, percent.
   a. Wood Species: Redwood **OR** Western red cedar **OR** Eastern white, Idaho white, lodgepole, ponderosa, or sugar pine, **as directed**.
2. Shafts: Built up from tongue-and-groove staves joined with waterproof glue. Lathe turn shafts to provide base diameter indicated and true architectural entasis taper. Precisely mill flutes as indicated.
3. Capital and Base: Molded glass-fiber-reinforced plastic **OR** Built up from wood components with waterproof glue. Turn circular elements on lathes.
4. Plinths: Cast-aluminum or molded glass-fiber-reinforced plastic, constructed to ventilate the interior of column shaft.
5. Treatment and Finishing:
   a. Treat wood columns with water-repellant preservative by nonpressure process.
   b. Coat inside of column shafts with bituminous mastic.
   c. Prime columns with two coats of exterior alkyd wood primer compatible with specified topcoats.

L. Miscellaneous Materials
1. Fasteners for Exterior Finish Carpentry: Provide nails or screws, in sufficient length to penetrate not less than 1-1/2 inches (38 mm) into wood substrate.
   a. For face-fastening siding, provide ringed-shank siding nails unless hot-dip galvanized nails are used.
   b. For redwood, provide brass/bronze **OR** stainless-steel **OR** hot-dip galvanized steel, **as directed**, fasteners.
   c. For prefinished items, provide matching prefinished aluminum fasteners where face fastening is required.
   d. For pressure-preservative-treated wood, provide stainless-steel **OR** hot-dip galvanized steel, **as directed**, fasteners.
   e. For applications not otherwise indicated, provide stainless-steel **OR** hot-dip galvanized steel **OR** aluminum, **as directed**, fasteners.
2. Wood Glue: Waterproof resorcinol glue recommended by manufacturer for exterior carpentry use.
3. Adhesive for Cellular PVC Trim: Product recommended by trim manufacturer.
4. Flashing: Comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim" for flashing materials installed in exterior finish carpentry.
   a. Horizontal Joint Flashing for Panel Siding: Preformed, galvanized steel **OR** aluminum **OR** prefinished aluminum **OR** stainless-steel, **as directed**, Z-shaped flashing.
5. Insect Screening for Soffit Vents: Aluminum, 18-by-16 (1.4-by-1.6-mm) mesh **OR** PVC-coated glass-fiber fabric, 18-by-14 (1.4-by-1.8-mm) or 18-by-16 (1.4-by-1.6-mm) mesh **OR** Stainless steel, 18-by-18 (1.4-by-1.4-mm) mesh, **as directed**.
6. Continuous Soffit Vents: Aluminum hat channel shape with stamped louvers **OR** perforations, **as directed**, 2 inches (51 mm) wide, and in lengths not less than 96 inches (2438 mm).
   a. Net Free Area: 4 sq. in./linear ft. (280 sq. cm/m) **OR** 6 sq. in./linear ft. (420 sq. cm/m) **OR** 8 sq. in./linear ft. (560 sq. cm/m), **as directed**.
   b. Finish: Mill finish **OR** White paint **OR** Brown paint, **as directed**.
7. Round Soffit Vents: Stamped aluminum louvered vents, 2 inches (51 mm) **OR** 2-1/2 inches (64 mm) **OR** 3 inches (76 mm) **OR** 4 inches (102 mm), **as directed**, in diameter, made to be inserted into round holes cut into soffit.
   a. Finish: Mill finish **OR** White paint **OR** Brown paint, **as directed**.
8. Sealants: Latex, complying with ASTM C 834, Type P, Grade NF and with applicable requirements in Division 07 Section "Joint Sealants", recommended by sealant manufacturer and manufacturer of substrates for intended application.

M. Fabrication
1. Back out or kerf backs of standing and running trim wider than 5 inches (125 mm), except members with ends exposed in finished work.
2. Ease edges of lumber less than 1 inch (25 mm) in nominal thickness to 1/16-inch (1.5-mm) radius and edges of lumber 1 inch (25 mm) or more in nominal thickness to 1/8-inch (3-mm) radius.

1.3 EXECUTION

A. Preparation
1. Clean substrates of projections and substances detrimental to application.
2. Prime lumber to be painted, including both faces and edges. Cut to required lengths and prime ends. Comply with requirements in Division 09 Section "Exterior Painting".

B. Installation, General
1. Do not use materials that are unsound, warped, improperly treated or finished, inadequately seasoned, or too small to fabricate with proper jointing arrangements.
   a. Do not use manufactured units with defective surfaces, sizes, or patterns.
2. Install exterior finish carpentry level, plumb, true, and aligned with adjacent materials. Use concealed shims where necessary for alignment.

a. Scribe and cut exterior finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
b. Install to tolerance of 1/8 inch in 96 inches (3 mm in 2438 mm) for level and plumb. Install adjoining exterior finish carpentry with 1/32-inch (0.8-mm) maximum offset for flush installation and 1/16-inch (1.5-mm) maximum offset for reveal installation.
c. Install stairs with no more than 3/16-inch (4.7-mm) variation between adjacent treads and risers and with no more than 3/8-inch (9.5-mm) variation between largest and smallest treads and risers within each flight.
d. Coordinate exterior finish carpentry with materials and systems in or adjacent to it. Provide cutouts for mechanical and electrical items that penetrate exterior finish carpentry.

C. Standing And Running Trim Installation
1. Install flat grain lumber with bark side exposed to weather.
2. Install cellular PVC trim to comply with manufacturer's written instructions.
3. Install trim with minimum number of joints practical, using full-length pieces from maximum lengths of lumber available. Do not use pieces less than 24 inches (610 mm) long except where necessary.
   a. Use scarf joints for end-to-end joints.
   b. Stagger end joints in adjacent and related members.
4. Fit exterior joints to exclude water. Cope at returns and miter at corners to produce tight-fitting joints with full-surface contact throughout length of joint. Plane backs of casings to provide uniform thickness across joints, where necessary for alignment.
5. Unless otherwise indicated, countersink fasteners, fill surface flush, and sand where face fastening is unavoidable.

D. Siding Installation
1. Install siding to comply with manufacturer's written instructions and warranty requirements.
2. Horizontal Lumber Siding: Apply starter strip along bottom edge of sheathing or sill. Install first course of siding with lower edge at least 1/8 inch (3 mm) below starter strip and subsequent courses lapped 1 inch (25 mm) over course below. Nail at each stud. Do not allow nails to penetrate more than one thickness of siding.
3. Diagonal Lumber Siding: Begin application at corner with tongue edge up. Install subsequent courses with tongue-and-groove edges tightly fitted together. Nail at each stud.
   a. Leave 1/8-inch (3-mm) gap at trim and corners unless otherwise recommended by manufacturer, and apply sealant.
   b. Butt joints only over framing or blocking, nailing top and bottom on each side and staggering joints in subsequent courses.
   c. Install prefabricated outside corners as recommended by manufacturer of siding materials.
4. Plywood Siding: Install panels with edges over framing or blocking. Nail at 6 inches (150 mm) o.c. at panel perimeter and 12 inches (300 mm) o.c. at intermediate supports unless manufacturer recommends closer spacing. Leave 1/16-inch (1.5-mm) gap between adjacent panels and 1/8-inch (3-mm) gap at perimeter, openings, and horizontal joints unless otherwise recommended by panel manufacturer.
   a. Seal butt joints at inside and outside corners and at trim locations.
   b. Install continuous metal flashing at horizontal panel joints.
   c. Apply battens and corner trim as indicated. Countersink nail heads, fill flush, and sand filler.
   d. Conceal fasteners to greatest practical extent by countersinking and filling, by placing in grooves of siding pattern or by concealing with applied trim or battens as detailed. Do not nail through overlapping pieces.
5. Hardboard Siding: Install hardboard siding complying with AHA's "Recommended Basic Application and Painting Instructions for Hardboard Siding." Install panels with edges over framing or blocking. Leave 3/16-inch (5-mm) gap at perimeter, openings, and horizontal panel joints unless otherwise recommended by panel manufacturer.
   a. Seal butt joints at inside and outside corners and at trim locations.

b. Install continuous metal flashing at horizontal panel joints.
c. Apply battens and corner trim as indicated.
d. Conceal fasteners to greatest practical extent by placing in grooves of siding pattern or by concealing with applied trim or battens as detailed.

6. Flashing: Install metal flashing as indicated on Drawings and as recommended by siding manufacturer.
7. Finish: Apply finish within two weeks of installation.

E. Stair And Railing Installation
1. Treads and Risers at Exterior Stairs: Secure treads and risers by gluing and nailing to carriages. Countersink nail heads, fill flush, and sand filler. Extend treads over carriages and finish with bullnose edge.
2. Balusters: Fit balusters to treads, glue, and nail in place. Countersink nail heads, fill flush, and sand filler. Let into railings and glue in place.
3. Newel Posts: Secure newel posts to stringers and risers with through bolts **OR** lag screws **OR** countersunk-head wood screws and glue, **as directed**.
4. Railings: Secure wall rails with metal brackets. Fasten freestanding railings to newel posts and to trim at walls with countersunk-head wood screws or rail bolts, and glue.

F. Ornamental Column Installation
1. Install columns to comply with manufacturer's written instructions. Comply with requirements below unless manufacturer's written instructions state otherwise.
2. Lay out column locations on soffits and beams and plumb down to locate column locations at supports.
3. Set plinths in location, shim as required to temporarily level, and scribe and trim as required so that top of plinths will sit level without use of shims. Fasten plinths in place to support using pins or fasteners as recommended by manufacturer.
4. Scribe and trim tops of columns to fit to soffits and beams. Maintain ventilation passages to interior of columns.
5. Seal ends of columns with two coats of wood sealer or primer.
6. Install column caps and flashing on columns and fasten to column. Install caps and flashing so that loads are not imposed on caps and so that ventilation of column interior is not blocked.
7. Secure columns in place at top and bottom with fasteners recommended by manufacturer.

G. Adjusting
1. Replace exterior finish carpentry that is damaged or does not comply with requirements. Exterior finish carpentry may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing. Adjust joinery for uniform appearance.

H. Cleaning
1. Clean exterior finish carpentry on exposed and semiexposed surfaces. Touch up factory-applied finishes to restore damaged or soiled areas.

I. Protection
1. Protect installed products from damage from weather and other causes during construction.
2. Remove and replace finish carpentry materials that are wet, moisture damaged, and mold damaged.
a. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
b. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 06220

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SECTION 06220a - INTERIOR FINISH CARPENTRY

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for interior finish carpentry. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Interior standing and running trim.
b. Fire-rated interior door and sidelight frames.
c. Plywood, Hardboard, and Board paneling.
d. Shelving and clothes rods.
e. Interior stairs and railings.
f. Interior ornamental wood columns.

C. Definitions
1. Lumber grading agencies, and the abbreviations used to reference them, include the following:
a. NeLMA: Northeastern Lumber Manufacturers' Association.
b. NHLA: National Hardwood Lumber Association.
c. NLGA: National Lumber Grades Authority.
d. SPIB: The Southern Pine Inspection Bureau.
e. WCLIB: West Coast Lumber Inspection Bureau.
f. WWPA: Western Wood Products Association.
2. MDF: Medium-density fiberboard.
3. MDO Plywood: Plywood with a medium-density overlay on the face.

D. Submittals
1. Product Data: For each type of process and factory-fabricated product.
2. Samples: For each type of paneling indicated.
3. LEED Submittals:
a. Product Data for Credit EQ 4.1: For adhesives and glues used at Project site, including printed statement of VOC content.
b. Product Data for Credit EQ 4.4: For composite-wood products, documentation indicating that product contains no urea formaldehyde.
c. Certificates for Credit MR 7: Chain-of-custody certificates certifying that products specified to be made from certified wood comply with forest certification requirements. Include evidence that mill is certified for chain of custody by an FSC-accredited certification body.
1) Include statement indicating costs for each certified wood product.
4. Research/Evaluation Reports: Showing that fire-retardant-treated wood complies with building code in effect for Project.
5. Warranty: Special warranty specified in this Section.

E. Quality Assurance
1. Forest Certification: For the following wood products, provide materials produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship":
a. Interior standing and running trim.
b. Interior plywood, hardboard, and board paneling.
c. Shelving and clothes rods.
d. Interior stairs and railings.

e. Interior ornamental wood columns.

F. Delivery, Storage, And Handling
1. Protect materials against weather and contact with damp or wet surfaces. Stack lumber, plywood, and other panels flat with spacers between each bundle to provide air circulation. Provide for air circulation within and around stacks and under temporary coverings.
2. Deliver interior finish carpentry materials only when environmental conditions meet requirements specified for installation areas. If interior finish carpentry materials must be stored in other than installation areas, store only where environmental conditions meet requirements specified for installation areas.

G. Warranty
1. Special Warranty for Columns: Manufacturer's standard form, signed by manufacturer, Installer, and Contractor, in which manufacturer agrees to repair or replace columns that fail in materials or workmanship five years from date of Substantial Completion.

1.2 PRODUCTS

A. Materials, General
1. Lumber: DOC PS 20 and applicable grading rules of inspection agencies certified by ALSC's Board of Review.
2. Softwood Plywood: DOC PS 1.
3. Hardboard: AHA A135.4.
4. MDF: ANSI A208.2, Grade 130, made with binder containing no urea-formaldehyde resin.
5. Particleboard: ANSI A208.1, Grade M-2 **OR** M-2-Exterior Glue **OR** M-2, made with binder containing no urea-formaldehyde resin, **as directed**.
6. Melamine-Faced Particleboard: Particleboard complying with ANSI A208.1, Grade M-2, finished on both faces with thermally fused, melamine-impregnated decorative paper complying with LMA SAT-1.

B. Wood-Preservative-Treated Materials
1. Lumber: AWPA C2 **OR** AWPA C31 (treated with inorganic boron), **as directed**. Kiln dry after treatment to a maximum moisture content of 19 percent.
2. Plywood: AWPA C9. Kiln dry after treatment to a maximum moisture content of 18 percent.
3. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
4. For exposed items indicated to receive transparent finish, do not use chemical formulations that contain colorants or that bleed through or otherwise adversely affect finishes.
5. Do not use material that is warped or does not comply with requirements for untreated material.
6. Mark lumber with treatment quality mark of an inspection agency approved by ALSC's Board of Review.
7. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.
8. Application: Where indicated.

C. Fire-Retardant-Treated Materials
1. Lumber: Comply with performance requirements in AWPA C20, Exterior type **OR** Interior Type A, **as directed**. Kiln dry after treatment to a maximum moisture content of 19 percent.
2. Plywood: Comply with performance requirements in AWPA C27, Exterior type **OR** Interior Type A, **as directed**. Kiln dry after treatment to a maximum moisture content of 15 percent.
3. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not contain colorants and provide materials that do not have marks from spacer sticks on the exposed face.

4. Do not use material that does not comply with requirements for untreated material or is warped or discolored.
5. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
6. Application: Where indicated **OR** All interior lumber and plywood, **as directed**.

D. Standing And Running Trim
1. Softwood Lumber Trim for Transparent Finish (Stain or Clear Finish):
   a. Species and Grade:
      1) Eastern white pine, C Select **OR** D Select **OR** Finish or 1 Common **OR** Premium or 2 Common, **as directed**; NeLMA or NLGA.
      2) Idaho white, lodgepole, ponderosa, radiata, or sugar pine; C Select (Choice) **OR** D Select (Quality) **OR** 1 Common (Colonial) **OR** 2 Common (Sterling), **as directed**; NLGA or WWPA.
      3) Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine; C Select (Choice) **OR** D Select (Quality) **OR** Finish or 1 Common (Colonial) **OR** Premium or 2 Common (Sterling), **as directed**; NeLMA, NLGA, or WWPA.
      4) White woods, C Select **OR** D Select **OR** 1 Common **OR** 2 Common, **as directed**; WWPA.
      5) Douglas fir-larch or Douglas fir south, Superior or C & Btr **OR** Prime or D, **as directed**, finish; NLGA, WCLIB, or WWPA.
      6) Southern pine, B & B **OR** C & Btr, **as directed**, finish; SPIB.
      7) Western red cedar, Clear Heart **OR** Grade A **OR** Grade B, **as directed**; NLGA, WCLIB, or WWPA.
   b. Maximum Moisture Content: 19 **OR** 15, **as directed**, percent with at least 85 percent of shipment at 12 percent or less, **as directed**.
   c. Finger Jointing: Allowed **OR** Not allowed, **as directed**.
   d. Face Surface: Surfaced (smooth) **OR** Saw textured, **as directed**.
2. Hardwood Lumber Trim for Transparent Finish (Stain or Clear Finish):
   a. Species and Grade: Red oak **OR** White maple **OR** Alder **OR** Aspen, basswood, cottonwood, sap gum, sycamore, white maple, or yellow poplar, **as directed**; Clear **OR** A finish **OR** B finish, **as directed**; NHLA.
   b. Maximum Moisture Content: 13 **OR** 10 **OR** 9, **as directed**, percent.
   c. Finger Jointing: Not allowed.
   d. Gluing for Width: Allowed **OR** Not allowed **OR** Use for lumber trim wider than 6 inches (150 mm), **as directed**.
   e. Veneered Material: Allowed **OR** Not allowed **OR** Use for lumber trim wider than 6 inches (150 mm), **as directed**.
   f. Face Surface: Surfaced (smooth) **OR** Saw textured, **as directed**.
   g. Matching: Selected for compatible grain and color.
3. Lumber Trim for Opaque Finish (Painted):
   a. Species and Grade:
      1) Eastern white pine, D Select **OR** Finish or 1 Common **OR** Premium or 2 Common, **as directed**; NeLMA or NLGA.
      2) Idaho white, lodgepole, ponderosa, radiata, or sugar pine; D Select (Quality) **OR** 1 Common (Colonial) **OR** 2 Common (Sterling), **as directed**; NLGA or WWPA.
      3) Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine; D Select (Quality) **OR** Finish or 1 Common (Colonial) **OR** Premium or 2 Common (Sterling), **as directed**; NeLMA, NLGA, or WWPA.
      4) White woods, D Select **OR** 1 Common **OR** 2 Common, **as directed**; WWPA.
      5) Douglas fir-larch or Douglas fir south, Superior or C & Btr **OR** Prime or D, **as directed**, finish; NLGA, WCLIB, or WWPA.
      6) Spruce-pine-fir, 1 **OR** 2, **as directed**, Common; NeLMA, NLGA, WCLIB, or WWPA.
      7) Alder, aspen, basswood, cottonwood, gum, magnolia, soft maple, sycamore, tupelo, or yellow poplar; A **OR** B, **as directed**, finish; NHLA.

b. Maximum Moisture Content: 19 **OR** 15, **as directed**, percent with at least 85 percent of shipment at 12 percent or less, **as directed**.
c. Finger Jointing: Allowed **OR** Not allowed, **as directed**.
d. Face Surface: Surfaced (smooth) **OR** Saw textured, **as directed**.
e. Optional Material: Primed MDF of same actual dimensions as lumber indicated may be used in lieu of lumber.

4. Softwood Moldings for Transparent Finish (Stain or Clear Finish): WMMPA WM 4, N-grade wood moldings. Made to patterns included in WMMPA WM 12.
   a. Species: Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine **OR** Southern pine **OR** Western red cedar **OR** Douglas fir, **as directed**.
   b. Maximum Moisture Content: 15 percent with at least 85 percent of shipment at 12 percent or less.
   c. Finger Jointing: Not allowed.
   d. Matching: Selected for compatible grain and color.
   e. Base Pattern: WM 623, 9/16-by-3-1/4-inch (14-by-83-mm) ogee **OR** WM 713, 9/16-by-3-1/4-inch (14-by-83-mm) ranch **OR** WM 753, 9/16-by-3-1/4-inch (14-by-83-mm) beaded-edge **OR** WM 620, 9/16-by-4-1/4-inch (14-by-108-mm) ogee **OR** WM 750, 9/16-by-4-1/4-inch (14-by-108-mm) beaded-edge, **as directed**, base.
   f. Shoe-Mold Pattern: WM 129, 7/16-by-11/16-inch (11-by-17-mm) quarter-round **OR** WM 126, 1/2-by-3/4-inch (13-by-19-mm) quarter-round **OR** WM 131, 1/2-by-3/4-inch (13-by-19-mm) ogee, **as directed**, shoe mold.
   g. Casing Pattern: WM 327, 11/16-by-2-1/4-inch (17-by-57-mm) clamshell **OR** WM 366, 11/16-by-2-1/4-inch (17-by-57-mm) featheredge **OR** WM 376, 11/16-by-2-1/4-inch (17-by-57-mm) beaded-edge, **as directed**, casing.
   h. Mull-Casing Pattern: WM 957, 3/8-by-1-3/4-inch (9.5-by-44-mm) beaded-edge **OR** WM 973, 3/8-by-1-3/4-inch (9.5-by-44-mm) bullnose **OR** WM 983, 3/8-by-1-3/4-inch (9.5-by-44-mm) featheredge, **as directed**, casing.
   i. Stop Pattern: WM 856, 3/8-by-1-3/8-inch (9.5-by-35-mm) ranch **OR** WM 946, 3/8-by-1-3/8-inch (9.5-by-35-mm) ogee **OR** WM 886, 3/8-by-1-3/8-inch (9.5-by-35-mm) bullnose, **as directed**, stop.
   j. Chair-Rail Pattern: WM 297, 11/16-by-3-inch (17-by-76-mm) chair rail.

5. Hardwood Moldings for Transparent Finish (Stain or Clear Finish): WMMPA HWM 2, N-grade wood moldings made to patterns included in WMMPA HWM 1.
   a. Species: Red oak **OR** White maple **OR** Aspen, basswood, cottonwood, sap gum, sycamore, white maple, or yellow poplar, **as directed**.
   b. Kiln-dried softwood or MDF, with exposed surfaces veneered with species indicated, may be used in lieu of solid wood.
   c. Maximum Moisture Content: 9 percent.
   d. Finger Jointing: Not allowed.
   e. Matching: Selected for compatible grain and color.
   f. Base Pattern: HWM 633, 7/16-by-3-1/4-inch (11-by-83-mm) ogee **OR** HWM 713, 7/16-by-3-1/4-inch (11-by-83-mm) ranch **OR** HWM 753, 7/16-by-3-1/4-inch (11-by-83-mm) beaded-edge **OR** WM 620, 7/16-by-4-1/4-inch (11-by-108-mm) ogee, **as directed**, base.
   g. Shoe-Mold Pattern: HWM 129, 7/16-by-11/16-inch (11-by-17-mm) quarter-round **OR** HWM 126, 1/2-by-3/4-inch (13-by-19-mm) quarter-round **OR** HWM 131, 1/2-by-3/4-inch (13-by-19-mm) ogee, **as directed**, shoe mold.
   h. Casing Pattern: HWM 328, 1/2-by-2-1/4-inch (13-by-57-mm) clamshell **OR** HWM 366, 1/2-by-2-1/4-inch (13-by-57-mm) featheredge **OR** HWM 376, 1/2-by-2-1/4-inch (13-by-57-mm) beaded-edge, **as directed**, casing.
   i. Mull-Casing Pattern: HWM 989, 3/16-by-2-inch (5-by-51-mm) square-edge **OR** HWM 988, 3/8-by-1-1/2-inch (9.5-by-38-mm) featheredge **OR** HWM 987, 3/8-by-2-inch (9.5-by-51-mm) featheredge, **as directed**, casing.
   j. Stop Pattern: HWM 856, 3/8-by-1-3/8-inch (9.5-by-35-mm) ranch **OR** HWM 946, 3/8-by-1-3/8-inch (9.5-by-35-mm) ogee **OR** HWM 886, 3/8-by-1-3/8-inch (9.5-by-35-mm) bullnose, **as directed**, stop.

k. Chair-Rail Pattern: HWM 297, 11/16-by-3-inch (17-by-76-mm) chair rail.

6. Moldings for Opaque Finish (Painted): Made to patterns included in WMMPA WM 12.
   a. Softwood Moldings: WMMPA WM 4, P-grade.
      1) Species: Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine.
      2) Maximum Moisture Content: 15 percent with at least 85 percent of shipment at 12 percent or less.
   b. Hardwood Moldings: WMMPA HWM 2, P-grade.
      1) Species: Aspen, basswood, cottonwood, gum, magnolia, soft maple, tupelo, or yellow poplar.
      2) Maximum Moisture Content: 9 percent.
   c. Optional Material: Primed MDF.
   d. Finger Jointing: Allowed **OR** Not allowed, **as directed**.
   e. Base Pattern: WM 623, 9/16-by-3-1/4-inch (14-by-83-mm) ogee **OR** WM 713, 9/16-by-3-1/4-inch (14-by-83-mm) ranch **OR** WM 753, 9/16-by-3-1/4-inch (14-by-83-mm) beaded-edge **OR** WM 620, 9/16-by-4-1/4-inch (14-by-108-mm) ogee **OR** WM 750, 9/16-by-4-1/4-inch (14-by-108-mm) beaded-edge, **as directed**, base.
   f. Shoe-Mold Pattern: WM 129, 7/16-by-11/16-inch (11-by-17-mm) quarter-round **OR** WM 126, 1/2-by-3/4-inch (13-by-19-mm) quarter-round **OR** WM 131, 1/2-by-3/4-inch (13-by-19-mm) ogee, **as directed**, shoe mold.
   g. Casing Pattern: WM 327, 11/16-by-2-1/4-inch (17-by-57-mm) clamshell **OR** WM 366, 11/16-by-2-1/4-inch (17-by-57-mm) featheredge **OR** WM 376, 11/16-by-2-1/4-inch (17-by-57-mm) beaded-edge, **as directed**, casing.
   h. Mull-Casing Pattern: WM 957, 3/8-by-1-3/4-inch (9.5-by-44-mm) beaded-edge **OR** WM 973, 3/8-by-1-3/4-inch (9.5-by-44-mm) bullnose **OR** WM 983, 3/8-by-1-3/4-inch (9.5-by-44-mm) featheredge, **as directed**, casing.
   i. Stop Pattern: WM 856, 3/8-by-1-3/8-inch (9.5-by-35-mm) ranch **OR** WM 946, 3/8-by-1-3/8-inch (9.5-by-35-mm) ogee **OR** WM 886, 3/8-by-1-3/8-inch (9.5-by-35-mm) bullnose, **as directed**, stop.
   j. Chair-Rail Pattern: WM 297, 11/16-by-3-inch (17-by-76-mm) chair rail.

7. PVC-Wrapped Moldings: WMMPA WM 2 and made to patterns included in WMMPA WM 12.
   a. Base Pattern: WM 623, 9/16-by-3-1/4-inch (14-by-83-mm) ogee **OR** WM 713, 9/16-by-3-1/4-inch (14-by-83-mm) ranch, **as directed**, base.
   b. Shoe-Mold Pattern: WM 129, 7/16-by-11/16-inch (11-by-17-mm) quarter-round **OR** WM 126, 1/2-by-3/4-inch (13-by-19-mm) quarter-round, **as directed**, shoe mold.
   c. Casing Pattern: WM 327, 11/16-by-2-1/4-inch (17-by-57-mm) clamshell **OR** WM 366, 11/16-by-2-1/4-inch (17-by-57-mm) featheredge, **as directed**, casing.
   d. Mull-Casing Pattern: WM 973, 3/8-by-1-3/4-inch (9.5-by-44-mm) bullnose **OR** WM 983, 3/8-by-1-3/4-inch (9.5-by-44-mm) featheredge, **as directed**, casing.
   e. Stop Pattern: WM 856, 3/8-by-1-3/8-inch (9.5-by-35-mm) ranch **OR** WM 886, 3/8-by-1-3/8-inch (9.5-by-35-mm) bullnose, **as directed**, stop.
   f. Chair-Rail Pattern: WM 297, 11/16-by-3-inch (17-by-76-mm) chair rail.
   g. Colors, Textures, and Grain Patterns: As selected by the Owner from manufacturer's full range.

8. Foam Plastic Moldings: Molded product of shapes indicated, with a tough outer skin on exposed surfaces; factory primed. Exposed surfaces shall not be shaped after molding.
   a. Density: Not less than 20 lb/cu. ft. (320 kg/cu. m).
   b. Flame-Spread Index: Not more than 75 when tested according to ASTM E 84.
   c. Thickness: Not more than 1/2 inch (12.7 mm).
   d. Width: Not more than 8 inches (204 mm).
   e. Patterns: As indicated by manufacturer's designations.

E. Fire-Rated Interior Door And Sidelight Frames
   1. Frames, complete with casings, fabricated from fire-retardant particleboard or fire-retardant MDF with veneered exposed surfaces, or from solid fire-retardant-treated wood. Frames shall comply with NFPA 80 and be listed and labeled by a testing and inspecting agency acceptable to

authorities having jurisdiction, based on testing according to NFPA 252 **OR** UBC Standard 7-2, **as directed**.
a. Species: Red oak **OR** White oak **OR** White maple **OR** Cherry, **as directed**.
b. Fire Rating: 20 minutes **OR** 30 minutes **OR** 45 minutes **OR** 60 minutes **OR** 90 minutes **OR** As indicated, **as directed**.

F. Paneling
1. Hardwood Veneer Plywood Paneling: Manufacturer's stock hardwood plywood panels complying with HPVA HP-1, made without urea-formaldehyde adhesive.
a. Face Veneer Species and Cut: Rotary-cut white birch **OR** Plain-sliced red oak **OR** Plain-sliced hickory, **as directed**.
b. Veneer Matching: Random match **OR** Selected for similar color and grain, **as directed**.
c. Backing Veneer Species: Same species as face veneer **OR** Any hardwood compatible with face species, **as directed**.
d. Construction: Veneer core.
e. Thickness: 1/8 inch (3.2 mm) **OR** 5/32 inch (4 mm) **OR** 5 mm **OR** 1/4 inch (6.4 mm) **OR** 5/16 inch (7.9 mm) **OR** 7/16 inch (11 mm), **as directed**.
f. Glue Bond: Type II (interior) **OR** I (exterior), **as directed**.
2. Hardboard Paneling: Interior factory-finished hardboard paneling complying with AHA 135.5.
a. Thickness: 1/8 inch (3.2 mm) **OR** 5/32 inch (4 mm) **OR** 1/4 inch (6.4 mm), **as directed**.
b. Finish: Class I **OR** II, **as directed**.
c. Surface-Burning Characteristics: As follows, tested per ASTM E 84:
1) Flame-Spread Index: 25 or less.
2) Smoke-Developed Index: 450 or less.
3. Board Paneling: Interior wood board paneling complying with WMMPA WM 9.
a. Species: Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine **OR** Southern pine **OR** Western red cedar **OR** Figured red gum, **as directed**.
b. Grade: Clear No. 1 **OR** Clear No. 2 **OR** Knotty No. 1 **OR** Knotty No. 2 **OR** Finger jointed, **as directed**.
c. Maximum Moisture Content: 15 percent with at least 85 percent of shipment at 12 percent or less **OR** 9 percent, **as directed**.
4. Board Paneling:
a. Species and Grade:
1) Eastern white pine, C Select **OR** D Select **OR** Finish or 1 Common **OR** Premium or 2 Common, **as directed**; NeLMA or NLGA.
2) Idaho white, lodgepole, ponderosa, radiata, or sugar pine; C Select (Choice) **OR** D Select (Quality) **OR** 1 Common (Colonial) **OR** 2 Common (Sterling), **as directed**; NLGA or WWPA.
3) Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine; C Select (Choice) **OR** D Select (Quality) **OR** Finish or 1 Common (Colonial) **OR** Premium or 2 Common (Sterling), **as directed**; NeLMA, NLGA, or WWPA.
4) Southern pine, B & B **OR** C & Btr **OR** No. 2, **as directed**, Paneling; SPIB.
5) Western red cedar, Clear Heart **OR** Grade A **OR** Grade B, **as directed**; NLGA, WCLIB, or WWPA.
b. Maximum Moisture Content: 19 **OR** 15, **as directed**, percent with at least 85 percent of shipment at 12 percent or less, **as directed**.

G. Shelving And Clothes Rods
1. Exposed **OR** Closet **OR** Utility, **as directed**, Shelving: Made from one of the following materials, **as directed**, 3/4 inch (19 mm) thick. Do not use particleboard or MDF that contains urea formaldehyde.
a. Particleboard with radiused and filled **OR** solid-wood, **as directed**, front edge.
b. MDF with radiused **OR** solid-wood, **as directed**, front edge.
c. MDO softwood plywood with solid-wood edge.

d. Melamine-faced particleboard with radiused and filled **OR** applied PVC, **as directed**, front edge.
e. Wood boards as specified above for lumber trim for opaque **OR** softwood lumber trim for transparent **OR** hardwood lumber trim for transparent, **as directed**, finish.
f. Softwood Boards: Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine; C Select (Choice) **OR** D Select (Quality) **OR** Finish or 1 Common (Colonial) **OR** Premium or 2 Common (Sterling), **as directed**; NeLMA, NLGA, or WWPA; kiln dried.
g. Softwood Boards: Douglas fir-larch, Douglas fir south, or hem-fir; Superior or C & Btr **OR** Prime or D, **as directed**, finish; NLGA, WCLIB, or WWPA; or southern pine, B & B **OR** C, **as directed**, finish; SPIB; kiln dried.

2. Shelf Cleats: 3/4-by-3-1/2-inch (19-by-89-mm) boards **OR** 3/4-by-5-1/2-inch (19-by-140-mm) boards **OR** 3/4-by-5-1/2-inch (19-by-140-mm) boards with hole and notch to receive clothes rods, **as directed**, as specified above for shelving **OR** lumber trim for opaque finish **OR** softwood lumber trim for transparent finish **OR** hardwood lumber trim for transparent finish, **as directed**.
3. Shelf Brackets with Rod Support: BHMA A156.16, B04051; prime-painted formed steel.
4. Shelf Brackets without Rod Support: BHMA A156.16, B04041; prime-painted formed steel.
5. Standards for Adjustable Shelf Brackets: BHMA A156.9, B04102; powder-coat finished **OR** brass-finished **OR** zinc-plated, **as directed**, steel.
6. Adjustable Shelf Brackets: BHMA A156.9, B04112; powder-coat finished steel **OR** brass-finished steel **OR** zinc-plated steel **OR** bronze-anodized aluminum **OR** black-anodized aluminum **OR** natural aluminum, **as directed**.
7. Standards for Adjustable Shelf Supports: BHMA A156.9, B04071; powder-coat finished **OR** brass-finished **OR** zinc-plated, **as directed**, steel.
8. Adjustable Shelf Supports: BHMA A156.9, B04081 or B04091; powder-coat finished **OR** brass-finished **OR** zinc-plated, **as directed**, steel.
9. Clothes Rods: 1-1/2-inch- (38-mm-) diameter, clear, kiln-dried hardwood **OR** clear, kiln-dried softwood; either Douglas fir or southern pine, **as directed**.
10. Clothes Rods: 1-5/16-inch- (33-mm-) diameter, aluminum tubes **OR** chrome-plated steel tubes **OR** chrome-plated steel telescoping tubes with end brackets for mounting on shelf cleats, **as directed**.
11. Rod Flanges: Clear, kiln-dried, Douglas fir or southern pine **OR** eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine **OR** red oak **OR** white maple **OR** aspen, basswood, cottonwood, sap gum, white maple, or yellow poplar, **as directed**, turnings.
12. Rod Flanges: Aluminum **OR** Chrome-plated steel **OR** Stainless steel, **as directed**.

H. Stairs And Railings

1. Treads: 1-1/16-inch (27-mm), clear, kiln-dried, edge-glued, rift-sawn red oak **OR** red oak **OR** hard maple **OR** poplar, **as directed**, stepping with half-round nosing.
2. Risers: 13/16-inch (21-mm), clear, kiln-dried, edge-glued red oak **OR** hard maple **OR** poplar, **as directed**, stock.
3. Risers: 3/4-inch (19-mm) finish boards as specified above for interior lumber trim for opaque finish.
4. Finished Stringers: 3/4-inch (19-mm) finish boards as specified above for interior lumber trim for opaque finish.
5. Interior Railings: Clear, kiln-dried red oak **OR** hard maple **OR** yellow poplar, **as directed**.
6. Balusters: Clear, kiln-dried, red oak **OR** hard maple **OR** yellow poplar, **as directed**.
7. Newel Posts: Clear, kiln-dried, red oak **OR** hard maple **OR** yellow poplar, **as directed**.
8. Factory fabricate columns for transparent finish from clear, kiln-dried eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine **OR** aspen, basswood, cottonwood, sap gum, white maple, or yellow poplar **OR** red oak **OR** white maple **OR** mahogany, **as directed**.
9. Factory fabricate columns for opaque finish from clear, kiln-dried eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine **OR** aspen, basswood, cottonwood, sap gum, white maple, or yellow poplar, **as directed**. Column staves may be finger jointed.
10. Shafts: Built up from tongue-and-groove staves joined with waterproof glue. Lathe turn shafts to provide indicated base diameter and true architectural entasis taper. Precisely mill flutes as indicated.

11. Capital and Base: Molded glass-fiber-reinforced plastic **OR** Built up from wood components with waterproof glue. Turn circular elements on lathes, **as directed**.
12. Prime columns for opaque finish with one coat of interior wood primer compatible with specified topcoats.

I. Miscellaneous Materials
1. Fasteners for Interior Finish Carpentry: Nails, screws, and other anchoring devices of type, size, material, and finish required for application indicated to provide secure attachment, concealed where possible.
   a. Where galvanized finish is indicated, provide fasteners and anchorages with hot-dip galvanized coating complying with ASTM A 153/A 153M.
2. Glue: Aliphatic-resin, polyurethane, or resorcinol wood glue recommended by manufacturer for general carpentry use.
   a. Use wood glue that has a VOC content of 30 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Installation Adhesive for Foam Plastic Moldings: Product recommended for indicated use by foam plastic molding manufacturer.
   a. Use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
4. Paneling Adhesive: Comply with paneling manufacturer's written recommendations for adhesives.
   a. Use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
5. Multipurpose Construction Adhesive: Formulation complying with ASTM D 3498 that is recommended for indicated use by adhesive manufacturer.
   a. Use adhesive that has a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

J. Fabrication
1. Back out or kerf backs of the following members except those with ends exposed in finished work:
   a. Interior standing and running trim except shoe and crown molds.
   b. Wood board paneling.
2. Ease edges of lumber less than 1 inch (25 mm) in nominal thickness to 1/16-inch (1.5-mm) radius and edges of lumber 1 inch (25 mm) or more in nominal thickness to 1/8-inch (3-mm) radius.

1.3 EXECUTION

A. Preparation
1. Clean substrates of projections and substances detrimental to application.
2. Before installing interior finish carpentry, condition materials to average prevailing humidity in installation areas for a minimum of 24 hours unless longer conditioning is recommended by manufacturer.

B. Installation, General
1. Do not use materials that are unsound, warped, improperly treated or finished, inadequately seasoned, or too small to fabricate with proper jointing arrangements.
   a. Do not use manufactured units with defective surfaces, sizes, or patterns.
2. Install interior finish carpentry level, plumb, true, and aligned with adjacent materials. Use concealed shims where necessary for alignment.
   a. Scribe and cut interior finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
   b. Countersink fasteners, fill surface flush, and sand where face fastening is unavoidable.

c. Install to tolerance of 1/8 inch in 96 inches (3 mm in 2438 mm) for level and plumb. Install adjoining interior finish carpentry with 1/32-inch (0.8-mm) maximum offset for flush installation and 1/16-inch (1.5-mm) maximum offset for reveal installation.
d. Install stairs with no more than 3/16-inch (4.7-mm) variation between adjacent treads and risers and with no more than 3/8-inch (9.5-mm) variation between largest and smallest treads and risers within each flight.
e. Coordinate interior finish carpentry with materials and systems in or adjacent to it. Provide cutouts for mechanical and electrical items that penetrate interior finish carpentry.

C. Standing And Running Trim Installation
1. Install with minimum number of joints practical, using full-length pieces from maximum lengths of lumber available. Do not use pieces less than 24 inches (610 mm) long, except where necessary. Stagger joints in adjacent and related standing and running trim. Cope at returns and miter at corners to produce tight-fitting joints with full-surface contact throughout length of joint. Use scarf joints for end-to-end joints. Plane backs of casings to provide uniform thickness across joints where necessary for alignment.
a. Match color and grain pattern of trim for transparent finish (stain or clear finish) across joints.
b. Install trim after gypsum board joint finishing operations are completed.
c. Drill pilot holes in hardwood before fastening to prevent splitting. Fasten to prevent movement or warping. Countersink fastener heads on exposed carpentry work and fill holes.

D. Paneling Installation
1. Plywood Paneling: Select and arrange panels on each wall to minimize noticeable variations in grain character and color between adjacent panels. Leave 1/4-inch (6-mm) gap to be covered with trim at top, bottom, and openings. Install with uniform tight joints between panels.
a. Attach panels to supports with manufacturer's recommended panel adhesive and fasteners. Space fasteners as recommended by panel manufacturer.
b. Conceal fasteners to greatest practical extent.
c. Arrange panels with grooves and joints over supports. Fasten to supports with nails of type and at spacing recommended by panel manufacturer. Use fasteners with prefinished heads matching groove color.
2. Hardboard Paneling: Install according to manufacturer's written recommendations. Leave 1/4-inch (6-mm) gap to be covered with trim at top, bottom, and openings. Butt adjacent panels with moderate contact. Use fasteners with prefinished heads matching paneling color.
a. Wood Stud or Furring Substrate: Install with 1-inch (25-mm) annular-ring shank hardboard nails.
b. Plaster or Gypsum Board Substrate: Install with 1-5/8-inch (41-mm) annular-ring shank hardboard nails.
c. Nailing: Space nails 4 inches (100 mm) o.c. at panel perimeter and 8 inches (200 mm) o.c. at intermediate supports unless otherwise required by manufacturer.
3. Board Paneling: Install according to manufacturer's written instructions. Arrange in random-width pattern suggested by manufacturer unless boards or planks are of uniform width.
a. Install in full lengths without end joints.
OR
Stagger end joints in random pattern to uniformly distribute joints on each wall.
b. Install with uniform end joints with only end-matched (tongue-and-groove) joints within each field of paneling.
OR
Install with uniform end joints. Locate end joints only over furring or blocking.
c. Select and arrange boards on each wall to minimize noticeable variations in grain character and color between adjacent boards. Install with uniform tight joints between boards.
d. Fasten paneling by face nailing, setting nails, and filling over nail heads.
OR

Fasten paneling with trim screws, set below face and filled.
OR
Fasten paneling by blind nailing through tongues.
OR
Fasten paneling with paneling system manufacturer's concealed clips.
OR
Fasten paneling to gypsum wallboard with panel adhesive.

E. Shelving And Clothes Rod Installation
1. Cut shelf cleats at ends of shelves about 1/2 inch (13 mm) less than width of shelves and sand exposed ends smooth.
2. Install shelf cleats by fastening to framing or backing with finish nails or trim screws, set below face and filled. Space fasteners not more than 16 inches (400 mm) o.c. Use 2 fasteners at each framing member or fastener location for cleats 4 inches nominal (89 mm actual) in width and wider.
   a. Apply a bead of multipurpose construction adhesive to back of shelf cleats right before installing. Remove adhesive that is squeezed out immediately after fastening shelf cleats in place.
3. Install shelf brackets according to manufacturer's written instructions, spaced not more than 36 inches (900 mm) o.c. Fasten to framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors.
4. Install standards for adjustable shelf supports according to manufacturer's written instructions. Fasten to framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors. Space fasteners not more than 12 inches (300 mm) o.c.
5. Install standards for adjustable shelf brackets according to manufacturer's written instructions, spaced not more than 36 inches (900 mm) o.c. and within 6 inches (150 mm) of end of shelves. Fasten to framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors.
6. Cut shelves to neatly fit openings with only enough gap to allow shelves to be removed and reinstalled. Install shelves, fully seated on cleats, brackets, and supports.
   a. Fasten shelves to cleats with finish nails or trim screws, set flush.
   b. Fasten shelves to brackets to comply with bracket manufacturer's written instructions.
7. Install rod flanges for rods as indicated. Fasten to shelf cleats, framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors. Install rods in rod flanges.

F. Stair And Railing Installation
1. Treads and Risers at Interior Stairs: Secure treads and risers by gluing and nailing to rough carriages.
   a. Closed Stringers: House treads and risers into wall stringers, glue, and wedge into place **OR** Cope wall stringers to fit tightly over treads and risers, **as directed**.
   b. Open Stringers: Miter risers and stringer at open stringers. Extend tread over open stringers and finish with bullnose edge cut from tread stock and fitted to tread with mitered return at nosing.
2. Balusters: Dovetail or mortise balusters into treads, glue, and nail in place. Let into railings and glue in place.
3. Newel Posts: Secure newel posts to stringers, rough carriages, and risers with countersunk-head wood screws and glue.
4. Railings: Secure wall rails with metal brackets. Fasten freestanding railings to newel posts and to trim at walls with countersunk-head wood screws or rail bolts, and glue. Assemble railings at goosenecks, easements, and splices with rail bolts and glue.

G. Ornamental Column Installation
1. Install columns to comply with manufacturer's written instructions. Comply with requirements below unless manufacturer's written instructions state otherwise.
2. Lay out column locations on ceiling and plumb down to locate column locations at floor.

3. Set plinths in location, shim to temporarily level, and scribe and trim as required so that tops of plinths will sit level without use of shims. Seal cut surfaces with wood sealer or primer and fasten plinths to floor using pins or fasteners as recommended by manufacturer.
4. Set columns in location, shim as required to temporarily plumb, scribe and trim as required so that columns will sit plumb without shims.
5. Scribe and trim tops of columns to fit to ceiling.
6. Seal ends of columns with wood sealer or primer.
7. Install column caps on columns and fasten to columns.
8. Secure columns in place at top and bottom with fasteners recommended by manufacturer.

H. Adjusting
1. Replace interior finish carpentry that is damaged or does not comply with requirements. Interior finish carpentry may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing. Adjust joinery for uniform appearance.

I. Cleaning
1. Clean interior finish carpentry on exposed and semiexposed surfaces. Touch up factory-applied finishes to restore damaged or soiled areas.

J. Protection
1. Protect installed products from damage from weather and other causes during remainder of the construction period.
2. Remove and replace finish carpentry materials that are wet, moisture damaged, and mold damaged.
   a. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
   b. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 06220a

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Task	Specification	Specification Description
06220	06110a	Miscellaneous Carpentry

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SECTION 06410 - INTERIOR ARCHITECTURAL WOODWORK

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for interior architectural woodwork. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
   a. Interior standing and running trim.
   b. Interior frames and jambs.
   c. Stairwork and rails.
   d. Flush wood paneling and wainscots.
   e. Interior ornamental work.
   f. Wood cabinets.
   g. Plastic-laminate cabinets.
   h. Wood countertops.
   i. Plastic-laminate countertops.
   j. Solid-surfacing-material countertops.
   k. Laminated-plastic laboratory tops.
   l. Closet and utility shelving.
   m. Shop finishing of interior woodwork.

C. Definitions
1. Interior architectural woodwork includes wood furring, blocking, shims, and hanging strips for installing woodwork items unless concealed within other construction before woodwork installation.
2. Rough carriages for stairs are a part of interior architectural woodwork. Platform framing, headers, partition framing, and other rough framing associated with stairwork are specified in Division 06 Section "Rough Carpentry".

D. Submittals
1. Product Data: For panel products, high-pressure decorative laminate, adhesive for bonding plastic laminate, solid-surfacing material, fire-retardant-treated materials, cabinet hardware and accessories, handrail brackets, and finishing materials and processes.
   a. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.
2. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
3. Samples:
   a. Lumber with or for transparent finish, for each species and cut, finished on 1 side and 1 edge.
   b. Veneer leaves representative of and selected from flitches to be used for transparent-finished woodwork.
   c. Veneer-faced panel products with or for transparent finish for each species and cut. Include at least one face-veneer seam and finish as specified.
   d. Lumber and panel products with shop-applied opaque finish, for each finish system and color, with exposed surface finished.
   e. Plastic-laminates, for each type, color, pattern, and surface finish.
   f. Thermoset decorative panels, for each type, color, pattern, and surface finish.
   g. Solid-surfacing materials.

h. Corner pieces as follows:
1) Cabinet-front frame joints between stiles and rails, as well as exposed end pieces, 18 inches (450 mm) high by 18 inches (450 mm) wide by 6 inches (150 mm) deep.
2) Miter joints for standing trim.
i. Exposed cabinet hardware and accessories, one unit for each type and finish.

4. LEED Submittals:
a. Product Data for Credit EQ 4.1: For installation adhesives, including printed statement of VOC content.
b. Product Data for Credit EQ 4.4:
1) For each composite-wood product used, documentation indicating that the bonding agent contains no urea formaldehyde.
2) For each adhesive used, documentation indicating that the adhesive contains no urea formaldehyde.
c. Product Data for Credit(s) MR 4.1 and MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content
1) Include statement indicating costs for each product having recycled content.
d. Certificates for Credit MR 7: Chain-of-custody certificates certifying that products specified to be made from certified wood comply with forest certification requirements. Include evidence that mill is certified for chain of custody by an FSC-accredited certification body.
1) Include statement indicating costs for each certified wood product.
5. Product Certificates: For each type of product, signed by product manufacturer.
6. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates **OR** WI-certified compliance certificates, **as directed**.

E. Quality Assurance
1. Installer Qualifications: Fabricator of woodwork.
2. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards" **OR** WI's "Manual of Millwork", **as directed**.
a. Provide AWI Quality Certification Program labels and certificates for woodwork, including installation.
b. Provide WI-certified compliance labels and certificates for woodwork, including installation.
3. Fire-Test-Response Characteristics: Where fire-retardant materials or products are indicated, provide materials and products with specified fire-test-response characteristics as determined by testing identical products per test method indicated by UL, ITS, or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify with appropriate markings of applicable testing and inspecting agency in the form of separable paper label or, where required by authorities having jurisdiction, imprint on surfaces of materials that will be concealed from view after installation.
4. Forest Certification: Provide interior architectural woodwork produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
5. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Do not deliver woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

1.2 PRODUCTS

A. Materials

1. General: Provide materials that comply with requirements of AWI's **OR** WI's, **as directed**, quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.
2. Wood Species and Cut for Transparent Finish: Red oak, plain sawn or sliced **OR** White oak, rift sawn or cut **OR** White ash, plain sawn or sliced **OR** Hickory, plain sawn or sliced, **as directed**.
3. Wood Species for Opaque Finish: Any closed-grain hardwood **OR** Eastern white pine, sugar pine, or western white pine, **as directed**.
4. Wood Products: Comply with the following:
   a. Hardboard: AHA A135.4.
   b. Medium-Density Fiberboard: ANSI A208.2, Grade MD, made with binder containing no urea formaldehyde.
   c. Particleboard: ANSI A208.1, Grade M-2 **OR** M-2-Exterior Glue, **as directed**.
   d. Particleboard: Straw-based particleboard complying with requirements in ANSI A208.1, Grade M-2, except for density.
   e. Softwood Plywood: DOC PS 1, Medium Density Overlay.
   f. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1, made with adhesive containing no urea formaldehyde.
5. Thermoset Decorative Panels: Particleboard or medium-density fiberboard finished with thermally fused, melamine-impregnated decorative paper complying with LMA SAT-1.
   a. Provide PVC or polyester edge banding complying with LMA EDG-1 on components with exposed or semiexposed edges.
6. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or, if not indicated, as required by woodwork quality standard.
7. Chemical-Resistant, High-Pressure Decorative Laminate: NEMA LD 3, Grade HGP.
8. Solid-Surfacing Material: Homogeneous solid sheets of filled plastic resin complying with ISSFA-2.
   a. Type: Standard type or Veneer type made from material complying with requirements for Standard type, as indicated, unless Special Purpose type is indicated.
   b. Colors and Patterns: As selected by the Owner from manufacturer's full range.
9. Float Glass for Cabinet Doors: ASTM C 1036, Type I, Class 1 (clear) **OR** 2 or 3 (tinted), **as directed**, Quality-Q3, 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm, **as directed**, thick.
   a. Tint Color: Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.
10. Tempered Float Glass for Cabinet Doors: ASTM C 1048, Kind FT, Condition A, Type I, Class 1 (clear) **OR** 2 or 3 (tinted), **as directed**, Quality-Q3, with exposed edges seamed before tempering, 6 mm thick, unless otherwise indicated.
    a. Tint Color: Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.
11. Mirror Glass for Cabinet Doors: ASTM C 1503, Mirror Select **OR** Glazing, **as directed**, Quality-Q3, 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm, **as directed**, thick.
12. Decorative Glass for Cabinet Doors: Provide decorative glass complying with Division 08 Section "Decorative Glass".
13. Tempered Float Glass for Cabinet Shelves: ASTM C 1048, Kind FT, Condition A, Type I, Class 1 (clear) **OR** 2 or 3 (tinted), **as directed**, Quality-Q3; with exposed edges seamed before tempering, 6 mm thick.
    a. Tint Color: Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.

B. Fire-Retardant-Treated Materials
1. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this Article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified.
   a. Do not use treated materials that do not comply with requirements of referenced woodworking standard or that are warped, discolored, or otherwise defective.
   b. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
   c. Identify fire-retardant-treated materials with appropriate classification marking of UL, U.S. Testing, Timber Products Inspection, or another testing and inspecting agency acceptable to authorities having jurisdiction.

2. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Comply with performance requirements of AWPA C20 (lumber) and AWPA C27 (plywood). Use the following treatment type:
   a. Exterior Type: Organic-resin-based formulation thermally set in wood by kiln drying.
   b. Interior Type A: Low-hygroscopic formulation.
   c. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking plant certified by testing and inspecting agency.
   d. Mill lumber before treatment and implement special procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of treated woodwork.
   e. Kiln-dry materials before and after treatment to levels required for untreated materials.
3. Fire-Retardant Particleboard: Panels made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less per ASTM E 84.
4. Fire-Retardant Fiberboard: Medium-density fiberboard panels complying with ANSI A208.2, made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less per ASTM E 84.

C. Cabinet Hardware And Accessories
1. General: Provide cabinet hardware and accessory materials associated with architectural cabinets, except for items specified in Division 08 Section "Door Hardware".
2. Butt Hinges: 2-3/4-inch (70-mm), 5-knuckle steel hinges made from 0.095-inch- (2.4-mm-) thick metal, and as follows:
   a. Semiconcealed Hinges for Flush Doors: BHMA A156.9, B01361.
   b. Semiconcealed Hinges for Overlay Doors: BHMA A156.9, B01521.
3. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 100 **OR** 135 **OR** 170, **as directed**, degrees of opening, self-closing.
4. Back-Mounted Pulls: BHMA A156.9, B02011.
5. Wire Pulls: Back mounted, solid metal **OR** plastic, **as directed**, 4 inches (100 mm) long, 5/16 inch (8 mm) in diameter **OR** 5 inches (127 mm) long, 2-1/2 inches (63.5 mm) deep, and 5/16 inch (8 mm) in diameter, **as directed**.
6. Catches: Magnetic catches, BHMA A156.9, B03141 **OR** Push-in magnetic catches, BHMA A156.9, B03131 **OR** Roller catches, BHMA A156.9, B03071 **OR** Ball friction catches, BHMA A156.9, B03013, **as directed**.
7. Adjustable Shelf Standards and Supports: BHMA A156.9, B04071; with shelf rests, B04081 **OR** BHMA A156.9, B04102; with shelf brackets, B04112, **as directed**.
8. Shelf Rests: BHMA A156.9, B04013; metal **OR** plastic **OR** metal, two-pin type with shelf hold-down clip, **as directed**.
9. Drawer Slides: BHMA A156.9, B05091.
   a. Standard Duty (Grade 1, Grade 2, and Grade 3): Side mounted and extending under bottom edge of drawer; full-extension **OR** partial-extension, **as directed**, type; zinc-plated steel **OR** epoxy-coated steel, **as directed**, with polymer rollers.
   b. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Side mounted; full-extension **OR** full-overtravel-extension, **as directed**, type; zinc-plated steel ball-bearing slides.
   c. Box Drawer Slides: Grade 1 **OR** Grade 1HD-100, **as directed**; for drawers not more than 6 inches (150 mm) high and 24 inches (600 mm) wide.
   d. File Drawer Slides: Grade 1HD-100 **OR** Grade 1HD-200, **as directed**; for drawers more than 6 inches (150 mm) high or 24 inches (600 mm) wide.
   e. Pencil Drawer Slides: Grade 2 **OR** Grade 1, **as directed**; for drawers not more than 3 inches (75 mm) high and 24 inches (600 mm) wide.
   f. Keyboard Slides: Grade 1 **OR** Grade 1HD-100, **as directed**; for computer keyboard shelves.

g. Trash Bin Slides: Grade 1HD-100 **OR** Grade 1HD-200, **as directed**; for trash bins not more than 20 inches (500 mm) high and 16 inches (400 mm) wide.

10. Plastic **OR** Aluminum, **as directed**, Slides for Sliding Glass Doors: BHMA A156.9, B07063.
11. Door Locks: BHMA A156.11, E07121.
12. Drawer Locks: BHMA A156.11, E07041.
13. Grommets for Cable Passage through Countertops: 1-1/4-inch (32-mm) **OR** 2-inch (51-mm), **as directed**, OD, brown **OR** black, **as directed**, molded-plastic grommets and matching plastic caps with slot for wire passage.
14. Paper Slots: 12 inches (305 mm) **OR** 17 inches (432 mm), **as directed**, long by 1-3/4 inches (45 mm) wide by 1 inch (25 mm) deep; brown **OR** black, **as directed**, molded-plastic, paper-slot liner with 1/4-inch (6.4-mm) lip.
15. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
    a. Dark, Oxidized, Satin Bronze, Oil Rubbed: BHMA 613 for bronze base; BHMA 640 for steel base; match the Owner's sample.
    b. Bright Brass, Clear Coated: BHMA 605 for brass base; BHMA 632 for steel base.
    c. Satin Brass, Blackened, Bright Relieved, Clear Coated: BHMA 610 for brass base; BHMA 636 for steel base.
    d. Satin Chromium Plated: BHMA 626 for brass or bronze base; BHMA 652 for steel base.
    e. Bright Chromium Plated: BHMA 625 for brass or bronze base; BHMA 651 for steel base.
    f. Satin Stainless Steel: BHMA 630.
16. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

D. Miscellaneous Materials

1. Furring, Blocking, Shims, and Hanging Strips:
    a. Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.
    OR
    Fire-retardant-treated softwood lumber, kiln dried to less than 15 percent moisture content.
2. Rough Carriages for Stairs:
    a. Select Structural **OR** No. 1 **OR** No. 2, **as directed**, grade and any of the following species, kiln dried to 15 percent maximum moisture content:
        1) Douglas fir-larch.
        2) Douglas fir-south.
        3) Douglas fir-larch (north).
        4) Hem-fir.
        5) Hem-fir (north).
        6) Southern pine.
        7) Spruce-pine-fir (south).
        8) Spruce-pine-fir.

        OR

        Laminated veneer lumber, made with an exterior-type adhesive complying with ASTM D 2559, and with the following allowable design values as determined according to ASTM D 5456:
        1) Extreme Fiber Stress in Bending, Edgewise: 2850 psi (19.7 MPa) **OR** 2600 psi (17.9 MPa) **OR** 2500 psi (17.2 MPa), **as directed**, for 12-inch nominal- (286-mm actual-) depth members.
        2) Modulus of Elasticity, Edgewise: 2,000,000 psi (13 800 MPa) **OR** 1,800,000 psi (12 400 MPa), **as directed**.
3. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.
4. Handrail Brackets: Cast **OR** Extruded **OR** Stamped, **as directed**, from malleable iron **OR** aluminum **OR** bronze **OR** stainless steel, **as directed**, with wall flange drilled for exposed anchor

OR and tapped for concealed hanger bolt, **as directed**, and with support arm for screwing to underside of rail. Sized to provide 1-1/2-inch (38-mm) clearance between handrail and wall.

5. Handrail/Bumper Rail Brackets: Pairs of extruded-aluminum channels; one for fastening to back of rail and one for fastening to face of wall. They are then assembled in overlapping fashion and fastened together top and bottom with self-tapping screws. Sized to provide 1-1/2-inch (38-mm) clearance between handrail and wall.
6. Adhesives, General: Do not use adhesives that contain urea formaldehyde.
7. VOC Limits for Installation Adhesives and Glues: Use installation adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
   a. Wood Glues: 30 g/L.
   b. Contact Adhesive: 250 g/L.
8. Adhesive for Bonding Plastic Laminate: Unpigmented contact cement **OR** Contact cement **OR** PVA **OR** Urea formaldehyde **OR** Resorcinol, **as directed**.
   a. Adhesive for Bonding Edges: Hot-melt adhesive or adhesive specified above for faces.

E. Fabrication, General
1. Interior Woodwork Grade: Unless otherwise indicated, provide Premium **OR** Custom **OR** Economy, **as directed**,-grade interior woodwork complying with referenced quality standard.
2. Wood Moisture Content: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.
3. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.
4. Fabricate woodwork to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:
   a. Corners of Cabinets and Edges of Solid-Wood (Lumber) Members 3/4 Inch (19 mm) Thick or Less: 1/16 inch (1.5 mm).
   b. Edges of Rails and Similar Members More Than 3/4 Inch (19 mm) Thick: 1/8 inch (3 mm).
   c. Corners of Cabinets and Edges of Solid-Wood (Lumber) Members and Rails: 1/16 inch (1.5 mm).
5. Complete fabrication, including assembly, finishing, **as directed**, and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
6. Shop-cut openings to maximum extent possible to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
   a. Seal edges of openings in countertops with a coat of varnish.
7. Install glass to comply with applicable requirements in Division 08 Section "Glazing" and in GANA's "Glazing Manual." For glass in wood frames, secure glass with removable stops.

F. Interior Standing and Running Trim:
1. For transparent-finished trim items wider than available lumber, use veneered construction. Do not glue for width.
2. Backout or groove backs of flat trim members and kerf backs of other wide, flat members, except for members with ends exposed in finished work.
3. Assemble casings in plant except where limitations of access to place of installation require field assembly.

G. Interior Frames and Jambs
1. Products fabricated from particleboard or medium-density fiberboard with veneered, exposed surfaces.

H. Fire-Rated Interior Frames and Jambs
   1. Products fabricated from fire-retardant particleboard or fire-retardant medium-density fiberboard with veneered, exposed surfaces and listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252.
      a. Fire Rating: 20 minutes.

I. Stairwork and Rails:
   1. Treads: Transparent **OR** Opaque, **as directed**, finish.
   2. Risers: Transparent **OR** Opaque, **as directed**, finish.
   3. Stringers: Transparent **OR** Opaque, **as directed**, finish.
   4. Balusters: Transparent **OR** Opaque, **as directed**, finish.
   5. Handrails: Transparent **OR** Opaque, **as directed**, finish.
   6. Scotia, Cove, and Other Moldings: Transparent **OR** Opaque, **as directed**, finish.

J. Flush Wood Paneling and Wainscots:
   1. Lumber Trim and Edges: At fabricator's option, trim and edges indicated as solid wood (except moldings) may be either lumber or veneered construction compatible with grain and color of veneered panels.
   2. Matching of Adjacent Veneer Leaves: Book **OR** Slip **OR** Random, **as directed**, match.
   3. Veneer Matching within Panel Face: Running **OR** Balance **OR** Center-balance, **as directed**, match.
   4. Panel-Matching Method (Economy Grade): No matching between panels is required. Select and arrange panels for similarity of grain pattern and color between adjacent panels.
   5. Panel-Matching Method (Custom or Premium Grade): In each separate area, use premanufactured sets used full width **OR** premanufactured sets selectively reduced in width **OR** sequence-matched, uniform-size sets, **as directed**.
   6. Fire-Retardant-Treated Paneling: Provide panels consisting of wood veneer and fire-retardant particleboard or fire-retardant medium-density fiberboard. Panels shall have flame-spread index of 75 **OR** 25, **as directed**, or less and smoke-developed index of 450 or less per ASTM E 84.

K. Interior Ornamental Work
   1. Interior ornamental work includes the following:
      a. Balustrades.
      b. Columns.
      c. Grilles.
      d. Mantels.
      e. Pediment heads.
      f. Pilasters.

L. Wood Cabinets for Transparent Finish:
   1. AWI Type of Cabinet Construction: Flush overlay **OR** Reveal overlay **OR** Reveal overlay on face frame **OR** Flush inset **OR** Flush inset with face frame **OR** As indicated, **as directed**.
   2. WI Construction Style: Style A, Frameless **OR** B, Face Frame, **as directed**.
   3. WI Construction Type: Type I, multiple self-supporting units rigidly joined together **OR** II, single-length sections to fit access openings, **as directed**.
   4. WI Door and Drawer Front Style: Flush overlay **OR** Reveal overlay **OR** Lipped **OR** Flush, **s directed**.
   5. Reveal Dimension: 1/2 inch (13 mm) **OR** As indicated, **as directed**.
   6. Grain Direction: Vertically for drawer fronts, doors, and fixed panels **OR** Horizontally for drawer fronts, doors, and fixed panels **OR** As indicated, **as directed**.
   7. Matching of Veneer Leaves: Book **OR** Slip **OR** Random, **as directed**, match.
   8. Veneer Matching within Panel Face: Running **OR** Balance **OR** Center-balance, **as directed**, match.

9. Semiexposed Surfaces Other Than Drawer Bodies: Same species and cut indicated for exposed surfaces **OR** Thermoset decorative panels **OR** Compatible species to that indicated for exposed surfaces, stained to match, **as directed**.
10. Drawer Sides and Backs: Solid-hardwood lumber, same species indicated for exposed surfaces **OR** Solid-hardwood lumber, stained to match species indicated for exposed surfaces **OR** Solid hardwood lumber **OR** Thermoset decorative panels, **as directed**.
11. Drawer Bottoms: Hardwood plywood **OR** Thermoset decorative panels, **as directed**.
12. Provide dust panels of 1/4-inch (6.4-mm) plywood or tempered hardboard above compartments and drawers, unless located directly under tops.

M. Wood Cabinets for Opaque Finish:
1. AWI Type of Cabinet Construction: Flush overlay **OR** Reveal overlay **OR** Reveal overlay on face frame **OR** Flush inset **OR** Flush inset with face frame **OR** As indicated, **as directed**.
2. WI Construction Style: Style A, Frameless **OR** B, Face Frame, **as directed**.
3. WI Construction Type: Type I, multiple self-supporting units rigidly joined together **OR** II, single-length sections to fit access openings, **as directed**.
4. WI Door and Drawer Front Style: Flush overlay **OR** Reveal overlay **OR** Lipped **OR** Flush, **as directed**.
5. Reveal Dimension: 1/2 inch (13 mm) **OR** As indicated, **as directed**.
6. Species for Exposed Lumber Surfaces: Any closed-grain hardwood.
7. Panel Product for Exposed Surfaces: Medium-density fiberboard **OR** overlay, **as directed**.
8. Semiexposed Surfaces Other Than Drawer Bodies: Match materials indicated for exposed surfaces **OR** Thermoset decorative panels, **as directed**.
9. Drawer Sides and Backs: Solid-hardwood lumber **OR** Thermoset decorative panels, **as directed**.
10. Drawer Bottoms: Hardwood plywood **OR** Thermoset decorative panels, **as directed**.
11. Provide dust panels of 1/4-inch (6.4-mm) plywood or tempered hardboard above compartments and drawers, unless located directly under tops.

N. Plastic-Laminate Cabinets:
1. AWI Type of Cabinet Construction: Flush overlay **OR** Reveal overlay **OR** Reveal overlay on face frame **OR** Flush inset **OR** Flush inset with face frame **OR** As indicated, **as directed**.
2. WI Construction Style: Style A, Frameless **OR** B, Face Frame, **as directed**.
3. WI Construction Type: Type I, multiple self-supporting units rigidly joined together **OR** II, single-length sections to fit access openings, **as directed**.
4. WI Door and Drawer Front Style: Flush overlay **OR** Reveal overlay **OR** Lipped **OR** Flush, **as directed**.
5. Reveal Dimension: 1/2 inch (13 mm) **OR** As indicated, **as directed**.
6. Laminate Cladding for Exposed Surfaces: High-pressure decorative laminate as follows:
    a. Horizontal Surfaces Other Than Tops: Grade HGS **OR** HGL, **as directed**.
    b. Postformed Surfaces: Grade HGP, **as directed**.
    c. Vertical Surfaces: Grade HGS **OR** VGS, **as directed**.
    d. Edges: Grade HGS **OR** Grade VGS **OR** PVC tape, 0.018-inch (0.460-mm) minimum thickness, matching laminate in color, pattern, and finish **OR** PVC T-mold matching laminate in color, pattern, and finish **OR** PVC edge banding, 0.12 inch (3 mm) thick, matching laminate in color, pattern, and finish, **as directed**.
7. Materials for Semiexposed Surfaces Other Than Drawer Bodies: High-pressure decorative laminate, Grade VGS **OR** High-pressure decorative laminate, Grade CLS **OR** Thermoset decorative panels, **as directed**.
8. Drawer Sides and Backs: Solid-hardwood lumber **OR** Thermoset decorative panels, **as directed**.
9. Drawer Bottoms: Hardwood plywood **OR** Thermoset decorative panels, **as directed**.
10. Colors, Patterns, and Finishes: As indicated by manufacturer's designations **OR** Match sample, **as directed**.
11. Colors, Patterns, and Finishes: As selected by the Owner from laminate manufacturer's full range of solid colors **OR** wood grains **OR** patterns, **as directed**, gloss **OR** matte, **as directed**, finish.

12. Provide dust panels of 1/4-inch (6.4-mm) plywood or tempered hardboard above compartments and drawers, unless located directly under tops.

O. Wood Countertops
1. Type of Top:
a. Solid wood for transparent finish, edge glued, with crown direction reversed in adjacent boards, to produce widths indicated. Select boards for similarity of color and grain and arrange boards for optimum match between adjacent boards.
OR
Solid laminated for transparent finish. Narrow strips of lumber glued together with crown direction reversed in adjacent strips. Arrange strips for random mix of color and grain.
OR
Panel product for transparent finish (wood veneer laminated over core).
1) Core Material: Particleboard or medium-density fiberboard **OR** Particleboard **OR** Medium-density fiberboard **OR** Particleboard made with exterior glue **OR** Medium-density fiberboard made with exterior glue **OR** Exterior-grade plywood **OR** Fire-retardant particleboard, **as directed**.

P. Plastic-Laminate Countertops:
1. High-Pressure Decorative Laminate Grade: HGS **OR** HGP, **as directed**.
2. Colors, Patterns, and Finishes: As selected by the Owner from laminate manufacturer's full range of solid colors **OR** wood grains **OR** patterns, **as directed**, gloss **OR** matte, **as directed**, finish.
3. Edge Treatment: Same as laminate cladding on horizontal surfaces **OR** Lumber edge for transparent finish matching wood species and cut on cabinet surfaces **OR** As indicated, **as directed**.
4. Core Material at Sinks: Particleboard made with exterior glue **OR** Medium-density fiberboard made with exterior glue or exterior-grade plywood, **as directed**.

Q. Solid-Surfacing-Material Countertops:
1. Solid-Surfacing-Material Thickness: 1/2 inch (13 mm) **OR** 3/4 inch (19 mm), **as directed**.
2. Colors, Patterns, and Finishes: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
3. Fabricate tops in one piece with shop-applied backsplashes **OR** loose backsplashes for field application, **as directed**. Comply with solid-surfacing-material manufacturer's written recommendations for adhesives, sealers, fabrication, and finishing.
4. Install integral sink bowls in countertops in shop.

R. Laminated-Plastic Laboratory Tops
1. High-Pressure Decorative Laminate: Grade HGS **OR** Grade HGP **OR** Chemical-resistant, Grade HGP, **as directed**.
2. Colors and Patterns: Provide materials and products that result in colors and patterns of exposed laminate surfaces complying with the following requirements:
3. Core Material: Particleboard **OR** Particleboard made with exterior glue **OR** Fire-retardant particleboard **OR** Rotary-cut lauan or closed-grain hardwood plywood **OR** Exterior-grade rotary-cut lauan or closed-grain hardwood plywood, **as directed**.

S. Closet And Utility Shelving
1. Shelf Material: 3/4-inch (19-mm) solid lumber **OR** veneer-faced panel product with solid-lumber edge **OR** veneer-faced panel product with veneer edge banding **OR** thermoset decorative panel with solid-lumber edge **OR** thermoset decorative panel with PVC or polyester edge banding **OR** medium-density fiberboard with solid-lumber edge **OR** particleboard with solid-lumber edge **OR** medium-density fiberboard with radiused edge **OR** particleboard with radiused and filled edge, **as directed**.
2. Cleats: 3/4-inch (19-mm) solid lumber **OR** thermoset decorative panel **OR** panel product, **as directed**.

3. Wood Species: Match species indicated for other types of transparent-finished architectural woodwork located in same area of building, unless otherwise indicated **OR** Match species indicated for door to closet where shelving is located **OR** Any closed-grain hardwood **OR** Eastern white pine, sugar pine, or western white pine, **as directed**.

T. Shop Finishing
1. Grade: Provide finishes of same grades as items to be finished.
2. General: Finish architectural woodwork at fabrication shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.
3. General: Shop finish transparent-finished interior architectural woodwork at fabrication shop as specified in this Section. Refer to Division 07 for finishing opaque-finished architectural woodwork.
4. General: Drawings indicate items that are required to be shop finished. Finish such items at fabrication shop as specified in this Section. Refer to Division 07 for finishing architectural woodwork not indicated to be shop finished.
5. Shop Priming: Shop apply the prime coat including backpriming, if any, for transparent-finished items specified to be field finished. Refer to Division 07 for material and application requirements.
6. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural woodwork, as applicable to each unit of work.
   a. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to back of paneling and to end-grain surfaces. Concealed surfaces of plastic-laminate-clad woodwork do not require backpriming when surfaced with plastic laminate, backing paper, or thermoset decorative panels.

U. Transparent Finish:
1. Grade: Premium **OR** Custom **OR** Economy, **as directed**.
2. AWI Finish System: Acrylic lacquer **OR** Conversion varnish **OR** Catalyzed vinyl, **as directed**.
3. WI Finish System: 2, water-reducible acrylic lacquer **OR** 3b., catalyzed vinyl lacquer **OR** 4, conversion varnish, **as directed**.
4. Staining: None required **OR** Match approved sample, **as directed**.
5. Wash Coat for Stained Finish: Apply wash-coat sealer to woodwork made from closed-grain wood before staining and finishing.
6. Open Finish for Open-Grain Woods: Do not apply filler to open-grain woods.
7. Filled Finish for Open-Grain Woods: After staining (if any), apply paste wood filler to open-grain woods and wipe off excess. Tint filler to match stained wood.
   a. Apply wash-coat sealer after staining and before filling.
8. Sheen: Flat, 15-30 **OR** Satin, 31-45 **OR** Semigloss, 46-60 **OR** Gloss, 61-100, **as directed** gloss units measured on 60-degree gloss meter per ASTM D 523.

V. Opaque Finish:
1. Grade: Premium **OR** Custom **OR** Economy, **as directed**.
2. AWI Finish System: Conversion varnish **OR** Catalyzed vinyl, **as directed**.
3. WI Finish System: 3b., catalyzed vinyl lacquer **OR** 4, conversion varnish **OR** 7a., synthetic enamel, **as directed**.
4. Color: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
5. Sheen: Flat, 15-30 **OR** Satin, 31-45 **OR** Semigloss, 46-60 **OR** Gloss, 61-100, **as directed**, gloss units measured on 60-degree gloss meter per ASTM D 523.

1.3 EXECUTION

A. Preparation

1. Before installation, condition woodwork to average prevailing humidity conditions in installation areas.
2. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

B. Installation
1. Grade: Install woodwork to comply with requirements for the same grade specified in Part 1.2 for fabrication of type of woodwork involved.
2. Assemble woodwork and complete fabrication at Project site to comply with requirements for fabrication in Part 1.2, to extent that it was not completed in the shop.
3. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm).
4. Scribe and cut woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
5. Fire-Retardant-Treated Wood: Handle, store, and install fire-retardant-treated wood to comply with chemical treatment manufacturer's written instructions, including those for adhesives used to install woodwork.
6. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.
7. Standing and Running Trim: Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible. Do not use pieces less than 36 inches (900 mm) **OR** 60 inches (1500 mm) **OR** 96 inches (2400 mm), **as directed**, long, except where shorter single-length pieces are necessary. Scarf running joints and stagger in adjacent and related members.
   a. Fill gaps, if any, between top of base and wall with plastic wood filler, sand smooth, and finish same as wood base if finished.
   b. Install wall railings on indicated metal brackets securely fastened to wall framing.
   c. Install standing and running trim with no more variation from a straight line than 1/8 inch in 96 inches (3 mm in 2400 mm).
8. Paneling: Anchor paneling to supporting substrate with concealed panel-hanger clips **OR** splined connection strips, **as directed**. Do not use face fastening, unless covered by trim **OR** otherwise indicated.
   a. Install flush paneling with no more than 1/16 inch in 96-inch (1.5 mm in 2400-mm) vertical cup or bow and 1/8 inch in 96-inch (3 mm in 2400-mm) horizontal variation from a true plane.
9. Stairs: Securely anchor carriages to supporting substrates. Install stairs with treads and risers no more than 1/8 inch (3 mm) from indicated position.
10. Railings:
    a. General: Install rails with no more than 1/8 inch in 96-inch (3 mm in 2400-mm) variation from a straight line.
    b. Stair Rails: Glue and dowel or pin balusters to treads and railings, and railings to newel posts.
    c. Wall Rails: Support rails on indicated metal brackets securely fastened to wall framing.
11. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
    a. Install cabinets with no more than 1/8 inch in 96-inch (3 mm in 2400-mm) sag, bow, or other variation from a straight line.
    b. Maintain veneer sequence matching of cabinets with transparent finish.
    c. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches (400 mm) o.c. with No. 10 wafer-head screws sized for 1-inch (25-mm) penetration into wood framing, blocking, or hanging strips **OR** No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish **OR** toggle bolts through metal backing or metal framing behind wall finish, **as directed**.

12. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
    a. Align adjacent solid-surfacing-material countertops and form seams to comply with manufacturer's written recommendations using adhesive in color to match countertop. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
    b. Install countertops with no more than 1/8 inch in 96-inch (3 mm in 2400-mm) sag, bow, or other variation from a straight line.
    c. Secure backsplashes to tops with concealed metal brackets at 16 inches (400 mm) o.c. and to walls with adhesive.
    d. Calk space between backsplash and wall with sealant specified in Division 07 Section "Joint Sealants".
13. Touch up finishing work specified in this Section after installation of woodwork. Fill nail holes with matching filler where exposed.
14. Refer to Division 07 for final finishing of installed architectural woodwork not indicated to be shop finished.

C. Adjusting And Cleaning
1. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.
2. Clean, lubricate, and adjust hardware.
3. Clean woodwork on exposed and semiexposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION 06410

SECTION 06415 - STONE COUNTERTOPS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for stone countertops. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes stone countertops.

C. Submittals
1. Product Data: For each variety of stone and manufactured products.
2. Shop Drawings: Include plans, sections, details, and attachments to other work.
3. Samples: For each stone type indicated.
4. LEED Submittal:
   a. Product Data for Credit EQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
5. Sealant Compatibility Test Report: From sealant manufacturer, complying with requirements in Division 07 Section "Joint Sealants" and indicating that sealants will not stain or damage stone.
6. Maintenance Data: For stone countertops to include in maintenance manuals. Include Product Data for stone-care products used or recommended by Installer, and names, addresses, and telephone numbers of local sources for products.

D. Quality Assurance
1. Installer Qualifications: Fabricator of products.
2. Source Limitations for Stone: Obtain each variety of stone from a single quarry with resources to provide materials of consistent quality in appearance and physical properties.
   a. Make stone slabs available for the Owner to examine for appearance characteristics. the Owner will select aesthetically acceptable slabs.

E. Delivery, Storage, And Handling
1. Lift stone with wide-belt slings; do not use wire rope or ropes that might cause staining. Move stone, if required, using dollies with cushioned wood supports.
2. Store stone on wood A-frames or pallets with nonstaining separators and nonstaining, waterproof covers. Ventilate under covers to prevent condensation.

F. Project Conditions
1. Field Measurements: Verify dimensions of construction to receive stone countertops by field measurements before fabrication.

1.2 PRODUCTS

A. Granite
1. Granite: Comply with ASTM C 615.
2. Cut stone from contiguous, matched slabs in which natural markings occur, **as directed**.
3. Finish: Polished **OR** Honed **OR** Thermal **OR** As indicated **OR** Match the Owner's sample, **as directed**.

B. Marble
1. Marble: Comply with ASTM C 503.

a. Stone Abrasion Resistance: Minimum value of 10, based on testing according to ASTM C 241 or ASTM C 1353.
2. Cut stone from contiguous, matched slabs in which natural markings occur, **as directed**.
3. Finish: Polished **OR** Honed **OR** As indicated **OR** Match the Owner's sample, **as directed**.

C. Serpentine
1. Serpentine: Comply with ASTM C 1526, Classification I Exterior **OR** II Interior, **as directed**.
a. Stone Abrasion Resistance: Minimum value of 10, based on testing according to ASTM C 241 or ASTM C 1353.
2. Cut stone from contiguous, matched slabs in which natural markings occur, **as directed**.
3. Finish: Polished **OR** Honed **OR** As indicated **OR** Match the Owner's sample, **as directed**.

D. Slate
1. Slate: Comply with ASTM C 629, Classification I Exterior **OR** II Interior, **as directed**, with a fine, even grain and unfading color, from clear, sound stock.
a. Stone Abrasion Resistance: Minimum value of 8, based on testing according to ASTM C 241 or ASTM C 1353.
2. Finish: Honed **OR** Sand rubbed **OR** Natural cleft **OR** As indicated **OR** Match the Owner's sample, **as directed**.

E. Adhesives, Grout, Sealants, And Stone Accessories
1. General: Use only adhesives formulated for stone and ceramic tile and recommended by their manufacturer for the application indicated.
2. Water-Cleanable Epoxy Adhesive: ANSI A118.3, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Water-Cleanable Epoxy Grout: ANSI A118.3, chemical-resistant, water-cleanable, tile-setting and -grouting epoxy.
4. Stone Adhesive: 2-part epoxy or polyester adhesive, formulated specifically for bonding stone to stone, with an initial set time of not more than 2 hours at 70 deg F (21 deg C), and with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
a. Color: Clear **OR** Match stone, **as directed**.
5. Sealant for Countertops: Manufacturer's standard sealant of characteristics indicated below that comply with applicable requirements in Division 07 Section "Joint Sealants" and will not stain the stone it is applied to.
a. Single-component, neutral-curing **OR** acid-curing, **as directed**, silicone sealant.
b. Color: Clear **OR** As selected by the Owner from manufacturer's full range, **as directed**.
c. Use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Stone Joint Splines: Stainless-steel or brass washers approximately 1 inch (25 mm) in diameter and of thickness to fit snugly in saw-cut kerf in edge of stone units.
7. Stone Cleaner: Cleaner specifically formulated for stone types, finishes, and applications indicated, as recommended by stone producer and, if a sealer is specified, by sealer manufacturer. Do not use cleaning compounds containing acids, caustics, harsh fillers, or abrasives.
8. Stone Sealer: Colorless, stain-resistant sealer that does not affect color or physical properties of stone surfaces, as recommended by stone producer for application indicated.

F. Stone Fabrication, General
1. Select stone for intended use to prevent fabricated units from containing cracks, seams, and starts that could impair structural integrity or function.
a. Repairs that are characteristic of the varieties specified are acceptable provided they do not impair structural integrity or function and are not aesthetically unpleasing, as judged by the Owner.
2. Grade and mark stone for final locations to produce assembled countertop units with an overall uniform appearance.

3. Fabricate stone countertops in sizes and shapes required to comply with requirements indicated, including details on Drawings and Shop Drawings.
   a. For granite, comply with recommendations in NBGQA's "Specifications for Architectural Granite."
   b. For marble and serpentine, comply with recommendations in MIA's "Dimension Stone--Design Manual."
   c. Clean sawed backs of stones to remove rust stains and iron particles.
   d. Dress joints straight and at right angle to face, unless otherwise indicated.
   e. Cut and drill sinkages and holes in stone for anchors, supports, and attachments.
   f. Provide openings, reveals, and similar features as needed to accommodate adjacent work.
   g. Fabricate molded edges with machines having abrasive shaping wheels made to reverse contour of edge profile to produce uniform shape throughout entire length of edge and with precisely formed arris slightly eased to prevent snipping, and matched at joints between units. Form corners of molded edges as indicated with outside corners slightly eased, unless otherwise indicated.
   h. Finish exposed faces of stone to comply with requirements indicated for finish of each type of stone required and to match approved Samples and mockups. Provide matching finish on exposed edges of countertops, splashes, and cutouts.
4. Carefully inspect finished stone units at fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units.

G. Stone Countertops
1. General: Comply with recommendations in MIA's "Dimension Stone - Design Manual."
2. Nominal Thickness: Provide thickness indicated, but not less than 3/4 inch (20 mm) **OR** 7/8 inch (22 mm) **OR** 1-1/4 inches (32 mm), **as directed**. Gage backs to provide units of identical thickness.
3. Edge Detail: Straight, slightly eased at top **OR** 3/8-inch (10-mm) bevel **OR** 3/4-inch (20-mm) full bullnose **OR** 1-1/4-inch (20-mm) full bullnose **OR** 3/8-inch (10-mm) radius with 2-inch (50-mm) apron **OR** 1-1/2-inch (40-mm) laminated bullnose **OR** As indicated, **as directed**.
4. Splashes: Provide 3/4-inch- (20-mm-) thick backsplashes **OR** end splashes **OR** backsplashes and end splashes, **as directed**, unless otherwise indicated.
5. Joints: Fabricate countertops without joints.
   OR
   Fabricate countertops in sections for joining in field, with joints at locations indicated and as follows:
   a. Bonded Joints: 1/32 inch (0.8 mm) or less in width.
   b. Grouted Joints: 1/16 inch (1.5 mm) in width.
   c. Sealant-Filled Joints: 1/16 inch (1.5 mm) in width.
   d. Splined Joints: Accurately cut kerfs in edges at joints for insertion of metal splines to maintain alignment of surfaces at joints where indicated. Make width of cuts slightly more than thickness of splines to provide snug fit. Provide at least three splines in each joint.
6. Cutouts and Holes:
   a. Undercounter Fixtures: Make cutouts for undercounter fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.
      1) Provide vertical edges, slightly eased at juncture of cutout edges with top and bottom surfaces of countertop and projecting 3/16 inch (5 mm) into fixture opening.
      2) Provide vertical edges, rounded to 3/8-inch (10-mm) radius at juncture of cutout edges with top surface of countertop, slightly eased at bottom, and projecting 3/16 inch (5 mm) into fixture opening.
      3) Provide 3/4-inch (20-mm) full bullnose edges projecting 3/8 inch (10 mm) into fixture opening.
   b. Counter-Mounted Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.
   c. Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.

1.3 EXECUTION

A. Preparation
1. Advise installers of other work about specific requirements for placement of inserts and similar items to be used by stone countertop Installer for anchoring stone countertops. Furnish installers of other work with Drawings or templates showing locations of these items.
2. Clean dirty or stained stone surfaces by removing soil, stains, and foreign materials before setting. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives. Allow stone to dry before installing.

B. Construction Tolerances
1. Variation from Plumb: For vertical lines and surfaces, do not exceed 1/16 inch in 48 inches (1.5 mm in 1200 mm).
2. Variation from Level: Do not exceed 1/8 inch in 96 inches (3 mm in 2400 mm), 1/4 inch (6 mm) maximum.
3. Variation in Joint Width: Do not vary joint thickness more than 1/4 of nominal joint width.
4. Variation in Plane at Joints (Lipping): Do not exceed 1/64-inch (0.4-mm) difference between planes of adjacent units.
5. Variation in Line of Edge at Joints (Lipping): Do not exceed 1/64-inch (0.4-mm) difference between edges of adjacent units, where edge line continues across joint.

C. Installation Of Countertops
1. General: Install countertops over plywood subtops with full spread of water-cleanable epoxy adhesive.
OR
Install countertops by adhering to supports with water-cleanable epoxy adhesive.
2. Do not cut stone in field, unless otherwise indicated. If stone countertops or splashes require additional fabrication not specified to be performed at Project site, return to fabrication shop for adjustment.
OR
Do necessary field cutting as stone is set. Use power saws with diamond blades to cut stone. Cut lines straight, true, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.
3. Set stone to comply with requirements indicated on Drawings and Shop Drawings. Shim and adjust stone to locations indicated, with uniform joints of widths indicated and with edges and faces aligned according to established relationships and indicated tolerances. Install anchors and other attachments indicated or necessary to secure stone countertops in place.
4. Bond joints with stone adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.
5. If joints are allowed, space joints with 1/16-inch (1.5-mm) gap for filling with grout **OR** sealant, **as directed**. Use temporary shims to ensure uniform spacing.
   a. Install metal splines in kerfs in stone edges at joints where indicated. Fill kerfs with stone adhesive **OR** setting adhesive **OR** sealant, **as directed**, before inserting splines and remove excess immediately after adjoining units are drawn into position.
   b. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.
6. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Use power saws with diamond blades to cut stone. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.
7. Install backsplash and end splash by adhering to wall with water-cleanable epoxy adhesive and to countertops with stone adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.
OR

Install backsplash and end splash by adhering to countertops with stone adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears. Leave 1/16-inch (1.5-mm) gap between splash and wall for filling with sealant. Use temporary shims to ensure uniform spacing.

OR

Install backsplash and end splash by adhering to wall with water-cleanable epoxy adhesive. Leave 1/16-inch (1.5-mm) gap between countertop and splash for filling with sealant. Use temporary shims to ensure uniform spacing.

8. If grouted joints are acceptable, grout joints to comply with ANSI A108.10. Remove temporary shims before grouting. Tool grout uniformly and smoothly with plastic tool.
9. Apply sealant to joints and gaps specified for filling with sealant; comply with Division 07 Section "Joint Sealants". Remove temporary shims before applying sealant.

D. Adjusting And Cleaning
   1. In-Progress Cleaning: Clean countertops as work progresses. Remove adhesive, grout, mortar, and sealant smears immediately.
   2. Remove and replace stone countertops of the following description:
      a. Broken, chipped, stained, or otherwise damaged stone. Stone may be repaired if methods and results are approved by the Owner.
      b. Defective countertops.
      c. Defective joints, including misaligned joints.
      d. Interior stone countertops and joints not matching approved Samples and mockups.
      e. Interior stone countertops not complying with other requirements indicated.
   3. Replace in a manner that results in stone countertops matching approved Samples and mockups, complying with other requirements, and showing no evidence of replacement.
   4. Clean stone countertops not less than six days after completion of sealant installation **OR** installation, **as directed**, using clean water and soft rags. Do not use wire brushes, acid-type cleaning agents, cleaning compounds with caustic or harsh fillers, or other materials or methods that could damage stone.
   5. Sealer Application: Apply stone sealer to comply with stone producer's and sealer manufacturer's written instructions.

END OF SECTION 06415

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SECTION 06415a - SOLID POLYMER FABRICATIONS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for cast, mineral filled, nonporous, solid polymer material used for countertops, vanity tops, sinks, bowls, window sills, tub and shower walls, and other applications where a hard, durable, stain resistant surface is desired. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Shop Drawings: Fabrications; indicate joints, shapes, dimensions, accessories and installation details.
2. Product Data: Solid polymer fabrications; panel adhesive; joint adhesive; sealant; heat reflective tape.
3. Samples: Solid polymer fabrications; where colors and patterns are not indicated, submit at least 3 different samples of manufacturer's standard colors and patterns for selection.
4. Test Reports: Tensile strength; hardness; flammability; thermal expansion; boiling water resistance; high temperature resistance; liquid absorption; mold and mildew growth; bacteria growth; impact resistance; sanitation.
5. Operation and Maintenance Data: Solid polymer fabrications; provide manuals indicating manufacturer's care and maintenance data, including repair and cleaning instructions. Provide maintenance kit(s) for selected finish(es).

C. Quality Assurance: Do not change source of supply for materials after work has started if the appearance of finished work would be affected. Variation in component size and location of openings to be plus or minus 1/8 inch (3 mm).

D. Delivery: Do not deliver until areas are ready for installation. Deliver components and materials to the site undamaged in containers, clearly marked and labeled with manufacturer's name. Store in dry, weathertight enclosure. Protect materials to prevent damage to finished surfaces. Provide protective coverings to prevent physical damage or staining after installation until completion of the project.

E. Warranty: Provide the solid surface material manufacturer's 10 year warranty, from date of acceptance of the work.

1.2 PRODUCTS

A. Solid Polymer Fabrications: Provide fabrication of cast, solid polymer material composed of acrylic polymer, mineral fillers and pigments. Material shall not be coated or laminated to substrates. Polymer thickness to be as indicated but not less than 1/4 inch (6 mm). Superficial damage to a depth of 0.010 inch (0.25 mm) shall be repairable by sanding or polishing.
1. Performance Requirements
a. Tensile strength, ASTM D 638: 5800 psi (40 Mpa) minimum
b. Hardness, ASTM D 2583: Barcol Impressor 55 minimum
c. Flammability, ASTM E 84: Class I/A, flame spread 25 maximum; smoke developed 30 maximum
d. Thermal Expansion, ASTM D 696: 0.00002 in/in/F (0.000036 mm/mm/K) maximum
e. Boiling water resistance, NEMA LD 3: No effect
f. High temperature resistance, NEMA LD 3: No effect
g. Liquid absorption, ASTM D 570 (24 hours): 0.10 percent maximum

h. Mold and mildew growth, ASTM G 21: No growth, no effect
i. Bacteria growth, ASTM G 22: No growth, no effect
j. Sanitation, NSF 51: "Food Contact" approval for food area applications
k. Impact resistance, NEMA LD 3 (1/2 lb. (0.227 kg) ball drop): 1/4 inch (6 mm) material, 36 inch (914 mm) drop, no failure **OR** 1/2 inch (13 mm) material, 120 inch (3048 mm) drop, no failure, **as directed**.

2. Joint Adhesive: Two part acrylic joint adhesive as recommended by the solid polymer manufacturer to form inconspicuous, non-porous joints by chemical bond.
3. Panel Adhesive: Neoprene based panel adhesive as recommended by the solid polymer manufacturer, UL listed.
4. Sealant: Mildew resistant, FDA compliant and UL listed, silicone sealant as recommended by the solid polymer manufacturer.
5. Heat Reflective Tape: Heat reflective tape as recommended by the solid polymer manufacturer for use with cutouts for heat sources.
6. Mounting Hardware: Provide mounting hardware including sink/bowl clips, inserts and fasteners for attachment of undermount sinks and lavatories.

B. Fabrications: Fabrication requirements.
1. Factory fabricate components to the greatest extent possible to the sizes and shapes indicated, in accordance with approved shop drawings. Where indicated, factory fabricate side and back splashes with 1/2 inch (13 mm) cove at intersections.
2. Form joints between components using manufacturer's standard acrylic joint adhesive. Joints shall be inconspicuous, non-porous, and reinforced with strips of solid polymer material in accordance with the manufacturer's printed instructions.
3. Provide factory cutouts for plumbing and accessories as indicated. Reinforce heated or cooled cutouts in accordance with approved shop drawings and the manufacturer's printed instructions. Support all cutouts in accordance with approved shop drawings and the manufacturer's printed instructions.
4. Cut and finish component edges with clean returns. Round edges of cutouts to 1/8 inch (3 mm) radius. Round corners of cutouts with 1/2 inch (13 mm) minimum radius. Use router to form all cutouts. Provide thick edges where indicated using strips of solid polymer material and manufacturer's acrylic joint adhesive. All joints to be inconspicuous and non-porous. All exposed surfaces to have uniform finish and gloss.

1.3 EXECUTION

A. Installation: Deliver fabrications to the locations indicated. Assemble and install complete with accessories and hardware.
1. Assembly Requirements
a. Install components plumb and level and scribed to adjacent finishes in accordance with approved shop drawings and data.
b. Fasten and support fabrications to walls, brackets, and partitions as indicated. Fasteners shall be appropriate for use with adjoining construction.
c. Form field joints using manufacturer's recommended acrylic adhesive. Joints shall be inconspicuous and non-porous. Keep components and hands clean when forming joints. Seal flexible joints using manufacturer's recommended sealant.
d. Provide integral backsplashes and sidesplashes as indicated. Attach splashes with silicone or joint adhesive as indicated.
e. Keep components and hands clean during installation. Remove excessive adhesive and sealants. Clean finished surfaces of all dirt and stains.
2. Protection: Provide protective coverings to prevent physical damage or staining following installation.

END OF SECTION 06415a

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Task	Specification	Specification Description
06415	06410	Interior Architectural Woodwork

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SECTION 06420 - PANELING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for paneling. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Board paneling.
b. Flush wood paneling.
c. Plastic-laminate-clad flush paneling.
d. Stile and rail wood paneling.

C. Definitions
1. Paneling includes wood furring, blocking, and shims for installing paneling, unless concealed within other construction before paneling installation.

D. Submittals
1. Product Data: For each type of product indicated, including finishing materials and processes.
a. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.
2. Shop Drawings: Show location of paneling, large-scale details, attachment devices, and other components. Include dimensioned plans and elevations.
a. For paneling produced from premanufactured sets, show finished panel sizes, set numbers, sequence numbers within sets, and method of cutting panels to produce indicated sizes.
b. For paneling veneered in fabrication shop, show veneer leaves with dimensions, grain direction, exposed face, and identification numbers indicating the flitch and sequence within the flitch for each leaf.
c. Apply WI-certified compliance label to first page of Shop Drawings, **as directed**.
3. Samples:
a. Lumber and panel products for transparent finish, for each species and cut, finished on one side and one edge.
b. Veneer leaves representative of and selected from flitches to be used for transparent-finished paneling.
c. Veneer-faced panel products with or for transparent finish, for each species and cut. Include at least one face-veneer seam and finish as specified.
d. Lumber and panel products with shop-applied opaque finish, for each finish system and color, with 1/2 of exposed surface finished.
e. Plastic laminates, 8 by 10 inches (200 by 250 mm), for each type, color, pattern, and surface finish, with 1 sample applied to core material.
f. Corner pieces for stile and rail paneling, 18 inches (450 mm) high by 18 inches (450 mm) wide by 6 inches (150 mm) deep.
4. LEED Submittals:
a. Product Data for Credit EQ 4.1: For installation adhesives, including printed statement of VOC content.
b. Product Data for Credit EQ 4.4: For composite-wood products and fabrication adhesives, documentation indicating that products contain no urea formaldehyde.

c. Product Data for Credit(s) MR 4.1 and MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
   1) Include statement indicating costs for each product having recycled content.
d. Certificates for Credit MR 7: Chain-of-custody certificates certifying that products specified to be made from certified wood comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
   1) Include statement indicating costs for each certified wood product.

5. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates **OR** WI-certified compliance certificates, **as directed**.

E. Quality Assurance
1. Installer Qualifications: Fabricator of products.
2. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards"**OR** WIC's "Manual of Millwork," **as directed**.
   a. Provide AWI Quality Certification Program labels and certificates for woodwork, including installation.
   b. Provide WIC-certified compliance labels and certificates for woodwork, including installation.
3. Fire-Test-Response Characteristics: Where fire-retardant materials or products are indicated, provide materials and products with specified fire-test-response characteristics as determined by testing identical products per test method indicated by UL, ITS, or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify with appropriate markings of applicable testing and inspecting agency in the form of separable paper label or, where required by authorities having jurisdiction, imprint on surfaces of materials that will be concealed from view after installation.
4. Forest Certification: Provide paneling produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
5. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Do not deliver paneling until painting and similar operations that could damage paneling have been completed in installation areas. If paneling must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

G. Project Conditions
1. Environmental Limitations: Do not deliver or install paneling until building is enclosed, wet work is complete, and HVAC system is operating and will maintain temperature and relative humidity at occupancy levels during the remainder of the construction period.

1.2 PRODUCTS

A. Materials
1. General: Provide materials that comply with requirements of AWI's **OR** WI's, **as directed**, quality standard for quality grade specified, unless otherwise indicated.
2. Wood Products: Comply with the following:
   a. Medium-Density Fiberboard: ANSI A208.2, Grade MD, made with binder containing no urea formaldehyde.
   b. Particleboard: ANSI A208.1, Grade M-2 **OR** M-2-Exterior Glue, **as directed**.
   c. Particleboard: Straw-based particleboard complying with requirements in ANSI A208.1, Grade M-2, except for density.

d. Softwood Plywood: DOC PS 1, Medium Density Overlay.
e. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1, made with adhesive containing no urea formaldehyde.

3. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated, or if not indicated, as required by woodwork quality standard.
4. Adhesives: Do not use adhesives that contain urea formaldehyde.
5. Adhesive for Bonding Plastic Laminate: Unpigmented contact cement **OR** Contact cement **OR** PVA **OR** Urea formaldehyde **OR** Resorcinol, **as directed**.
   a. Adhesive for Bonding Edges: Hot-melt adhesive or adhesive specified above for faces.
6. VOC Limits for installation Adhesives and Glues: Use installation adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
   a. Wood Glues: 30 g/L.
   b. Panel Adhesives: 50 g/L.
   c. Contact Adhesive: 80 g/L.
   d. Special Purpose Contact Adhesive (contact adhesive that is used to bond melamine covered board, metal, unsupported vinyl, Teflon, ultra-high molecular weight polyethylene, rubber or wood veneer 1/16 inch or less in thickness to any surface): 250 g/L.

B. Fire-Retardant-Treated Materials
1. General: Where fire-retardant-treated materials are indicated, use materials that are acceptable to authorities having jurisdiction and that comply with requirements in this Article and with fire-test-response characteristics specified.
   a. Do not use treated materials that do not comply with requirements of referenced woodworking standard or that are warped, discolored, or otherwise defective.
   b. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
   c. Identify fire-retardant-treated materials with appropriate classification marking of UL, U.S. Testing, Timber Products Inspection, or another testing and inspecting agency acceptable to authorities having jurisdiction.
2. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Comply with performance requirements of AWPA C20 (lumber) and AWPA C27 (plywood). Use the following treatment type:
   a. Exterior Type: Organic-resin-based formulation thermally set in wood by kiln drying.
   b. Interior Type A: Low-hygroscopic formulation.
   c. Mill lumber after treatment, within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking plant certified by testing and inspecting agency.
   d. Mill lumber before treatment and implement special procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of treated woodwork.
   e. Kiln-dry materials before and after treatment to levels required for untreated materials.
3. Fire-Retardant Particleboard: Panels complying with the following requirements, made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less per ASTM E 84.
4. Fire-Retardant Fiberboard: Medium-density fiberboard panels complying with ANSI A208.2, made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less per ASTM E 84.

C. Installation Materials
1. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, fire-retardant-treated, **as directed**, kiln-dried to less than 15 percent moisture content.

2. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

D. Fabrication, General
1. Paneling Grade: Provide Premium **OR** Custom **OR** Economy, **as directed**, grade paneling complying with referenced quality standard.
2. Wood Moisture Content: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.
3. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.
4. Arrange paneling in shop or other suitable space in proposed sequence for examination by the Owner. Mark units with temporary sequence numbers to indicate position in proposed layout.
   a. Lay out one elevation at a time if approved by the Owner.
   b. Notify the Owner seven days in advance of the date and time when layout will be available for viewing.
   c. Provide lighting of similar type and level as that of final installation for viewing layout, unless otherwise approved by the Owner.
   d. Rearrange paneling as directed by the Owner until layout is approved.
   e. Do not trim end units and other nonmodular size units to less than modular size until after the Owner's approval of layout. Indicate trimming by masking edges of units with nonmarking material.
   f. Obtain the Owner's approval of layout before start of assembly. Mark units and Shop Drawings with assembly sequence numbers based on approved layout.
5. Complete fabrication, including assembly and finishing, **as directed**, to maximum extent possible, before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
6. Shop cut openings, to maximum extent possible, to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

E. Board Paneling For Transparent Finish
1. Grade: Provide Premium **OR** Custom **OR** Economy, **as directed**.
2. Wood Species and Cut: Hickory, quarter sawn **OR** Red gum, plain sawn **OR** Western white pine, plain sawn **OR** Cypress, plain sawn, **as directed**.
3. Pattern: 1-by-6, vee joint, tongue and groove, 5-1/16-inch (129-mm) coverage **OR** 1-by-8, pickwick paneling (WWPA Pattern WP-2), 6-3/4-inch (172-mm) coverage **OR** 1-by-4, beaded ceiling, 3-3/16-inch (81-mm) coverage **OR** As indicated, **as directed**.
4. Shop fabricate board paneling in lengths to provide pieces that are uninterrupted by joints **OR** random-lengths, **as directed**. Machine edges of boards to provide joint profiles indicated.
5. Preassemble board paneling into largest units that can be delivered into installation areas using permanent or temporary backing members as indicated. To maximum extent possible, fabricate units in sizes determined by field measurements of existing conditions and that will avoid fitting in the field; make provision for separate scribing pieces to be fitted to adjoining finished surfaces. Provide shop-prepared detachable pieces for forming joints with other units at Project site and with other types of architectural woodwork.

F. Board Paneling For Opaque Finish
1. Grade: Provide Premium **OR** Custom **OR** Economy, **as directed**.
2. Wood Species: Eastern white pine, sugar pine, or western white pine **OR** Any closed-grain hardwood, **as directed**.

3. Pattern: 1-by-6, vee joint, tongue and groove, 5-1/16-inch (129-mm) coverage **OR** 1-by-8, pickwick paneling (WWPA Pattern WP-2), 6-3/4-inch (172-mm) coverage **OR** 1-by-4, beaded ceiling, 3-3/16-inch (81-mm) coverage **OR** As indicated, **as directed**.
4. Shop fabricate board paneling in lengths to provide pieces that are uninterrupted by joints **OR** random-lengths, **as directed**. Machine edges of boards to provide joint profiles indicated.
5. Preassemble board paneling into largest units that can be delivered into installation areas using permanent or temporary backing members as indicated. To maximum extent possible, fabricate units in sizes determined by field measurements of existing conditions and that will avoid fitting in the field; make provision for separate scribing pieces to be fitted to adjoining finished surfaces. Provide shop-prepared detachable pieces for forming joints with other units at Project site and with other types of architectural woodwork.

G. Flush Wood Paneling For Transparent Finish
1. Grade: Provide Premium **OR** Custom **OR** Economy, **as directed**.
2. Wood Species and Cut: White oak, rift sliced **OR** Cherry, plain sliced **OR** Butternut, plain sliced **OR** Avodire, quarter sliced, **as directed**.
   a. Lumber Trim and Edges: At paneling fabricator's option, trim and edges indicated as solid wood (except moldings) may be either lumber or veneered construction of same species and cut as panel faces and compatible with grain and color of panel faces.
3. Matching of Adjacent Veneer Leaves: Book **OR** Slip **OR** Random, **as directed** match.
4. Matching within Panel Face: Running **OR** Balance **OR** Center-balance, **as directed**, match.
5. Panel-Matching Method:
   a. No matching is required between panels. Select and arrange panels for similarity of grain pattern and color between adjacent panels.
      OR
      Premanufactured sets used full width **OR** Premanufactured sets selectively reduced in width **OR** Sequence-matched, uniform-size sets **OR** Blueprint-matched panels and components, **as directed**, within each separate area.
6. Vertical Panel-Matching Method: Continuous match; veneer leaves of upper panels are continuations of veneer leaves of lower panels **OR** Vertical book match; veneer leaves are individually book matched from lower panels to upper panels **OR** Vertical slip match; veneer leaves are individually slip matched from lower panels to upper panels **OR** Panel vertical book match; panels are book matched from lower panels to upper panels **OR** Panel vertical slip match; panels are slip matched from lower panels to upper panels, **as directed**.
7. Panel Core Construction: Hardwood veneer-core plywood **OR** Particleboard or medium-density fiberboard **OR** Fire-retardant particleboard or fire-retardant, medium-density fiberboard, **as directed**.
8. Exposed Panel Edges: Solid wood or wood veneer matching faces **OR** Legs of metal channels forming reveals **OR** Bronze flat bars 1/16 inch (1.6 mm) thick by depth of panels, **as directed**.
9. Panel Reveals: Matte black plastic laminate **OR** Bronze sheet **OR** Stainless-steel sheet **OR** Bronze channels, 1 by 1 by 1/8 inch (25.4 by 25.4 by 3.2 mm) thick **OR** Stainless-steel channels, 1 by 1 by 1/16 inch (25.4 by 25.4 by 1.6 mm) thick, **as directed**.
10. Fire-Retardant-Treated Paneling: Provide panels consisting of wood-veneer and fire-retardant particleboard or fire-retardant, medium-density fiberboard. Panels shall have a flame-spread index of 75 **OR** 25, **as directed**, or less and a smoke-developed index of 450 or less per ASTM E 84.
    a. Provide paneling of 3/4-inch (19-mm) minimum thickness.

H. Plastic-Laminate-Clad Flush Paneling
1. Grade: Provide Premium **OR** Custom **OR** Economy, **as directed**.
2. Plastic-Laminate Cladding: High-pressure decorative laminate, in the following grades:
   a. Faces: Grade HGS **OR** VGS **OR** SGF **OR** HGF **OR** VGF, **as directed**.
   b. Backs: Grade BKH **OR** BKV **OR** BKL, **as directed**.
   c. Exposed Edges: Same as faces or Grade VGS.
3. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed surfaces complying with the following requirements:

a. As indicated by manufacturer's designations.
b. Match the Owner's samples.
c. As selected by the Owner from laminate manufacturer's full range in the following categories:
1) Solid colors, gloss **OR** matte, **as directed,** finish.
2) Solid colors with core same color as surface, gloss **OR** matte, **as directed**, finish.
3) Wood grains, gloss **OR** matte, **as directed**, finish.
4) Patterns, gloss **OR** matte, **as directed**, finish.

4. Panel Core Construction: Particleboard or medium-density fiberboard **OR** Fire-retardant particleboard or fire-retardant, medium-density fiberboard, **as directed**.
5. Fire-Retardant-Treated Paneling: Provide panels consisting of fire-retardant plastic laminate and fire-retardant particleboard or fire-retardant, medium-density fiberboard. Panels shall have a flame-spread index of 75 **OR** 25, **as directed**, or less and a smoke-developed index of 450 or less per ASTM E 84.
a. Provide paneling of 3/4-inch (19-mm) minimum thickness.

I. Stile And Rail Wood Paneling For Transparent Finish
1. Grade: Premium **OR** Custom **OR** Economy, **as directed**.
2. Wood Species: White oak, rift sawn/sliced **OR** Figured English ash, quarter sawn/sliced **OR** Butternut, plain sawn/sliced **OR** Figured red gum, plain-sawn/sliced panels, quarter-sawn/sliced stiles and rails, **as directed**.
3. Stiles and Rails: At fabricator's option, stiles and rails may be either lumber or veneered construction with edges banded or with lumber moldings, as indicated, to conceal core and veneer joints.
4. Panels: Flat panels **OR** Raised panels with veneered faces and solid lumber rims **OR** Raised panels with veneered faces extending across rims **OR** Raised panels made from edge-glued solid lumber, **as directed**.
5. Insert Panels:
a. Blueprint matched in a horizontal sequence for adjacent panels and doors, with continuous vertical matching between adjacent panels. Book and balance **OR** Book, balance, and center, **as directed**, match face-veneer leaves within each panel.
OR
Cut panels from premanufactured, sequence-matched sets of book-matched veneered panels. Cut panels with an even **OR** even or odd, **as directed**, number of veneer leaves centered in each panel and with each of the remainders at least half as wide as the full veneer leaves, **as directed**. Cut panels with continuous matching between vertically adjacent panels; veneer leaves of upper panels are continuations of veneer leaves of panels below them.
OR
Book and balance match face veneers within panels. No matching is required between adjacent panels; select and arrange panels for similarity of grain pattern and color between adjacent panels.
6. Shop assemble stile and rail paneling into largest units practical for delivery and installation. Provide shop-prepared detachable joints for necessary field connections. Sand and pull joints tight in shop so field joints will comply with joint tolerances for specified grade. Unless otherwise indicated, provide continuous mortise-and-tenon joints between panel units and provide removable temporary protection for joints during handling and delivery.
a. Outside Corner of Stile and Rail Paneling: Shop prepare using lock-mitered or mitered-and-splined construction. Assemble, sand, and glue in shop, if site conditions permit.

J. Stile And Rail Wood Paneling For Opaque Finish
1. Grade: Premium **OR** Custom **OR** Economy, **as directed**.
2. Wood Species: Any closed-grain hardwood **OR** Eastern white pine, ponderosa pine, sugar pine, or western white pine, **as directed**.

3. Stiles and Rails: Either solid lumber or particleboard, shop filled on face, with veneered or lumber-banded edges, at paneling fabricator's option.
4. Flat Insert Panels: Medium-density fiberboard or particleboard with shop-filled face.
5. Raised Insert Panels: Medium-density overlaid softwood plywood (Exterior) APA MDO EXT, machined to profile indicated and shop filled on exposed machined surfaces **OR** Medium-density fiberboard, machined to profile indicated, **as directed**.
6. Provide fire-retardant treatment of stile and rail paneling as indicated below. For components of paneling fabricated from solid lumber, mill pieces before treatment.
   a. For stiles and rails, use fire-retardant-treated lumber or fire-retardant medium-density fiberboard.
   b. For built-up stiles and rails, use fire-retardant particleboard with fire-retardant lumber edge-bands or fire-retardant medium-density fiberboard.
   c. For insert panels, use fire-retardant medium-density fiberboard.
      OR
      For insert panels, use fire-retardant particleboard with closed-grain hardwood veneer on face and back.
7. Shop assemble stile and rail paneling into largest units practical for delivery and installation. Provide shop-prepared detachable joints for necessary field connections. Sand and pull joints tight in shop so field joints will comply with joint tolerances for specified grade. Unless otherwise indicated, provide continuous mortise-and-tenon joints between panel units and provide removable temporary protection for joints during handling and delivery.
   a. Outside Corner of Stile and Rail Paneling: Shop prepare using lock-mitered or mitered-and-splined construction. Assemble, sand, and glue in shop, if site conditions permit.

K. Shop Finishing
1. Grade: Provide finishes of same grades as paneling to be finished.
2. General:
   a. Finish paneling at fabrication shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.
      OR
      Shop finish transparent-finished paneling at fabrication shop as specified in this Section. Refer to Division 07 for finishing of opaque-finished paneling.
      OR
      Drawings indicate paneling that is required to be shop finished. Finish such paneling at fabrication shop as specified in this Section. Refer to Division 07 for finishing paneling not indicated to be shop finished.
3. Shop Priming: Shop apply the prime coat including backpriming, if any, for transparent-finished paneling specified to be field finished. Refer to Division 07 for material and application requirements.
4. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing paneling, as applicable to each unit of work.
   a. Backpriming: Apply two coats of sealer or primer, compatible with finish coats, to concealed surfaces of paneling. Concealed surfaces of plastic-laminate-clad paneling do not require backpriming when surfaced with plastic laminate.
5. Transparent Finish:
   a. Grade: Premium **OR** Custom **OR** Economy, **as directed**.
   b. AWI Finish System: TR-0, synthetic penetrating oil **OR** TR-3, cellulose acetate butyrate or water-reducible acrylic lacquer **OR** TR-4, conversion varnish **OR** TR-5, catalyzed vinyl lacquer, **as directed**.
   c. WIC Finish System: 2, water-reducible acrylic lacquer **OR** 3b., catalyzed vinyl lacquer **OR** 4, conversion varnish **OR** 6, penetrating oil, **as directed**.
   d. Staining: None required **OR** Match approved sample for color **OR** Match the Owner's sample, **as directed**.
   e. Wash Coat for Stained Finish: Apply wash-coat sealer to woodwork made from closed-grain wood before staining and finishing.

f. Open Finish for Open-Grain Woods: Do not apply filler to open-grain woods.
g. Filled Finish for Open-Grain Woods: After staining (if any), apply paste wood filler to open-grain woods and wipe off excess. Tint filler to match stained wood.
1) Apply wash-coat sealer after staining and before filling.
h. Sheen: Flat, 15-30 **OR** Satin, 31-45 **OR** Semigloss, 46-60 **OR** Gloss, 61-100, **as directed**, gloss units measured on 60-degree gloss meter per ASTM D 523.

6. Opaque Finish: Comply with requirements indicated below for grade, finish system, color, effect, and sheen, with sheen measured on 60-degree gloss meter per ASTM D 523.
a. Grade: Premium **OR** Custom **OR** Economy, **as directed**.
b. AWI Finish System: OP-4, conversion varnish **OR** OP-5, catalyzed vinyl, **as directed**.
c. WIC Finish System: 3b., catalyzed vinyl lacquer **OR** 4, conversion varnish **OR** 7a., synthetic enamel, **as directed**.
d. Color: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
e. Sheen: Flat, 10-25 **OR** Satin, 30-50 **OR** Semigloss, 55-75 **OR** Gloss, 80-100, **as directed**, gloss units.

1.3 EXECUTION

A. Preparation
1. Before installation, condition paneling to average prevailing humidity conditions in installation areas.
2. Before installing paneling, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

B. Installation
1. Grade: Install paneling to comply with requirements for same grade specified in Part 1.2 for fabrication of type of paneling involved.
2. Install paneling level, plumb, true, and straight with no distortions. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm). Install with no more than 1/16 inch in 96-inch (1.6 mm in 2400-mm) vertical cup or bow and 1/8 inch in 96-inch (3 mm in 2400-mm) horizontal variation from a true plane.
a. For flush paneling with revealed joints, install with variations in reveal width, alignment of top and bottom edges, and flushness between adjacent panels not exceeding 1/32 inch (0.8 mm) **OR** 1/16 inch (1.5 mm), **as directed**.
3. Scribe and cut paneling to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
4. Anchor paneling to supporting substrate with concealed panel-hanger clips **OR** splined connection strips **OR** blind nailing, **as directed**. Do not use face fastening unless covered by trim **OR** otherwise indicated, **as directed**.
5. Complete finishing work specified in this Section to extent not completed at shop or before installation of paneling. Fill nail holes with matching filler where exposed. Apply specified finish coats, including stains and paste fillers if any, to exposed surfaces where only sealer/prime coats are applied in shop.
6. Refer to Division 07 for final finishing of installed paneling.

C. Adjusting And Cleaning
1. Repair damaged and defective paneling, where possible, to eliminate functional and visual defects; where not possible to repair, replace paneling. Adjust for uniform appearance.
2. Clean paneling on exposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION 06420

SECTION 06420a - PLASTIC PANELING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for plastic paneling. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes glass-fiber reinforced plastic (FRP) wall paneling and trim accessories.

C. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
   a. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content and chemical components.
   b. Product Data for Credit EQ 4.4: For laminating adhesive and composite wood products used in factory-laminated plastic panels, indicating that product contains no urea formaldehyde.
3. Samples: For plastic paneling and trim accessories.

D. Quality Assurance
1. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   a. Flame-Spread Index: 25 **OR** 200, **as directed**, or less.
   b. Smoke-Developed Index: 450 or less.
   c. Testing Agency: Acceptable to authorities having jurisdiction **OR** FM Approvals **OR** UL, **as directed**.

1.2 PRODUCTS

A. Plastic Sheet Paneling
1. General: Gelcoat-finished, glass-fiber reinforced plastic panels complying with ASTM D 5319.
   a. Nominal Thickness: Not less than 0.075 inch (1.9 mm) **OR** 0.09 inch (2.3 mm) **OR** 0.12 inch (3.0 mm), **as directed**.
   b. Surface Finish: Smooth **OR** Molded pebble texture **OR** Smooth surface with filled grooves at 4 inches (102 mm) o.c. to resemble tile **OR** As selected by the Owner from manufacturer's full range, **as directed**.
   c. Color: White **OR** As selected by the Owner from manufacturer's full range, **as directed**.

B. Factory-Laminated Plastic Panels
1. General: Gelcoat-finished, glass-fiber reinforced plastic panels complying with ASTM D 5319, laminated to plywood **OR** oriented strand board **OR** fire-retardant particleboard **OR** gypsum board **OR** high-impact gypsum board **OR** moisture- and mold-resistant gypsum board, **as directed**.
   a. Glass-Fiber Reinforced Plastic Panel Nominal Thickness: Not less than 0.03 inch (0.76 mm) **OR** 0.05 inch (1.3 mm) **OR** 0.075 inch (1.9 mm) **OR** 0.09 inch (2.3 mm), **as directed**.
   b. Surface Finish: Smooth **OR** Molded pebble texture **OR** Smooth surface with filled grooves at 4 inches (102 mm) o.c. to resemble tile **OR** As selected by the Owner from manufacturer's full range, **as directed**.
   c. Color: White **OR** As selected by the Owner from manufacturer's full range, **as directed**.

d. Plywood: DOC PS 1, Exterior B-C, 1/4 inch (6.4 mm) **OR** 3/8 inch (9.5 mm) **OR** 1/2 inch (12.7 mm) **OR** 5/8 inch (15.9 mm) **OR** 3/4 inch (19.1 mm), **as directed**, thick.
e. Oriented Strand Board: DOC PS 2, 1/4 inch (6.4 mm) **OR** 3/8 inch (9.5 mm) **OR** 1/2 inch (12.7 mm) **OR** 3/4 inch (19.1 mm), **as directed**, thick.
f. Fire-Retardant Particleboard: Product complying with ANSI A208.1, Grade M-S, except for modulus of rupture; with flame-spread index of 25 or less per ASTM E 84; and 3/8 inch (9.5 mm) **OR** 1/2 inch (12.7 mm), **as directed**, thick.
g. Gypsum Board: ASTM C 1396/C 1396M, Regular, 1/2 inch (12.7 mm) **OR** Type X, 5/8 inch (15.9 mm), **as directed**.
h. High-Impact Gypsum Board: ASTM C 1396/C 1396M, 5/8 inch (15.9 mm), with Type X core, and 0.010-inch (0.254-mm) **OR** 0.020-inch (0.508-mm) **OR** 0.030-inch (0.762-mm) **OR** 0.081-inch (2.057-mm), **as directed**, plastic film laminated to back side for greater resistance to through penetration (impact resistance).
i. Moisture- and Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M or ASTM C 1178/C 1178M, 5/8 inch (15.9 mm), Type X, with moisture- and mold-resistant core and surfaces.
j. Laminating Adhesive: Manufacturers standard adhesive that does not contain urea formaldehyde.

C. Accessories
1. Trim Accessories: Manufacturer's standard one-piece **OR** two-piece, snap-on, **as directed**, vinyl extrusions designed to retain and cover edges of panels. Provide division bars, inside corners, outside corners, and caps as needed to conceal edges.
a. Color: White **OR** Match panels **OR** As selected by the Owner from manufacturer's full range, **as directed**.
2. Exposed Fasteners: Nylon drive rivets recommended by panel manufacturer.
3. Concealed Mounting Splines: Continuous, H-shaped aluminum extrusions designed to fit into grooves routed in edges of factory-laminated panels and to be fastened to substrate.
4. Adhesive: As recommended by plastic paneling manufacturer.
a. VOC Content: 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
5. Sealant: Single-component, mildew-resistant, neutral-curing silicone **OR** Single-component, mildew-resistant, acid-curing silicone **OR** Latex, **as directed**, sealant recommended by plastic paneling manufacturer and complying with requirements in Division 07 Section "Joint Sealants".
a. VOC Content: 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1.3 EXECUTION

A. Preparation
1. Remove wallpaper, vinyl wall covering, loose or soluble paint, and other materials that might interfere with adhesive bond.
2. Prepare substrate by sanding high spots and filling low spots as needed to provide flat, even surface for panel installation.
3. Clean substrates of substances that could impair bond of adhesive, including oil, grease, dirt, and dust.
4. Condition panels by unpacking and placing in installation space before installation according to manufacturer's written recommendations.
5. Lay out paneling before installing. Locate panel joints where indicated **OR** to provide equal panels at ends of walls not less than half the width of full panels **OR** so that trimmed panels at corners are not less than 12 inches (300 mm) wide, **as directed**.
a. Mark plumb lines on substrate at trim accessory **OR** panel joint, **as directed**, locations for accurate installation.

b. Locate trim accessories **OR** panel joints, **as directed**, to allow clearance at panel edges according to manufacturer's written instructions.

B. Installation

1. Install plastic paneling according to manufacturer's written instructions.
   OR
   Install panels in a full spread of adhesive.
   OR
   Install panels with fasteners. Layout fastener locations and mark on face of panels so that fasteners are accurately aligned.
   a. Drill oversized fastener holes in panels and center fasteners in holes.
   b. Apply sealant to fastener holes before installing fasteners.
2. Install factory-laminated panels using concealed mounting splines in panel joints.
3. Install trim accessories with adhesive and nails or staples. Do not fasten through panels.
4. Fill grooves in trim accessories with sealant before installing panels and bed inside corner trim in a bead of sealant.
5. Maintain uniform space between panels and wall fixtures. Fill space with sealant.
6. Maintain uniform space between adjacent panels and between panels and floors, ceilings, and fixtures. Fill space with sealant.
7. Remove excess sealant and smears as paneling is installed. Clean with solvent recommended by sealant manufacturer and then wipe with clean dry cloths until no residue remains.

END OF SECTION 06420a

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Task	Specification	Specification Description
06430	06410	Interior Architectural Woodwork
06440	06410	Interior Architectural Woodwork

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SECTION 06450 - EXTERIOR ARCHITECTURAL WOODWORK

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for exterior architectural woodwork. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
   a. Exterior standing and running trim.
   b. Exterior frames and jambs.
   c. Exterior shutters.
   d. Exterior ornamental work.
   e. Shop priming exterior woodwork.
   f. Shop finishing exterior woodwork.

C. Submittals
1. Product Data: For each type of product and process indicated and incorporated into items of exterior architectural woodwork during fabrication, finishing, and installation.
   a. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.
   b. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.
2. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
3. Samples: For lumber for exterior wood stain finish and lumber and panel products for shop-applied opaque finish, for each finish system and color, with one-half of exposed surface finished.
4. LEED Submittal:
   a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that products specified to be made from certified wood comply with forest certification requirements. Include evidence that mill is certified for chain of custody by an FSC-accredited certification body.
      1) Include statement indicating costs for each certified wood product.
5. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates **OR** WI-certified compliance certificates, **as directed**.

D. Quality Assurance
1. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards" **OR** WI's "Manual of Millwork", **as directed**.
   a. Provide AWI Quality Certification Program labels and certificates indicating that woodwork, including installation.
   b. Provide WI-certified compliance labels and certificates indicating that woodwork, including installation.
2. Fire-Test-Response Characteristics: Where fire-retardant materials or products are indicated, provide materials and products with specified fire-test-response characteristics as determined by testing identical products per test method indicated by UL, ITS, or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify with appropriate markings of applicable testing and inspecting agency in the form of separable paper label or, where required by authorities having jurisdiction, imprint on surfaces of materials that will be concealed from view after installation.

3. Forest Certification: Provide exterior architectural woodwork produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

1.2 PRODUCTS

A. Materials
1. General: Provide materials that comply with requirements of AWI's **OR** WI's, **as directed**, quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.
2. Wood Products: Comply with the following:
a. Hardboard: AHA A135.4.
b. Softwood Plywood: DOC PS 1, Exterior **OR** Medium Density Overlay, **as directed**.

B. Wood-Preservative-Treated Materials
1. Preservative Treatment by Nonpressure Process: Comply with AWPA N1 using the following preservative for woodwork items indicated to receive water-repellent preservative treatment:
a. Water-Repellent Preservative: Formulation made specifically for dip treatment of woodwork items and containing 3-iodo-2-propynyl butyl carbamate (IPBC) complying with AWPA P8 as its active ingredient.
b. Water-Repellent Preservative/Insecticide: Formulation made specifically for dip treatment of woodwork items and containing 3-iodo-2-propynyl butyl carbamate (IPBC) as its active ingredient, combined with an insecticide containing chlorpyrifos as its active ingredient, both complying with AWPA P8.
2. Preservative Treatment by Pressure Process: AWPA C2 (lumber) and AWPA C9 (plywood) and the following:
a. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Use chemical formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
b. Kiln-dry lumber and plywood after treatment to a maximum moisture content, respectively, of 19 and 15 percent. Do not use materials that are warped or do not comply with requirements for untreated materials.
c. Mark each treated item with treatment quality mark of an inspection agency approved by the American Lumber Standards Committee Board of Review.
3. Extent of Treatment: Treat blocking and nailers by pressure process and treat other exterior architectural woodwork either by pressure or nonpressure process.
a. Items fabricated from the following wood species need not be treated:
1) Redwood **OR** All-heart redwood, **as directed**.
2) Western red cedar **OR** All-heart western red cedar, **as directed**.
3) Teak.
4) African mahogany.

C. Fire-Retardant-Treated Materials
1. General: Where fire-retardant-treated materials are indicated, provide materials that comply with performance requirements of AWPA C20 (lumber) and AWPA C27 (plywood), exterior type.
a. Fire-Retardant Chemicals: Use chemical formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
b. Mill lumber before treatment and implement special procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of treated woodwork.
c. Kiln-dry materials before and after treatment to levels required for untreated materials.

d. Do not use treated materials that do not comply with requirements of referenced woodworking standard or that are warped, discolored, or otherwise defective.
e. Identify fire-retardant-treated materials with appropriate classification marking of UL, U.S. Testing, Timber Products Inspection, or another testing and inspecting agency acceptable to authorities having jurisdiction.

D. Installation Materials
1. Blocking, Shims, and Nailers: Softwood or hardwood lumber, pressure-preservative treated **OR** fire-retardant treated, **as directed**, kiln dried to less than 15 percent moisture content.
2. Nails: Aluminum **OR** Hot-dip galvanized **OR** Stainless steel, **as directed**.
3. Screws: Aluminum **OR** Bronze **OR** Hot-dip galvanized **OR** Stainless steel, **as directed**.
   a. Provide self-drilling screws for metal framing supports, as recommended by metal-framing manufacturer.
4. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts, unless otherwise indicated. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

E. Fabrication
1. Wood Moisture Content: 9 to 15 **OR** 10 to 15 **OR** 7 to 12, **as directed**, percent.
2. Fabricate woodwork to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:
   a. Edges of Solid-Wood (Lumber) Members 3/4 Inch (19 mm) Thick or Less: 1/16 inch (1.6 mm).
   b. Edges of Rails and Similar Members More Than 3/4 Inch (19 mm) Thick: 1/8 inch (3 mm).
3. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
4. Shop cut openings, to maximum extent possible, to receive hardware, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Smooth edges of cutouts and seal with a water-resistant coating suitable for exterior applications.
5. Woodwork for Transparent Finish:
   a. Grade: Premium **OR** Custom **OR** Economy, **as directed**.
   b. Wood Species: Teak **OR** African mahogany **OR** White oak **OR** All-heart redwood **OR** Western red cedar **OR** Eastern white pine, **as directed**.
6. Woodwork for Opaque Finish:
   a. Grade: Premium **OR** Custom **OR** Economy, **as directed**.
   b. Wood Species: All-heart redwood **OR** Western red cedar **OR** Ponderosa pine **OR** Eastern white pine, sugar pine, or western white pine **OR** Any closed-grain hardwood, **as directed**.
7. Backout or groove backs of flat trim members and kerf backs of other wide, flat members, except for members with ends exposed in finished work.
8. Shop Priming: Shop prime woodwork for paint finish with one coat of wood primer specified in Division 07.
   a. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to surfaces installed in contact with concrete or masonry and to end-grain surfaces.
9. Shop Finishing: Entire finish of exterior architectural woodwork is specified in this Section. To greatest extent possible, finish architectural woodwork at fabrication shop. Defer only final touchup and cleaning until after installation.
   a. Grade: Same grade as item to be finished **OR** Premium **OR** Custom **OR** Economy, **as directed**.
   b. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to surfaces installed in contact with concrete or masonry and to end-grain surfaces.
   c. AWI Finish System: Conversion varnish **OR** Catalyzed polyurethane, **as directed**.

d. WI Finish System: 4, conversion varnish **OR** 5, catalyzed polyurethane **OR** 7a., synthetic enamel, **OR as directed**.
e. Sheen: Satin 31-45 **OR** Semigloss 46-60 **OR** Gloss 61-100, **as directed**, gloss units measured on 60-degree gloss meter per ASTM D 523.

1.3 EXECUTION

A. Preparation
1. Before installation, condition woodwork to average prevailing humidity conditions in installation areas.
2. Deliver concrete inserts and similar anchoring devices to be built into substrates well in advance of time substrates are to be built.
3. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

B. Installation
1. Quality Standard: Install woodwork to comply with same grade specified in Part 1.2 for type of woodwork involved.
2. Install woodwork true and straight with no distortions. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm).
3. Scribe and cut woodwork to fit adjoining work, and refinish cut surfaces or repair damaged finish at cuts.
4. Fire-Retardant-Treated Wood: Handle, store, and install fire-retardant-treated wood to comply with chemical treatment manufacturer's written instructions, including those for adhesives used to install woodwork.
5. Preservative-Treated Wood: Where cut or drilled in field, treat cut ends and drilled holes according to AWPA M4.
6. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure to grounds, stripping and blocking with countersunk concealed fasteners and blind nailing. Use fine finishing nails for exposed nailing, countersunk and filled flush with woodwork.
7. Standing and Running Trim: Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible. Do not use pieces less than 36 inches (900 mm) long, except where shorter single-length pieces are necessary. Scarf running joints and stagger in adjacent and related members.
   a. Install standing and running trim with no more variation from a straight line than 1/8 inch in 96 inches (3 mm in 2400 mm).
8. Complete finishing work specified in this Section to extent not completed at shop or before installation of woodwork. Fill nail and screw holes with matching filler where exposed.
9. Refer to Division 07 for final finishing of installed architectural woodwork.

C. Adjusting And Cleaning
1. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; replace woodwork where not possible to repair. Adjust joinery for uniform appearance.
2. Clean woodwork on exposed and semiexposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION 06450

Task	Specification	Specification Description
06450	01352	No Specification Required
06450	06410	Interior Architectural Woodwork

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SECTION 06510 - PLASTIC LUMBER

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of plastic lumber. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Basic Uses
1. For both residential and municipal applications, high-density polyethylene (HDPE) products are well suited for decking, porch flooring, docks, piers, furnishings, fencing, and lawn and garden items. HDPE products are cost-effective alternatives for ground contact and animal contact, wet, and environmentally harsh conditions.

C. Limitations
1. Plastic lumber has less rigidity (modulus of elasticity) and greater elongation than wood lumber. Therefore, it is not recommended for use as a true structural member. Examples of applications that are inappropriate would be load-bearing walls, deck framing, and floor joists. It is recommended that an engineering study be performed prior to use of HDPE products if the application involves structural requirements. For commercial applications where the system design calls for concentrated loads, structural plastic lumber should be considered.
2. When utilizing HDPE products for decking or flooring, pay careful attention to joist spacing and joist spans. Consult manufacturer for allowable live loads, deflection limits, joist spacing, and joist spans.

D. Quality Assurance
1. Plastic lumber shall meet applicable standards established by ASTM for recycled plastic lumber and hygrothermal testing.
2. Plastic lumber shall pass testing by UL and meet flammability standards established by ASTM.

1.2 PRODUCTS

A. Materials
1. High-density polyethylene (HDPE), UV-inhibited pigment systems, foaming compounds, and selected process additives, shall be derived from post-consumer bottle waste, such as milk and detergent bottles, then compounded into a rigid board stock material, with the resulting finished product containing minimum 75% recycled plastic by weight.
2. Plastic lumber shall have exceptional resistance to corrosive substances, oil and fuels, insects, fungi, salt spray, and other environmental stresses. They shall not absorb moisture; nor shall they rot, splinter, or crack.
3. HDPE products shall be manufactured in standard dimensional lumber sizes, and shapes.
4. Color of plastic lumber shall be selected from manufacturer’s standard colors.

1.3 EXECUTION

A. Installation
1. HDPE products shall have the capability of being fabricated and installed with the same tools used to work wood lumber. The product shall cut and drill very cleanly, as there is no grain to split or chip. It shall not be necessary to pre-drill the plastic lumber when fastening. Stainless steel or coated decking nails and screws are recommended for use with HDPE products. Screws

offer the best form of attachment; however, nails and staples may also be utilized in some applications.

2. The use of full length boards is suggested to avoid unattractive butt-to-butt joints.
3. HDPE products offer multiple deck board attachment options to accommodate expansion and contraction concerns in different climatic conditions and to address specific installation parameters. These options include:
   a. Tongue and groove deck board attachment with toe screwing options.
   b. Direct screw attachment with feature strip options.
   c. Floating attachment with clip options.
   d. Floating attachment with groove & groove options.

B. Maintenance

1. HDPE products are unaffected by most corrosive substances and will not absorb moisture. To maintain the original finish, clean the lumber with soap and water. No sealing or painting is required; as a general rule, paint will not adhere to HDPE products.
2. Clean graffiti from the plastic lumber with the use of a conventional all-purpose cleaner or petroleum-based cleaner.
3. If the skin or surface layer of an HDPE product becomes marred or blemished, sand off the top skin. The surface can also be buffed to eliminate abrasions.

END OF SECTION 06510

SECTION 06510a - COMPOSITE PLASTIC LUMBER

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of composite plastic lumber. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Basic Uses
1. Composite plastic lumber or boards are well designed for deck, porch, boardwalk, dock, and similar applications. These boards may also be used for many lumber applications, where a non-load bearing member is required. This material is particularly well suited for outdoor uses due to its durability characteristics. Composite boards have many beneficial properties for decking applications, including:
   a. Low moisture absorption.
   b. No rotting, splitting or splintering.
   c. Inherent termite and UV resistance.
   d. Excellent dimensional stability and wet/dry traction.
   e. No toxic compounds (CCA) to leach into soil or groundwater.
   f. Workability and appearance of natural lumber products.

C. Limitations
1. Composite plastic lumber has less rigidity (modulus of elasticity) than wood lumber and is more flexible. Therefore, this material should not be employed as a structural component unless an engineering study indicates that its use is appropriate. These boards are not intended to be used as joists, beams, studs, columns or stringers.
2. When utilizing composite plastic lumber products for decking, pay careful attention to joist spacing and joist spans. Consult manufacturer for allowable live loads, deflection limits, joist spacing, and joist spans.

D. Quality Assurance
1. Composite plastic lumber shall meet applicable standards established by ASTM for recycled plastic lumber.
2. Plastic lumber shall meet flammability standards established by ASTM.

E. Handling
1. This material is more flexible and more dense than wood, which should be considered when handling boards.
2. Storing boards on uneven or unsupported surfaces may lead to deformation of the material. Therefore, always store boards on a flat surface, or support with dunnage on centers of 24" or less.

1.2 PRODUCTS

A. Materials
1. Composite plastic lumber products shall be composed of approximately 65% recycled wood/natural fiber and 35% recycled plastic, with selected process additives. The plastic raw material utilized in this product is recycled plastic. It shall be processed to a uniform feedstock, compounded with recovered fibers and extruded into a rigid board product.
2. Colors and sizes of composite plastic lumber shall be selected from manufacturer’s standard.

1.3 EXECUTION

A. Installation
1. Composite plastic lumber products shall have the capability of being fabricated and installed with the same tools used to work wood lumber. The product shall cut and drill very cleanly, as there is no grain to split or chip. For best results, use carbide-tipped blades and bits.
2. For optimum water drainage, allow a gap of 3/16" to 1/4" between boards.
3. Both nails and screws may be used to attach USPL composite boards; stainless steel or coated screw type fasteners are recommended.
4. #8, 2 1/2" stainless steel or ceramic-coated deck screws are recommended for 5/4x6 boards, and #10, 3" stainless steel or ceramic-coated deck screws are recommended for 2x6 boards for best results.
5. In cold weather, consider pre-drilling screw holes. Do not use fasteners within 3/4" of the edge of a board. Pneumatic nail guns work with this material.

B. Maintenance
1. Composite boards will weather to a lighter hue during the first few months; fading may take much longer in shaded areas.
2. To clean dirt and most stains from the deck boards, use common deck cleaners available in hardware stores, home centers and lumberyards. Oil stains from grills and foods may require the use of a degreasing cleaner or light sanding to remove the stain. Mold and mildew are common on many exterior surfaces, and they may form on composite plastic lumber. Use common deck washes that contain sodium hypochlorite for best cleaning results.

END OF SECTION 06510a

SECTION 06510b - STRUCTURAL PLASTIC LUMBER

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of structural plastic lumber. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Basic Uses
1. Structural plastic lumber products are used in a variety of commercial and marine applications and are often the product of choice for exterior applications where resistance to salt and fresh water, marine borers, and other environmentally harsh conditions is required. Due to the unique composition of structural plastic lumber, the product can be used for a number of structural members in commercial and shoreline timberwork.
2. It is well suited for:
   a. Dock and deck planks
   b. Wale timbers
   c. Sheet piling
   d. Camels
   e. Pilings
   f. Fenders
   g. Channel markers
   h. Posts, beams, and joists

C. Limitations
1. This type of plastic lumber product has a significantly higher modulus of elasticity (MOE) than conventional forms of plastic lumber. However, the MOE of structural plastic lumber is lower than wood timber in good condition; therefore, it is important to evaluate the suitability of this product for specific uses. It is recommended that an engineering study be performed prior to use of structural plastic lumber products for structural applications. Building code regulations vary by region, so all users should consult local building and safety codes prior to installation for specific requirements.

D. Quality Assurance
1. Structural plastic lumber shall meet applicable standards established by ASTM for recycled plastic lumber and hygrothermal testing.
2. Plastic lumber shall meet flammability standards established by ASTM.

1.2 PRODUCTS

A. Materials
1. Structural plastic lumber shall be a high-performance construction material consisting of a patented formula of recycled plastic, fiberglass, and selected additives. The plastic raw material utilized in structural plastic lumber is derived from post-consumer bottle waste such as milk and detergent bottles. This material is compounded into a consistent, reinforced plastic timber product using reactive compatibilizers, creating a strong and stable plastic/fiber matrix.
2. Colors, sizes, and shapes of structural plastic lumber shall be selected from manufacturer’s standard.

1.3 EXECUTION

A. Installation
   1. Structural plastic lumber can be fabricated and installed with the same tools used to work wood lumber. The product will cut and drill very cleanly, as there is no grain to split or chip, or knots to bind tools and bend fasteners. It is reinforced with glass fibers, and precautions should be taken when fabricating this product. Maintain adequate ventilation when generating fabrication dust, and personal respiratory protection such as dust masks should be employed during fabrication, as well as safety glasses or goggles.
   2. Pilings and sheet piling products can be driven with piledriving equipment such as vibratory hammers, land-based or barge-mounted drop hammers, or waterjets. For sheet piling installations, backfill soils should always be analyzed to determine that the proper amount of force would be exerted on the sheet piling system. For shoreline timberwork applications, structural plastic lumber is used with conventional hardware such as stainless or galvanized bolts, tie rods, nuts, washers, and anchor systems.
   3. When utilizing structural plastic lumber products for decking, pay careful attention to joist spacing and joist spans. Consult manufacturer for allowable live loads, deflection limits, joist spacing, and joist spans.

B. Maintenance
   1. Structural plastic lumber products are unaffected by most corrosive substances and will not absorb moisture. To maintain the original finish, clean the lumber with soap and water. No sealing or painting is required; as a general rule, paint will not adhere well to these products.
   2. Clean graffiti from the plastic lumber with the use of a conventional all-purpose cleaner or petroleum-based cleaner. If the skin or surface layer of plastic lumber becomes marred or blemished, sand off the top skin. The surface can also be buffed to eliminate abrasions.

END OF SECTION 06510b

SECTION 06520 - PULTRUDED FIBERGLASS STRUCTURAL SHAPES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of pultruded fiberglass structural shapes. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Shop drawings of all fabricated structural systems and accessories.
2. Manufacturer's shop drawings clearly showing material sizes, types, styles, part or catalog numbers, complete details for the fabrication of and erection of components including, but not limited to, location, lengths, type and sizes of fasteners, clip angles, member sizes, and connection details.
3. Manufacturer's published literature including structural design data, structural properties data, corrosion resistance tables, certificates of compliance, test reports as applicable, and design calculations for systems not sized or designed in the contract documents, sealed by a Professional Engineer.
4. Sample pieces of each item specified herein for acceptance as to quality and color. Sample pieces shall be manufactured by the method to be used in the work.

C. Quality Assurance
1. All items to be provided under this Section shall be furnished only by manufacturers having experience in the design and manufacture of similar products and systems. If requested, experience shall be demonstrated by a record of at least five (5) previous, separate, similar successful installations in the last five (5) years.

D. Product Delivery and Storage
1. Delivery of Materials: Manufactured materials shall be delivered in original, unbroken pallets, packages, containers, or bundles bearing the label of the manufacturer. Adhesives, resins and their catalysts and hardeners shall be crated or boxed separately and noted as such to facilitate their movement to a dry indoor storage facility.
2. Storage of Products: All materials shall be carefully handled to prevent them from abrasion, cracking, chipping, twisting, other deformations, and other types of damage. Store items in an enclosed area and free from contact with soil and water. Store adhesives, resins and their catalysts and hardeners in dry indoor storage facilities between 70 and 85 degrees Fahrenheit (21 to 29 degrees Celsius) until they are required.

1.2 PRODUCTS

A. Materials
1. All structural shapes shall be manufactured by the pultrusion process with a glass content minimum of 45%, maximum of 55% by weight for maximum sunlight and chemical resistance. The structural shapes shall be composed of fiberglass reinforcement and resin in qualities, quantities, properties, arrangements and dimensions as necessary to meet the design requirements and dimensions as specified in the Contract Documents.
2. Fiberglass reinforcement shall be a combination of continuous roving, continuous strand mat, and surfacing veil in sufficient quantities as needed by the application and/or physical properties required.
3. Resins shall be ISO, non-fire retardant isophthalic polyester; ISOFR, fire retardant isophthalic polyester or VEFR, vinyl ester, with chemical formulation necessary to provide the corrosion resistance, strength and other physical properties as required.

4. All finished surfaces of FRP items and fabrications shall be smooth, resin-rich, free of voids and without dry spots, cracks, crazes or unreinforced areas. All glass fibers shall be well covered with resin to protect against their exposure due to wear or weathering.
5. All pultruded structural shapes shall be further protected from ultraviolet (UV) attack with 1) integral UV inhibitors in the resin and 2) a synthetic surfacing veil to help produce a resin rich surface.
6. All FRP products shall have a tested flame spread rating of 25 or less per ASTM E-84 Tunnel Test.

B. Pultruded structural shapes shall have the minimum longitudinal mechanical properties listed below:

Property	**ASTM Method**	**Value**	**Units**
Tensile Strength	D-638	30,000 (206)	psi (MPa)
Tensile Modulus	D-638	2.5×10^6 (17.2)	psi (GPa)
Flexural Strength	D-790	30,000 (206)	psi (MPa)
Flexural Modulus	D-790	1.8×10^6 (12.4)	psi (GPa)
Flexural Modulus (Full Section)	N/A	2.8×10^6 (19.3)	psi (GPa)
Short Beam Shear (Transverse)	D-2344	4,500 (31)	psi (MPa)
Shear Modulus (Transverse)	N/A	4.5×10^5 (3.1)	psi (GPa)
Coefficient of Thermal Expansion	D-696	8.0×10^{-6} (1.4×10^{-6})	in/in/°F (cm/cm/°C)
Flame Spread	E-84	25 or less	N/A

1.3 EXECUTION

A. Fabrication
1. Measurements: Structural Shapes supplied shall meet the minimum dimensional requirements as shown or specified. The Contractor shall provide and/or verify measurements in field for work fabricated to fit field conditions as required by manufacturer to complete the work. Determine correct size and locations of required holes or coping from field dimensions before structural shape fabrication.
2. Sealing: All shop fabricated cuts or drilling shall be coated with vinyl ester resin to provide maximum corrosion resistance. All field fabricated cuts or drilling shall be coated similarly by the contractor in accordance with the manufacturer's instructions.
3. Hardware: Type 316 stainless steel connection hardware shall be provided.

B. Inspection
1. Shop inspection shall be authorized as required by the Owner and shall be at Owner's expense. The fabricator shall give ample notice to Contractor prior to the beginning of any fabrication work so that inspection may be provided.
2. The structural shapes shall be as free, as commercially possible, from visual defects such as foreign inclusions, delamination, blisters, resin burns, air bubbles and pits.

END OF SECTION 06520

SECTION 06520a - PULTRUDED FIBERGLASS INDUSTRIAL GRATING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for pultruded fiberglass industrial grating. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Shop drawings of all fabricated gratings and accessories in accordance with the provisions of this Section.
2. Manufacturer's shop drawings clearly showing material sizes, types, styles, part or catalog numbers, complete details for the fabrication of and erection of components including, but not limited to, location, lengths, type and sizes of fasteners, clip angles, member sizes, and connection details.
3. Manufacturer’s published literature including structural design data, structural properties data, grating load/deflection tables, corrosion resistance tables, certificates of compliance, test reports as applicable, concrete anchor systems and their allowable load tables, and design calculations for systems not sized or designed in the contract documents.
4. Sample pieces of each item specified herein for acceptance as to quality and color. Sample pieces shall be manufactured by the method to be used in the work.

C. Quality Assurance
1. All items to be provided under this Section shall be furnished only by manufacturers having experience in the design and manufacture of similar products and systems. If requested, experience shall be demonstrated by a record of at least five (5) previous, separate, similar successful installations in the last five (5) years.

D. Product Delivery And Storage
1. Delivery of Materials: Manufactured materials shall be delivered in original, unbroken pallets, packages, containers, or bundles bearing the label of the manufacturer. Adhesives, resins and their catalysts and hardeners shall be crated or boxed separately and noted as such to facilitate their movement to a dry indoor storage facility.
2. Storage of Products: All materials shall be carefully handled to prevent them from abrasion, cracking, chipping, twisting, other deformations, and other types of damage. Store items in an enclosed area and free from contact with soil and water. Store adhesives, resins and their catalysts and hardeners in dry indoor storage facilities between 70 and 85 degrees Fahrenheit (21 to 29 degrees Celsius) until they are required.

1.2 PRODUCTS

A. General
1. All FRP items furnished under this Section shall be composed of fiberglass reinforcement and resin in qualities, quantities, properties, arrangements and dimensions as necessary to meet the design requirements and dimensions as specified or required.
2. Fiberglass reinforcement shall be a combination of continuous roving, continuous strand mat, and surfacing veil in sufficient quantities as needed by the application and/or physical properties required.
3. Resins shall be vinyl ester or isophthalic with chemical formulations as necessary to provide the corrosion resistance, strength and other physical properties as required.

4. All finished surfaces of FRP items and fabrications shall be smooth, resin-rich, free of voids and without dry spots, cracks, crazes or unreinforced areas. All glass fibers shall be well covered with resin to protect against their exposure due to wear or weathering.
5. All pultruded structural shapes shall be further protected from ultraviolet (UV) light with 1) integral UV inhibitors in the resin and 2) a synthetic surfacing veil to help produce a resin rich surface.
6. All FRP products shall have a tested flame spread rating of 15 or less per ASTM E-84 Tunnel Test. Gratings shall also have a tested burn time of less than 30 seconds and an extent of burn rate of less than or equal to 10 millimeters per ASTM D-635.
7. All grating clips shall be manufactured of Type 316SS (stainless steel).

B. Pultruded Grating
1. Manufacture: Grating components shall be high strength and high stiffness pultruded elements having a maximum of 70% and a minimum of 60% glass content (by weight) of continuous roving and continuous strand mat fiberglass reinforcements. The finished surface of the product shall be provided with a surfacing veil to provide a resin rich surface which improves corrosion resistance and resistance to ultraviolet degradation. Bearing bars shall be interlocked and epoxied in place with a two piece cross rod system to provide a mechanical and chemical lock.
2. Non-slip surfacing: Grating shall be provided with a quartz grit bonded and baked to the top surface of the finished grating product.
3. Fire rating: Grating shall be fire retardant with a tested flame spread rating of 15 or less when tested in accordance with ASTM E 84. Manufacturer may be required to provide certification of ASTM E84 test on grating panels from an independent testing laboratory. Certification shall be dated within the past two years. Test data shall be from full scale testing of actual production grating, of the same type and material supplied on the project. Test data performed only on the base resin shall not be acceptable.
4. Resin system: The resin system used in the manufacture of the grating shall be VEFR, vinyl ester or ISOFR, isophthalic . Manufacturer may be required to submit corrosion data from tests performed on actual grating products in standard chemical environments. Corrosion resistance data of the base resin from the manufacturer is not a true indicator of grating corrosion resistance and shall not be accepted.
5. Color: Gray or Yellow.
6. Depth: 2" deep load bars with a tolerance of plus or minus 1/32".
7. Mesh Configuration: 2" load bar spacing, 6" tie bar spacing on centers.
8. Load/Deflection: Grating shall meet manufacturer's published safe recommended loadings with deflection not to exceed the following:
   a. Uniform distributed load over a 66" span: 50 pounds per square foot, with a maximum deflection of 0.13".
9. Substitutions: Other products of equal strength, stiffness, corrosion resistance and overall quality may be submitted with the proper supporting data to the engineer for approval.

C. Grating Fabrication
1. Measurements: Grating supplied shall meet the minimum dimensional requirements as shown or specified. The Contractor shall provide and/or verify measurements in field for work fabricated to fit field conditions as required by grating manufacturer to complete the work.
   a. Determine correct size and locations of required holes or cutouts from field dimensions before grating fabrication.
2. Layout: Each grating section shall be readily removable, except where indicated on drawings. Manufacturer to provide openings and holes where located on the contract drawings. Grating supports shall be provided at openings in the grating by contractor where necessary to meet load/deflection requirements specified herein. Grating openings which fit around protrusions (pipes, cables, machinery, etc.) shall be discontinuous at approximately the centerline of opening so each section of grating is readily removable. Gratings shall be fabricated free from warps, twists, or other defects which affect appearance and serviceability.

3. Sealing: All shop fabricated grating cuts shall be coated with vinyl ester resin to provide maximum corrosion resistance. All field fabricated grating cuts shall be coated similarly by the contractor in accordance with the manufacturer's instructions.
4. Hardware: Type 316 stainless steel hold-down clips shall be provided and spaced at a maximum of four feet apart with a minimum of four per piece of grating, or as recommended by the manufacturer.

1.3 EXECUTION

A. Inspection
1. Shop inspection is authorized as required by the Owner and shall be at Owner's expense. The fabricator shall give ample notice to Contractor prior to the beginning of any fabrication work so that inspection may be provided.
2. The grating shall be as free, as commercially possible, from visual defects such as foreign inclusions, delamination, blisters, resin burns, air bubbles and pits.

B. Installation
1. Contractor shall install gratings in accordance with manufacturer’s assembly drawings. Lock grating panels securely in place with hold-down fasteners as specified herein. Field cut and drill fiberglass reinforced plastic products with carbide or diamond tipped bits and blades. Seal cut or drilled surfaces in accordance with manufacturer's instructions. Follow manufacturer's instructions when cutting or drilling fiberglass products or using resin products; provide adequate ventilation.

END OF SECTION 06520a

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Task	Specification	Specification Description
06620	06110a	Miscellaneous Carpentry
06625	06110a	Miscellaneous Carpentry
06710	06180	Timber Bridge Components
06710	06110	Rough Carpentry
06710	06110a	Miscellaneous Carpentry
06710	06130	Heavy Timber Construction
06720	06180	Timber Bridge Components
06720	06110	Rough Carpentry

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SECTION 07110 - BITUMINOUS DAMPPROOFING

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for bituminous dampproofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
   a. Hot-applied asphalt dampproofing.
   b. Cold-applied, cut-back asphalt dampproofing.
   c. Cold-applied, emulsified-asphalt dampproofing.

C. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:
   a. Product Data for Credit EQ 4.2: For dampproofing, including printed statement of VOC content.

D. Project Conditions
1. Ventilation: Provide adequate ventilation during application of dampproofing in enclosed spaces. Maintain ventilation until dampproofing has cured.

1.2 PRODUCTS

A. Hot-Applied Asphalt Dampproofing
1. Hot-Applied Asphalt Dampproofing: ASTM D 449, Type I **OR** II **OR** III, **as directed**.
2. VOC Content: 250 g/L **OR** 2.5 lb/gal. (300 g/L) **OR** 4.2 lb/gal. (500 g/L), **as directed**, or less.

B. Cold-Applied, Cut-Back Asphalt Dampproofing
1. Trowel Coats: ASTM D 4586, Type I, Class 1, fibered.
2. Brush and Spray Coats: ASTM D 4479, Type I, fibered[or nonfibered].
3. VOC Content: 250 g/L **OR** 2.5 lb/gal. (300 g/L) **OR** 4.2 lb/gal. (500 g/L), **as directed**, or less.

C. Cold-Applied, Emulsified-Asphalt Dampproofing
1. Trowel Coats: ASTM D 1227, Type II, Class 1.
2. Fibered Brush and Spray Coats: ASTM D 1227, Type II, Class 1.
3. Brush and Spray Coats: ASTM D 1227, Type III, Class 1.
4. VOC Content: Zero **OR** 0.25 lb/gal. (30 g/L) or less, **as directed**.

D. Protection Course
1. Protection Course, Asphalt-Board Type: ASTM D 6506, premolded, 1/8-inch- (3-mm-) thick, multi-ply, semirigid board consisting of a mineral-stabilized asphalt core sandwiched between layers of asphalt-saturated felt, and faced on 1 side with polyethylene film.
2. Protection Course: Fan folded, with a core of extruded-polystyrene board insulation faced on one or both side(s) with plastic film, nominal thickness 1/4 inch (6 mm), with compressive strength of not less than 8 psi (55 kPa) per ASTM D 1621, and maximum water absorption by volume of 0.6 percent per ASTM C 272.

3. Protection Course: Unfaced, fan-folded, extruded-polystyrene board insulation, nominal thickness 1/4 inch (6 mm) with compressive strength of not less than 8 psi (55 kPa) per ASTM D 1621.
4. Protection Course, Roll-Roofing Type: Smooth-surfaced roll roofing complying with ASTM D 6380, Class S, Type III.

E. Miscellaneous Materials
1. Cut-Back Asphalt Primer: ASTM D 41.
2. Emulsified-Asphalt Primer: ASTM D 1227, Type III, Class 1, except diluted with water as recommended by manufacturer.
3. Asphalt-Coated Glass Fabric: ASTM D 1668, Type I.
4. Patching Compound: Epoxy or latex-modified repair mortar **OR** Manufacturer's fibered mastic, **as directed**, of type recommended by dampproofing manufacturer.

1.3 EXECUTION

A. Preparation
1. Protection of Other Work: Mask or otherwise protect adjoining exposed surfaces from being stained, spotted, or coated with dampproofing. Prevent dampproofing materials from entering and clogging weep holes and drains.
2. Clean substrates of projections and substances detrimental to work; fill voids, seal joints, and apply bond breakers if any, as recommended by prime material manufacturer.
3. Apply patching compound for filling and patching tie holes, honeycombs, reveals, and other imperfections; cover with asphalt-coated glass fabric.

B. Application, General
1. Comply with manufacturer's written recommendations unless more stringent requirements are indicated or required by Project conditions to ensure satisfactory performance of dampproofing.
   a. Apply additional coats if recommended by manufacturer or if required to achieve coverages indicated.
   b. Allow each coat of dampproofing to cure six **OR** 12 **OR** 24, **as directed**, hours before applying subsequent coats.
   c. Allow 24 **OR** 36 **OR** 48, **as directed**, hours drying time prior to backfilling.
2. Apply dampproofing to footings and foundation walls where opposite side of wall faces building interior **OR** occupied space, **as directed**.
   a. Apply from finished-grade line to top of footing, extend over top of footing, and down a minimum of 6 inches (150 mm) over outside face of footing.
   b. Extend 12 inches (300 mm) onto intersecting walls and footings, but do not extend onto surfaces exposed to view when Project is completed.
   c. Install flashings and corner protection stripping at internal and external corners, changes in plane, construction joints, cracks, and where shown as "reinforced," by embedding an 8-inch- (200-mm-) wide strip of asphalt-coated glass fabric in a heavy coat of dampproofing. Dampproofing coat for embedding fabric is in addition to other coats required.
3. Apply dampproofing to provide continuous plane of protection on exterior face of inner wythe of exterior masonry cavity walls.
   a. Lap dampproofing at least 1/4 inch (6 mm) onto flashing, masonry reinforcement, veneer ties, and other items that penetrate inner wythe.
   b. Extend dampproofing over outer face of structural members and concrete slabs that interrupt inner wythe, and lap dampproofing at least 1/4 inch (6 mm) onto shelf angles supporting veneer.
4. Apply dampproofing to provide continuous plane of protection on interior face of above-grade, exterior concrete and masonry and single-wythe masonry walls unless walls are indicated to receive direct application of paint.

a. Continue dampproofing through intersecting walls by keeping vertical mortar joints at intersection temporarily open or by delaying construction of intersecting walls until dampproofing is applied.

C. Hot-Applied Asphalt Dampproofing
1. Do not apply hot asphalt when substrate condition causes foaming.
2. Kettle Temperature: Comply with dampproofing material manufacturer's written recommendations, and keep at least 25 deg F (14 deg C) below the flash point.
3. Prime masonry and other porous substrates.
4. Apply a uniform coat of hot asphalt by mopping or spraying at not less than 20 lb or 2.5 gal./100 sq. ft. (98 kg or 1 L/sq. m).
5. Apply a second coat to below-grade foundation walls as specified above. Apply double thickness of second coat where first application has failed to produce a smooth, shiny, impervious coat.

D. Cold-Applied, Cut-Back Asphalt Dampproofing
1. On Concrete Foundations and Parged Masonry Foundation Walls: Apply 2 brush or spray coats at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m) for first coat and 1 gal./100 sq. ft. (0.4 L/sq. m) for second coat, or 1 trowel coat at not less than 4 gal./100 sq. ft. (1.6 L/sq. m).
2. On Unparged Masonry Foundation Walls: Apply primer and 2 brush or spray coats at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m) for first coat and 1 gal./100 sq. ft. (0.4 L/sq. m) for second coat, or primer and 1 trowel coat at not less than 4 gal./100 sq. ft. (1.6 L/sq. m).
3. On Unexposed Face of Concrete Retaining Walls: Apply 1 brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).
4. On Unexposed Face of Masonry Retaining Walls: Apply primer and 1 brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).
5. On Concrete Backup for Stone Veneer Assemblies and Dimension Stone Cladding: Apply 1 brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).
6. On Masonry Backup for Stone Veneer Assemblies and Dimension Stone Cladding: Apply primer and 1 brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).
7. On Exterior Face of Inner Wythe of Cavity Walls: Apply primer and 1 brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

E. Cold-Applied, Emulsified-Asphalt Dampproofing
1. On Concrete Foundations and Parged Masonry Foundation Walls: Apply 2 brush or spray coats at not less than 1.5 gal./100 sq. ft. (0.6 L/sq. m) for first coat and 1 gal./100 sq. ft. (0.4 L/sq. m) for second coat, 1 fibered brush or spray coat at not less than 3 gal./100 sq. ft. (1.2 L/sq. m), or 1 trowel coat at not less than 4 gal./100 sq. ft. (1.6 L/sq. m).
2. On Unparged Masonry Foundation Walls: Apply primer and 2 brush or spray coats at not less than 1.5 gal./100 sq. ft. (0.6 L/sq. m) for first coat and 1 gal./100 sq. ft. (0.4 L/sq. m) for second coat, primer and 1 fibered brush or spray coat at not less than 3 gal./100 sq. ft. (1.2 L/sq. m), or primer and 1 trowel coat at not less than 5 gal./100 sq. ft. (2 L/sq. m).
3. On Unexposed Face of Concrete Retaining Walls: Apply 1 brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).
4. On Unexposed Face of Masonry Retaining Walls: Apply primer and 1 brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).
5. On Concrete Backup for Stone Veneer Assemblies and Dimension Stone Cladding: Apply 1 brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).
6. On Masonry Backup for Stone Veneer Assemblies and Dimension Stone Cladding: Apply primer and 1 brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).
7. On Exterior Face of Inner Wythe of Cavity Walls: Apply primer and 1 brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).
8. On Interior Face of Exterior Concrete Walls: Where above grade and indicated to be furred and finished, apply 1 brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).
9. On Interior Face of Exterior masonry Walls **OR** Single-Wythe Exterior Masonry Walls, **as directed**: Where above grade and indicated to be furred and finished, apply primer and 1 brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

F. Installation Of Protection Course
   1. Where indicated, install protection course over completed-and-cured dampproofing. Comply with dampproofing material manufacturer's written recommendations for attaching protection course.
      a. Support extruded-polystyrene board protection course with spot application of adhesive of type recommended by protection board manufacturer over cured coating.
      b. Install asphalt-board-type protection course on same day **OR** within 24 hours, **as directed**, of installation of dampproofing (while coating is tacky) to ensure adhesion.

G. Cleaning
   1. Remove dampproofing materials from surfaces not intended to receive dampproofing.

END OF SECTION 07110

SECTION 07110a - COLD FLUID-APPLIED WATERPROOFING

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for cold fluid-applied waterproofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Single-component polyurethane waterproofing.
b. Two-component polyurethane waterproofing.
c. Polyester waterproofing.
d. Latex-rubber waterproofing.
e. Molded-sheet drainage panels.
f. Insulation.
g. Plaza deck pavers.

C. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.
3. Product test reports.

D. Quality Assurance
1. Installer Qualifications: A firm that is approved or licensed by **OR** acceptable to, **as directed**, waterproofing manufacturer for installation of waterproofing required for this Project.
2. Preinstallation Conference: Conduct conference at Project site.
a. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and flashings, installation procedures, testing and inspection procedures, and protection and repairs.

E. Delivery, Storage, And Handling
1. Deliver liquid materials to Project site in original containers with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, shelf life, and directions for storing and mixing with other components.
2. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by waterproofing manufacturer.
3. Remove and replace liquid materials that cannot be applied within their stated shelf life.
4. Protect stored materials from direct sunlight.

F. Project Conditions
1. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate, when relative humidity exceeds 85 percent, or when temperatures are less than 5 deg F (3 deg C) above dew point.

G. Warranty

1. Special Manufacturer's Warranty: Manufacturer's standard form in which waterproofing manufacturer and Installer agree to repair or replace waterproofing that does not comply with requirements or that fails to remain watertight within specified warranty period.
   a. Warranty Period: Five years from date of Substantial Completion.

1.2 PRODUCTS

A. Single-Component Polyurethane Waterproofing
1. Single-Component, Modified Polyurethane Waterproofing: Comply with ASTM C 836 and with manufacturer's written physical requirements.
2. Single-Component, Reinforced, Modified Polyurethane Waterproofing: Comply with ASTM C 836 and with manufacturer's written physical requirements.
3. Single-Component, Unmodified Polyurethane Waterproofing: Comply with ASTM C 836 and with manufacturer's written physical requirements.

B. Two-Component Polyurethane Waterproofing
1. Two-Component, Modified Polyurethane Waterproofing: Comply with ASTM C 836 and with manufacturer's written physical requirements.
2. Two-Component, Unmodified Polyurethane Waterproofing: Comply with ASTM C 836 and with manufacturer's written physical requirements.
3. Two-Component, Reinforced, Unmodified Polyurethane Waterproofing: Comply with ASTM C 836 and with manufacturer's written physical requirements.

C. Polyester Waterproofing
1. Two-Component, Reinforced, Unsaturated Polyester Waterproofing: Comply with ASTM C 836 and with manufacturer's written physical requirements.

D. Latex-Rubber Waterproofing
1. Two-Component, Unreinforced, Latex-Rubber Waterproofing: Comply with ASTM C 836 and with manufacturer's written physical requirements.
2. Two-Component, Reinforced, Latex-Rubber Waterproofing: Comply with ASTM C 836 and with manufacturer's written physical requirements.

E. Auxiliary Materials
1. General: Provide auxiliary materials recommended by manufacturer to be compatible with one another and with waterproofing, as demonstrated by waterproofing manufacturer, based on testing and field experience.
2. Primer: Manufacturer's standard, factory-formulated polyurethane or epoxy primer.
3. Sheet Flashing: 50-mil- (1.3-mm-) minimum, nonstaining, uncured sheet neoprene.
   a. Adhesive: Manufacturer's recommended contact adhesive.
4. Membrane-Reinforcing Fabric: Nonwoven, needle-punched white polyester fabric, 6-oz./sq. yd. (200-g/sq. m) **OR** 5-oz./sq. yd. (169-g/sq. m) **OR** 3.2-oz./sq. yd. (109-g/sq. m) **OR** manufacturer's standard, **as directed**, weight.
5. Joint Reinforcing Strip: Manufacturer's recommended fiberglass mesh or polyester fabric.
6. Joint Sealant: Multicomponent polyurethane sealant, compatible with waterproofing, complying with ASTM C 920 Type M, Class 25; Grade NS for sloping and vertical applications or Grade P for deck applications; Use NT exposure; and as recommended by manufacturer for substrate and joint conditions.
   a. Backer Rod: Closed-cell polyethylene foam.

F. Protection Course
1. Protection Course: ASTM D 6506, semirigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners and as follows:

a. Thickness: 1/8 inch (3 mm), nominal, for vertical applications; 1/4 inch (6 mm), nominal, elsewhere.
b. Adhesive: Rubber-based solvent type recommended by waterproofing manufacturer for type of protection course.

2. Protection Course: Fan folded, with a core of extruded-polystyrene board insulation faced one or both side(s) with plastic film, nominal thickness of 1/4 inch (6 mm), with compressive strength not less than 8 psi (55 kPa) per ASTM D 1621 and maximum water absorption by volume of 0.6 percent per ASTM C 272.
3. Protection Course: Unfaced, fan-folded, rigid, extruded-polystyrene board insulation; nominal thickness of 1/4 inch (6 mm) with compressive strength of not less than 8 psi (55 kPa) per ASTM D 1621.
4. Protection Course: Fan folded, with a core of molded-polystyrene board insulation faced both sides with plastic film, nominal thickness of 1/4 inch (6 mm) **OR** 3/8 inch (9.5 mm) **OR** 1/2 inch (13 mm), **as directed**, with compressive strength not less than 12 psi (83 kPa) per ASTM D 1621 and water absorption by volume of less than 1 percent per ASTM C 272.
5. Protection Course: Unfaced, extruded-polystyrene board insulation; ASTM C 578, Type X, 1/2 inch (13 mm) thick.
6. Protection Course: Molded-polystyrene board insulation, ASTM C 578, Type I, 0.90-lb/cu. ft. (15-kg/cu. m) minimum density, 1-inch (25-mm) minimum thickness.

G. Molded-Sheet Drainage Panels
1. Molded-Sheet Drainage Panel: Comply with Division 02 Section "Subdrainage".
2. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel: Manufactured composite subsurface drainage panels consisting of a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 (0.21-mm) sieve laminated to one side with or without a polymeric film bonded to the other side of a studded, nonbiodegradable, molded-plastic-sheet drainage core, with a vertical flow rate of 9 to 15 gpm per ft. (112 to 188 L/min. per m).
3. Woven-Geotextile-Faced, Molded-Sheet Drainage Panel: Manufactured composite subsurface drainage panels consisting of a woven-geotextile facing with an apparent opening size not exceeding No. 40 (0.43-mm) sieve, laminated to one side with or without a polymeric film bonded to the other side of a studded, nonbiodegradable, molded-plastic-sheet drainage core, with a horizontal flow rate not less than 2.8 gpm per ft. (35 L/min. per m).

H. Insulation
1. Board Insulation: Extruded-polystyrene board insulation complying with ASTM C 578, square or shiplap edged.
a. Type IV, 25-psi (173-kPa) minimum compressive strength.
b. Type VI, 40-psi (276-kPa) minimum compressive strength.
c. Type VII, 60-psi (414-kPa) minimum compressive strength.
d. Type V, 100-psi (690-kPa) minimum compressive strength.
2. Unfaced, Wall Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type IV, 25-psi (173-kPa) **OR** Type VI, 40-psi (276-kPa), **as directed**, minimum compressive strength; unfaced; fabricated with shiplap or channel edges and with one side having grooved drainage channels.
3. Geotextile-Faced, Wall Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type IV, 25-psi (173-kPa) **OR** Type VI, 40-psi (276-kPa), **as directed**, minimum compressive strength; fabricated with tongue-and-groove edges and with one side having grooved drainage channels faced with a nonwoven-geotextile filter fabric.
4. Unfaced, Plaza Deck, Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type VI, 40-psi (276-kPa) **OR** Type VII, 60-psi (414-kPa), **as directed**, minimum compressive strength; unfaced; fabricated with shiplapped or channel edges and with one side having ribbed drainage channels.
5. Geotextile-Faced, Plaza Deck, Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type VII, 60-psi (414-kPa) minimum compressive strength; fabricated with tongue-and-groove edges and with one side having grooved drainage channels faced with manufacturer's standard, nonwoven-geotextile filter fabric.

I. Plaza Deck Pavers
1. Plaza Deck Pavers: Brick **OR** Concrete **OR** Asphalt-block, **as directed**, pavers specified in Division 02 Section "Unit Pavers".
2. Plaza Deck Pavers: Granite **OR** Limestone **OR** Marble **OR** Quartz-based stone **OR** Slate, **as directed**, pavers specified in Division 09 Section "Stone Flooring".
3. Plaza Deck Pavers: Heavyweight, hydraulically pressed, concrete units, square edged **OR** with top edges beveled 3/16 inch (5 mm), **as directed**, manufactured for use as plaza deck pavers; minimum compressive strength of 7500 psi (52 MPa) **OR** 6500 psi (45 MPa), **as directed**, ASTM C 140; absorption not greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance according to ASTM C 67.
   a. Thickness: 1-5/8 inches (41 mm) **OR** 1-3/4 inches (45 mm) **OR** 2 inches (51 mm) **OR** 2-3/8 inches (60 mm), **as directed**.
   b. Face Size: 8-7/8 inches (225 mm) square **OR** 9 inches (229 mm) square **OR** 9-by-18 inches (229-by-457 mm) **OR** 12 inches (305 mm) square **OR** 12-by-24 inches (305-by-610 mm) **OR** 18 inches (457 mm) square **OR** 24 inches (610 mm) square **OR** As indicated, **as directed**.
   c. Color: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
4. Setting Bed: Provide aggregate **OR** mortar **OR** bituminous, **as directed**, setting-bed materials specified in Division 02 Section "Unit Pavers".
5. Paver Pedestals: Paver manufacturer's standard SBR rubber, high-density polyethylene, or polyurethane paver support assembly, including fixed-height **OR** adjustable or stackable, **as directed**, pedestals, shims, and spacer tabs for joint spacing of 1/8 inch (3 mm) **OR** 3/16 inch (5 mm) **OR** 1/8 to 3/16 inch (3 to 5 mm), **as directed**.
   a. Concrete Fill: ACI 301, compressive strength of 5000 psi (34 MPa) at 28 days and air content of 6 percent.

1.3 EXECUTION

A. Surface Preparation
1. Clean and prepare substrate according to manufacturer's written recommendations. Provide clean, dust-free, and dry substrate for waterproofing application.
2. Mask off adjoining surfaces not receiving waterproofing to prevent spillage or overspray affecting other construction.
3. Close off deck drains and other deck penetrations to prevent spillage and migration of waterproofing fluids.
4. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, acid residues, and other penetrating contaminants or film-forming coatings from concrete.
   a. Abrasive blast clean concrete surfaces uniformly to expose top surface of fine aggregate according to ASTM D 4259 with a self-contained, recirculating, blast-cleaning apparatus. Remove material to provide a sound surface free of laitance, glaze, efflorescence, curing compounds, concrete hardeners, or form-release agents. Remove remaining loose material and clean surfaces according to ASTM D 4258.
5. Remove fins, ridges, and other projections and fill honeycomb, aggregate pockets, and other voids.

B. Preparation At Terminations And Penetrations
1. Prepare vertical and horizontal surfaces at terminations and penetrations through waterproofing and at expansion joints, drains, and sleeves according to ASTM C 898 **OR** ASTM C 1471, **as directed**, and manufacturer's written instructions.
2. Prime substrate unless otherwise instructed by waterproofing manufacturer.
3. Apply waterproofing in two separate applications, and embed a joint reinforcing strip in the first preparation coat when recommended by waterproofing manufacturer.

a. Provide sealant cants around penetrations and at inside corners of deck-to-wall butt joints when recommended by waterproofing manufacturer.

C. Joint And Crack Treatment
1. Prepare, treat, rout, and fill joints and cracks in substrate according to ASTM C 898 **OR** ASTM C 1471, **as directed**, and waterproofing manufacturer's written instructions. Remove dust and dirt from joints and cracks, complying with ASTM D 4258, before coating surfaces.
a. Comply with ASTM C 1193 for joint-sealant installation.
b. Apply bond breaker between sealant and preparation strip.
c. Prime substrate and apply a single thickness of preparation strip extending a minimum of 3 inches (75 mm) along each side of joint. Apply waterproofing in two separate applications and embed a joint reinforcing strip in the first preparation coat.
2. Install sheet flashing and bond to deck and wall substrates where indicated or required according to waterproofing manufacturer's written instructions.
a. Extend sheet flashings onto perpendicular surfaces and other work penetrating substrate according to ASTM C 898.

D. Waterproofing Application
1. Apply waterproofing according to ASTM C 898 **OR** ASTM C 1471, **as directed**, and manufacturer's written instructions.
2. Start installing waterproofing in presence of manufacturer's technical representative.
3. Apply primer over prepared substrate.
4. Unreinforced Waterproofing Applications: Mix materials and apply waterproofing by spray, roller, notched squeegee, trowel, or other application method suitable to slope of substrate.
a. Apply one or more coats of waterproofing to obtain a seamless membrane free of entrapped gases, with an average dry film thickness of 60 mils (1.5 mm) and a minimum dry film thickness of 50 mils (1.3 mm) at any point **OR** 120 mils (3 mm), **as directed**.
b. Apply waterproofing to prepared wall terminations and vertical surfaces.
c. Verify wet film thickness of waterproofing every 100 sq. ft. (9.3 sq. m).
5. Reinforced Waterproofing Applications: Mix materials and apply waterproofing by roller, notched squeegee, trowel, or other suitable application method.
a. Apply first coat of waterproofing, embed membrane-reinforcing fabric, and apply second coat of waterproofing to completely saturate reinforcing fabric and to obtain a seamless reinforced membrane free of entrapped gases, with an average dry film total thickness of 70 mils (1.8 mm) **OR** 80 mils (2 mm) **OR** 120 mils (3 mm)**as directed**, .
b. Apply reinforced waterproofing to prepared wall terminations and vertical surfaces.
c. Verify wet film thickness of waterproofing every 100 sq. ft. (9.3 sq. m).
6. Install protection course with butted joints over nominally cured membrane before starting subsequent construction operations.
a. Molded-sheet drainage panels **OR** Insulation drainage panels **OR** Board insulation, **as directed**, may be used in place of a separate protection course to vertical applications when approved by waterproofing manufacturer.

E. Molded-Sheet Drainage Panel Installation
1. Place and secure molded-sheet drainage panels, with geotextile facing away from wall or deck substrate, according to manufacturer's written instructions. Use adhesives or mechanical fasteners that do not penetrate waterproofing. Lap edges and ends of geotextile fabric to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.
a. For vertical applications, install board insulation **OR** protection course, **as directed**, before installing drainage panels.

F. Insulation Installation
1. Install one or more layers of board insulation to achieve required thickness **OR** insulation drainage panels, **as directed**, over waterproofed surfaces. Cut and fit to within 3/4 inch (19 mm) of projections and penetrations.

2. On vertical surfaces, set insulation units in adhesive applied according to manufacturer's written instructions. Use type of adhesive recommended in writing by insulation manufacturer.
3. On horizontal surfaces, place insulation units unadhered according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

G. Plaza Deck Paver Installation
1. Setting Bed: Install setting bed in locations and of thickness indicated to comply with requirements in Division 02 Section(s) "Unit Pavers" OR Division 09 Section(s) "Stone Flooring", **as directed**.
2. Install concrete pavers, in locations indicated, according to manufacturer's written instructions.
3. Accurately install fixed **OR** adjustable, **as directed**,-height paver pedestals in locations and to elevations required. Adjust for final level and slope with shims.
   a. Fill paver pedestal with concrete mix, strike smooth with top of pedestal, and cure according to ACI 301.
4. Loosely lay pavers on pedestals, maintaining a uniform open joint width. Tightly seat pavers against spacers to eliminate lateral movement or drift of paving assembly. Align joint patterns parallel in each direction.
   a. Lay out pavers to avoid less-than-half-width pavers at perimeter or other terminations.
5. Install pavers to not vary more than 1/16 inch (1.6 mm) in elevation between adjacent pavers or more than 1/16 inch (1.6 mm) from surface plane elevation of individual paver.
6. Maintain tolerances of paving installation within 1/4 inch in 10 feet (1:48) of surface plane in any direction.

H. Field Quality Control
1. Flood Testing: Flood test each deck area for leaks, according to recommendations in ASTM D 5957, after completing waterproofing but before overlaying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.
   a. Flood to an average depth of 2-1/2 inches (64 mm) with a minimum depth of 1 inch (25 mm) and not exceeding a depth of 4 inches (100 mm). Maintain 2 inches (50 mm) of clearance from top of sheet flashings.
   b. Flood each area for 24 **OR** 48 **OR** 72, **as directed**, hours.
   c. After flood testing, repair leaks, repeat flood tests, and make further repairs until waterproofing installation is watertight.
2. Engage an independent testing agency to observe flood testing and examine underside of decks and terminations for evidence of leaks during flood testing.

I. Curing, Protection, And Cleaning
1. Cure waterproofing according to manufacturer's written recommendations, taking care to prevent contamination and damage during application stages and curing.
   a. Do not permit foot or vehicular traffic on unprotected membrane.
2. Protect waterproofing from damage and wear during remainder of construction period.
3. Protect installed board insulation **OR** insulation drainage panels, **as directed**, from damage due to ultraviolet light, harmful weather exposures, physical abuse, and other causes. Immediately after installation, provide temporary coverings where insulation will be subject to abuse and cannot be concealed and protected by permanent construction.
4. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07110a

SECTION 07110b - HOT FLUID-APPLIED RUBBERIZED ASPHALT WATERPROOFING

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for hot fluid-applied rubberized asphalt waterproofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Rubberized-asphalt waterproofing membrane, unreinforced and reinforced.
   b. Molded-sheet drainage panels.
   c. Insulation.
   d. Plaza deck pavers.

C. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins to adjoining waterproofing, and other termination conditions.
   a. Include setting drawings showing layout, sizes, sections, profiles, and joint details of pedestal-supported concrete pavers.
3. Product test reports.
4. Sample warranties

D. Quality Assurance
1. Installer Qualifications: A firm that is approved or licensed by **OR** acceptable to, **as directed**, manufacturer for installation of waterproofing required for this Project and is eligible to receive special warranties specified.
2. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
1. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by waterproofing manufacturer.
2. Remove and replace liquid materials that cannot be applied within their stated shelf life.
3. Protect stored materials from direct sunlight.

F. Project Conditions
1. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate, or when temperature is below 0 deg F (minus 18 deg C).
   a. Do not apply waterproofing in snow, rain, fog, or mist.
2. Maintain adequate ventilation during application and curing of waterproofing materials.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace waterproofing and sheet flashings that do not comply with requirements or that fail to remain watertight within five **OR** 10, **as directed**, years from date of Substantial Completion.

1.2 PRODUCTS

A. Waterproofing Membrane
1. Hot Fluid-Applied, Rubberized-Asphalt Waterproofing Membrane: Single component; 100 percent solids; hot fluid-applied, rubberized asphalt.

B. Flashing Sheet Materials
1. Elastomeric Flashing Sheet: 50-mil- (1.3-mm-) minimum, uncured sheet neoprene as follows:
a. Tensile Strength: 1400 psi (9.6 MPa) minimum; ASTM D 412, Die C.
b. Elongation: 300 percent minimum; ASTM D 412.
c. Tear Resistance: 125 psi (860 kPa) minimum; ASTM D 624, Die C.
d. Brittleness: Does not break at minus 30 deg F (34 deg C); ASTM D 2137.

C. Auxiliary Materials
1. Primer: ASTM D 41, asphaltic primer.
2. Elastomeric Sheet: 50-mil- (1.3-mm-) minimum, uncured sheet neoprene as follows:
a. Tensile Strength: 1400 psi (9.6 MPa) minimum; ASTM D 412, Die C.
b. Elongation: 300 percent minimum; ASTM D 412.
c. Tear Resistance: 125 psi (860 kPa) minimum; ASTM D 624, Die C.
d. Brittleness: Does not break at minus 30 deg F (34 deg C); ASTM D 2137.
3. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum termination bars; approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.
4. Sealants and Accessories: Manufacturer's recommended sealants and accessories.
5. Reinforcing Fabric: Manufacturer's recommended, spun-bonded polyester fabric.
6. Protection Course: ASTM D 6506, semirigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners and nominal thickness of 1/8 inch (3 mm) **OR** 1/4 inch (6 mm), **as directed**.
7. Protection Course: Manufacturer's standard, 80- to 90-mil- (2.0- to 2.3-mm-) thick, fiberglass-reinforced rubberized asphalt or modified bituminous sheet.

D. Molded-Sheet Drainage Panels
1. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel: Manufactured composite subsurface drainage panels consisting of a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 (0.21-mm) sieve, laminated to one side with **OR** without, **as directed**, a polymeric film bonded to the other side of a studded, nonbiodegradable, molded-plastic-sheet drainage core, with a vertical flow rate of 9 to 15 gpm/ft. (112 to 188 L/min. per m).
2. Woven-Geotextile-Faced, Molded-Sheet Drainage Panel: Manufactured composite subsurface drainage panels consisting of a woven-geotextile facing with an apparent opening size not exceeding No. 40 (0.43-mm) sieve, laminated to one side with **OR** without, **as directed**, a polymeric film bonded to the other side of a studded, nonbiodegradable, molded-plastic-sheet drainage core, with a horizontal flow rate not less than 2.8 gpm/ft. (35 L/min. per m).

E. Insulation
1. Board Insulation: Extruded-polystyrene board insulation complying with ASTM C 578, square **OR** shiplap, **as directed**, edged.
a. Type IV, 25-psi (173-kPa) minimum compressive strength.
b. Type VI, 40-psi (276-kPa) minimum compressive strength.
c. Type VII, 60-psi (414-kPa) minimum compressive strength.
d. Type V, 100-psi (690-kPa) minimum compressive strength.
2. Unfaced Wall Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type IV, 25-psi (173-kPa) **OR** Type VI, 40-psi (276-kPa), **as directed**, minimum compressive strength; unfaced; fabricated with shiplap or channel edges and with one side having grooved drainage channels.

3. Geotextile-Faced Wall Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type IV, 25-psi (173-kPa) **OR** Type VI, 40-psi (276-kPa), **as directed**, minimum compressive strength; fabricated with tongue-and-groove edges and with one side having grooved drainage channels faced with a nonwoven, geotextile filter fabric.
4. Unfaced Plaza Deck Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type VI, 40-psi (276-kPa) **OR** Type VII, 60-psi (414-kPa), **as directed**, minimum compressive strength; unfaced; fabricated with shiplapped or channel edges and with one side having ribbed drainage channels.
5. Geotextile-Faced Plaza Deck Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type VII, 60-psi (414-kPa) minimum compressive strength; fabricated with tongue-and-groove edges and with one side having grooved drainage channels faced with a nonwoven, geotextile filter fabric.

F. Plaza Deck Pavers
1. Plaza Deck Pavers:
   a. Brick **OR** Concrete **OR** Asphalt-block, **as directed**, pavers specified in Division 02 Section "Unit Pavers".
      OR
      Granite **OR** Limestone **OR** Marble **OR** Quartz-based stone **OR** Slate, **as directed**, pavers specified in Division 09 Section "Stone Flooring".
      OR
      Heavyweight, hydraulically pressed, concrete units, square edged **OR** with top edges beveled 3/16 inch (5 mm), **as directed**, manufactured for use as plaza deck pavers; minimum compressive strength 7500 psi (52 MPa) **OR** 6500 psi (45 MPa), **as directed**, ASTM C 140; absorption not greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance according to ASTM C 67.
      1) Thickness: 1-5/8 inches (41 mm) **OR** 1-3/4 inches (45 mm) **OR** 2 inches (51 mm) **OR** 2-3/8 inches (60 mm), **as directed**.
      2) Face Size: 8-7/8 inches (225 mm) square **OR** 9 inches (229 mm) square **OR** 9 by 18 inches (229 by 457 mm) **OR** 12 inches (305 mm) square **OR** 12 by 24 inches (305 by 610 mm) **OR** 18 inches (457 mm) square **OR** 24 inches (610 mm) square, **as directed**.
      3) Color: As selected from manufacturer's full range.
2. Setting Bed: Provide aggregate **OR** mortar **OR** bituminous, **as directed**, setting-bed materials specified in Division 02 Section "Unit Pavers".
3. Paver Supports: Paver manufacturer's standard SBR rubber, high-density polyethylene, or polyurethane paver support assembly, including fixed-height **OR** adjustable or stackable, **as directed**, pedestals, shims, and spacer tabs for joint spacing of 1/8 inch (3 mm) **OR** 3/16 inch (5 mm), **as directed**.
   a. Concrete Fill: ACI 301, compressive strength of 5000 psi (34 MPa) at 28 days, and air content of 6 percent.

1.3 EXECUTION

A. Preparation
1. Clean and prepare substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for waterproofing application.
2. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.
3. Close off deck drains and other deck penetrations to prevent spillage and migration of waterproofing fluids.
4. Remove grease, oil, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

a. Abrasive blast clean concrete surfaces uniformly to expose top surface of fine aggregate according to ASTM D 4259 with a self-contained, recirculating, blast-cleaning apparatus. Remove material to provide a sound surface free of laitance, glaze, efflorescence, curing compounds, concrete hardeners, or form-release agents. Remove remaining loose material and clean surfaces according to ASTM D 4258.

5. Remove fins, ridges, and other projections and fill honeycomb, aggregate pockets, and other voids.

B. Joints, Cracks, And Terminations

1. Prepare and treat substrates to receive waterproofing membrane, including joints and cracks, deck drains, corners, and penetrations according to manufacturer's written instructions.
   a. Rout and fill joints and cracks in substrate. Before filling, remove dust and dirt according to ASTM D 4258.
   b. Adhere strip of elastomeric sheet to substrate in a layer of hot rubberized asphalt. Extend elastomeric sheet a minimum of 6 inches (150 mm) on each side of moving joints and cracks or joints and cracks exceeding 1/8 inch (3 mm) thick, and beyond deck drains and penetrations. Apply second layer of hot fluid-applied, rubberized asphalt over elastomeric sheet.
   c. Embed strip of reinforcing fabric into a layer of hot rubberized asphalt. Extend reinforcing fabric a minimum of 6 inches (150 mm) on each side of nonmoving joints and cracks not exceeding 1/8 inch (3 mm) thick, and beyond roof drains and penetrations.
      1) Apply second layer of hot fluid-applied, rubberized asphalt over reinforcing fabric.
2. At expansion joints and discontinuous deck-to-wall or deck-to-deck joints, bridge joints with elastomeric sheet extended a minimum of 6 inches (150 mm) on each side of joints and adhere to substrates in a layer of hot rubberized asphalt. Apply second layer of hot fluid-applied, rubberized asphalt over elastomeric sheet.

C. Flashing Installation

1. Install elastomeric flashing sheets at terminations of waterproofing membrane according to manufacturer's written instructions.
2. Prime substrate with asphalt primer.
3. Install elastomeric flashing sheet and adhere to deck and wall substrates in a layer of hot rubberized asphalt.
4. Extend elastomeric flashing sheet up walls or parapets a minimum of 8 inches (200 mm) above plaza deck pavers and 6 inches (150 mm) onto deck to be waterproofed.
5. Install termination bars and mechanically fasten to top of elastomeric flashing sheet at terminations and perimeter of roofing.

D. Membrane Application

1. Apply primer, at manufacturer's recommended rate, over prepared substrate and allow to dry.
2. Heat and apply rubberized asphalt according to manufacturer's written instructions.
   a. Heat rubberized asphalt in an oil- or air-jacketed melter with mechanical agitator specifically designed for heating rubberized asphalt.
3. Start application with manufacturer's authorized representative present.
4. Unreinforced Membrane: Apply hot rubberized asphalt to substrates and adjoining surfaces indicated. Spread to form a uniform, unreinforced, seamless membrane, 180-mil (4.5-mm) minimum thickness **OR** 180-mil (4.5-mm) average thickness, but not less than 125 mil (3.2 mm) thick, **as directed**.
5. Reinforced Membrane: Apply hot rubberized asphalt to substrates and adjoining surfaces indicated. Spread to a thickness of 90 mils (2.3 mm); embed reinforcing fabric, overlapping sheets 2 inches (50 mm); spread another 125-mil- (3.2-mm-) thick layer to provide a uniform, reinforced, seamless membrane 215 mils (5.5 mm) thick.
6. Apply waterproofing over prepared joints and up wall terminations and vertical surfaces to heights indicated or required by manufacturer.

7. Cover waterproofing with protection course with overlapped joints before membrane is subject to backfilling **OR** construction or vehicular traffic, **as directed**.

E. Molded-Sheet Drainage Panel Installation
1. Place and secure molded-sheet drainage panels, with geotextile facing away from wall or deck substrate according to manufacturer's written instructions. Use methods that do not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.
   a. For vertical applications, install board insulation **OR** protection course, **as directed**, before installing drainage panels.

F. Insulation Installation
1. Install one or more layers of board insulation to achieve required thickness and insulation drainage panels over waterproofed surfaces. Cut and fit to within 3/4 inch (19 mm) of projections and penetrations.
2. On vertical surfaces, set insulation units into rubberized asphalt according to manufacturer's written instructions.
3. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

G. Plaza Deck Paver Installation
1. Setting Bed: Install setting bed in locations and of thickness indicated to comply with requirements in Division 02 Section(s) "Unit Pavers" OR Division 09 Section(s) "Stone Flooring", **as directed**.
2. Install concrete pavers in locations indicated according to manufacturer's written instructions.
3. Accurately install fixed-height **OR** adjustable-height, **as directed**, paver pedestals and accessories in locations and to elevations required. Adjust for final level and slope with shims.
   a. Fill paver pedestal with concrete mix, strike smooth with top of pedestal, and cure according to ACI 301.
4. Loosely lay pavers on pedestals, maintaining a uniform open joint width. Tightly seat pavers against spacers to eliminate lateral movement or drift of paving assembly. Align joint patterns parallel in each direction.
   a. Lay out pavers to avoid less-than-half-width pavers at perimeter or other terminations.
5. Install pavers to not vary more than 1/16 inch (1.6 mm) in elevation between adjacent pavers or more than 1/16 inch (1.6 mm) from surface plane elevation of individual paver.
6. Maintain tolerances of paving installation within 1/4 inch in 10 feet (1:48) of surface plane in any direction.

H. Cleaning And Protection
1. Protect waterproofing from damage and wear during remainder of construction period.
2. Protect installed board insulation **OR** insulation drainage panels, **as directed**, from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation will be subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.
3. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07110b

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Task	Specification	Specification Description
07110	01352	No Specification Required

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SECTION 07130 - BITUMINOUS WATERPROOFING

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for bituminous waterproofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated. Include recommendations for method of application, primer, number of coats, coverage or thickness, and protection course.

C. Delivery, Storage And Handling
1. Waterproofing materials shall be delivered to the project site in the original sealed containers bearing the name of the manufacturer, contents and brand name. Asphalt shall be protected from freezing in a weathertight enclosure. Reinforcement fabrics shall be protected from moisture damage and moisture absorption in a weathertight enclosure or shall be stored off the ground on pallets, and covered on top and all sides with breathable-type canvas tarpaulins. Plastic sheets cause condensation buildup and therefore shall not be used to cover waterproofing materials. Damaged or deteriorated materials shall be removed from project site.

D. Project Conditions
1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit waterproofing to be performed according to manufacturers' written instructions.
2. Ventilation: Provide adequate ventilation during application of waterproofing in enclosed spaces. Maintain ventilation until waterproofing has cured.

1.2 PRODUCTS

A. Asphalt Waterproofing
1. Primer: Primer for hot-applied asphalt waterproofing shall conform to ASTM D41, asbestos-free, non-fibrated, manufactured with highly ductile soft asphalts and selected hydrocarbons.
2. Above-Grade Hot-Applied Asphalt: For above-grade applications where asphalt will not be exposed to temperatures exceeding 122 degrees F (50 degrees C), hot-applied asphalt for membrane waterproofing system shall conform to ASTM D449, Type II. For above-grade applications where asphalt will be exposed to sunlight and temperatures exceeding 122 degrees F (50 degrees C), hot-applied asphalt shall conform to ASTM D449, Type III.
3. Below-Grade Hot-Applied Asphalt: Hot-applied asphalt for below-grade applications shall conform to ASTM D449, Type I, asbestos-free, manufactured from crude petroleum, suitable for use with membrane waterproofing systems.
4. Reinforcement Fabrics
a. Cotton Fabrics: Cotton fabrics shall be woven entirely of cotton conforming with ASTM D173, thoroughly and uniformly saturated with asphalt.
b. Woven Burlap Fabrics: Woven burlap fabrics shall be composed of 100 percent jute fiber and two cotton threads at each selvage conforming with ASTM D1327, thoroughly and uniformly saturated with asphalt. The fabric mesh shall not be completely closed or sealed by the process of saturation. Sufficient porosity shall be maintained to allow successive moppings of the plying asphalt to seep through. The surface shall not be coated or covered with talc or any other substances that will interfere with the adhesion between fabric and plying asphalt. The fabric surface shall be uniformly smooth and free of

irregularities, folds and knots. The finished woven burlap fabrics shall be free of ragged edges, untrue edges, breaks or cracks, and other visible external defects.

c. Glass Fabrics: Glass fabrics shall conform to ASTM D1668 Type I, asphalt-treated woven glass waterproofing fabrics coated with asphalt.

d. Flashing Cement: Flashing cement shall conform to ASTM D4586, Type I, trowel grade, asbestos free, manufactured from asphalts characterized as adhesive, healing and ductile.

B. Insulation Boards

1. Insulation boards shall conform to ASTM C208 cellulosic fiber boards, construction grade, 1/2 inch (13 mm) thick, fibrous-felted homogeneous panel. Insulation boards shall be manufactured from ligno-cellulosic fibers (wood or cane) by a felting or molding process, asphalt-saturated or coated, with a density of 10 to 31 psf (49 to 151 kg/square meter). Surfaces of insulation boards shall be free of cracks, lumps, excessive departure from planeness, or other defects that adversely affect performance.

1.3 EXECUTION

A. Surface Preparation

1. Surfaces scheduled for bituminous waterproofing shall be prepared in accordance with waterproofing manufacturer's recommendations. Surface preparation shall be approved prior to waterproofing application.
2. Protection of Surrounding Areas: Before starting the waterproofing work, the surrounding areas and surfaces shall be protected from spillage and migration of asphalt onto other work. Drains and conductors shall be protected from clogging with asphalt.
3. Masonry Surfaces: Surfaces shall be free of oil, grease, dirt, laitance, loose material, frost, debris and other contaminants. Mortar joints shall be flush and free of extraneous mortar and chipped or broken masonry.
4. Concrete Surfaces: Surfaces shall be properly cured, free of form release agents, oil, grease, dirt, laitance, loose material, frost, debris and other contaminants. Form ties shall be cut flush with surface. Sharp protrusions and form match lines shall be removed. Holes, voids, spalled areas and cracks which can damage waterproofing materials shall be repaired. Rough surfaces shall be parged with a well-adhering coat of cement mortar.
5. Metal Surfaces: Surfaces shall be dry and be free of rust, scale, loose paint, oil, grease, dirt, frost and debris.

B. Hot-Applied Asphalt Waterproofing

1. Asphalt waterproofing shall be applied when the ambient temperature is 40 degrees F (4 degrees C) or above. Heating kettles and tanks shall be provided with automatic thermostatic control capable of maintaining asphalt temperature. Controls shall be calibrated and maintained in working order for duration of work. At time of application, asphalt shall not be heated above the equiviscous temperature (EVT) recommended by manufacturer. Immediately before use, temperature shall be measured with a portable thermometer at the point of application. EVT and flashpoint temperatures of asphalt in kettle shall be conspicuously posted on kettle. Asphalt with a temperature not conforming to the manufacturer's recommendations shall be returned to the kettle. Asphalt overheated by more than 50 degrees F (10 degrees C) for more than 1 hour shall be removed from site.
2. Below-Grade Wall Waterproofing: Waterproofing for foundation walls shall consist of a 1-ply **OR** 2-ply **OR** 3-ply **OR** 4-ply **OR** 5-ply, **as directed**, hot-applied asphalt membrane system. Fabrics shall be installed using the "shingle" method. Joints shall be caulked prior to primer applications. Primer shall be applied at a rate of 1/2 gallon per 100 square feet (0.2 L/square meter). Fabrics shall be overlapped at ends and staggered a minimum 10 inch (250 mm) for 1-ply **OR** 19 inch (480 mm) for 2-ply **OR** 24 inch (610 mm) for 3-ply **OR** 27 inch (685 mm) for 4-ply **OR** 30 inch (750 mm) for 5-ply, **as directed**, system. End-to-end taping is not acceptable. Each fabric shall be firmly embedded into a solid uniform coating of hot asphalt at a rate of 20 pounds per 100 square

feet (0.98 kg/square meter) by pressing with broom. Fabrics shall not touch fabrics. Hot asphalt shall penetrate each fabric to provide the required adhesion. Asphalt between fabrics shall not be excessive to prevent slippage. Waterproofing system consisting of two or more fabrics shall be provided with fabric reinforcement at corners, angles, over construction joints, and in locations where waterproofing fabrics are subject to unusual stress.

3. Floor Waterproofing: Primer shall be applied at a rate of 1/2 gallon per 100 square feet (0.2 L/square meter). Primer shall not be left in puddles. Primer shall be dry to the touch before application of asphalt. Where slab abuts walls, first reinforcing fabric shall extend 6 inches (150 mm) minimum on slab and 8 inches (200 mm) on wall. At vertical corners, first fabric shall extend minimum 5 inches (125 mm) from corner on each side. Second fabric shall lap the first fabric 2 inches (50 mm) minimum. At floor drains, and elsewhere as indicated, the fabric shall extend into a clamping device, set in a heavy coating of flashing cement, and securely clamped.

C. Flood Testing

1. Prior to concealment, waterproofed floors over occupied spaces shall be tested for watertightness. Drains shall be plugged and floors shall be submerged with 3 inches (75 mm) of clean water. Water shall be permitted to stand for a minimum of 24 hours. If leaks occur, water shall be drained and repairs made. Upon completion of repairs, floors shall be flooded with 3 inches (75 mm) of clean water and flood testing shall be repeated for minimum of 24 hours from the time each leak is repaired. Waterproofing system shall be completely watertight, and shall be approved in writing before covering up with other materials. Additional coats of asphalt are not an acceptable method for repairing leaks.

D. Clean-Up

1. Surfaces of other work which are stained with waterproofing materials shall be cleaned with a cleaner recommended by waterproofing manufacturer.

E. Protection Of Completed Work

1. Floor Waterproofing: The completed waterproofing work shall be protected from damage during and after construction. Protective covering shall be placed immediately before proceeding with the work which will conceal the waterproofing.
2. Wall Waterproofing: Waterproofing against which backfill is to be placed shall be protected with a single layer of insulation board. Insulation boards shall be pressed into the final mopping while the asphalt is still hot, with edges of boards placed into moderate contact and joints staggered. For two-layer installation, joints in second layer shall be staggered over joints in first layer. Where surfaced insulation board is used, the surfaced side shall face outward. Boards shall be carefully and neatly fitted around projections, and shall cover the entire surface of the waterproofing materials. Waterproofing system not covered with protection board shall be protected to prevent damage from subsequent building operations. Installed boards shall not remain exposed at the end of a work day.

END OF SECTION 07130

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SECTION 07130a - SELF-ADHERING SHEET WATERPROOFING

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for self-adhering sheet waterproofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
   a. Modified bituminous sheet waterproofing.
   b. Modified bituminous sheet waterproofing, fabric reinforced.
   c. Modified bituminous deck paving sheet waterproofing.
   d. Modified bituminous composite panel waterproofing.
   e. Adhesive-coated HDPE sheet waterproofing.
   f. Molded-sheet drainage panels.
   g. Insulation.
   h. Plaza deck pavers and paver pedestals.

C. Submittals
1. Product Data: Include manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, and tested physical and performance properties of waterproofing.
2. Shop Drawings: Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.
3. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for waterproofing.
4. Special warranties.

D. Quality Assurance
1. Installer Qualifications: A firm that is approved or licensed by **OR** acceptable to, **as directed**, waterproofing manufacturer for installation of waterproofing required for this Project.
2. Preinstallation Conference: Conduct conference at Project site.
   a. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs.

E. Delivery, Storage, And Handling
1. Deliver liquid materials to Project site in original packages with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing and mixing with other components.
2. Store liquid materials in their original undamaged packages in a clean, dry, protected location and within temperature range required by waterproofing manufacturer.
3. Remove and replace liquid materials that cannot be applied within their stated shelf life.
4. Store rolls according to manufacturer's written instructions.
5. Protect stored materials from direct sunlight.

F. Project Conditions
1. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate.

G. Warranty
1. Special Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to replace waterproofing material that does not comply with requirements or that fails to remain watertight within specified warranty period.
a. Warranty Period: Three **OR** Five, **as directed**, years from date of Substantial Completion.

1.2 PRODUCTS

A. Modified Bituminous Sheet Waterproofing
1. Modified Bituminous Sheet: Not less than 60-mil- (1.5-mm-) thick, self-adhering sheet consisting of 56 mils (1.4 mm) of rubberized asphalt laminated to a 4-mil- (0.10-mm-) thick, polyethylene film with release liner on adhesive side and formulated for application with primer or surface conditioner that complies with VOC limits of authorities having jurisdiction.
a. Physical Properties:
1) Tensile Strength: 250 psi (1.7 MPa) minimum; ASTM D 412, Die C, modified.
2) Ultimate Elongation: 300 percent minimum; ASTM D 412, Die C, modified.
3) Low-Temperature Flexibility: Pass at minus 20 deg F (minus 29 deg C); ASTM D 1970.
4) Crack Cycling: Unaffected after 100 cycles of 1/8-inch (3-mm) movement; ASTM C 836.
5) Puncture Resistance: 40 lbf (180 N) minimum; ASTM E 154.
6) Hydrostatic-Head Resistance: 150 feet (45 m) minimum; ASTM D 5385.
7) Water Absorption: 0.15 percent weight-gain maximum after 48-hour immersion at 70 deg F (21 deg C); ASTM D 570.
8) Vapor Permeance: 0.05 perms (2.9 ng/Pa x s x sq. m); ASTM E 96, Water Method.
2. Modified Bituminous Sheet, Fabric Reinforced: 60-mil- (1.5-mm-) thick, self-adhering sheet consisting of rubberized-asphalt membrane embedded in spun-bonded polyester or fiberglass nonwoven fabric reinforcement laminated to a 0.50-mil- (0.01-mm-) thick polyester film with release liner on adhesive side.
a. Physical Properties:
1) Pliability: No cracks when bent 180 degrees over a 1-inch (25-mm) mandrel at minus 25 deg F (minus 32 deg C); ASTM D 146.
2) Hydrostatic-Head Resistance: 150 feet (45 m) minimum.
3) Vapor Permeance: 0.05 perms (2.9 ng/Pa x s x sq. m); ASTM E 96, Water Method.

B. Modified Bituminous Deck Paving Sheet Waterproofing
1. Modified Bituminous Deck Paving Sheet: Provide one of the products described below, **as directed**:
a. 65-mil- (1.6-mm-) thick, self-adhering sheets consisting of 53 to 56 mils (1.3 to 1.4 mm) of rubberized asphalt laminated to a heat-resisting, 9- to 12-mil- (0.2- to 0.3-mm-) thick, woven polypropylene geotextile reinforcement with release liner on adhesive side.
b. 70-mil- (1.8-mm-) thick, self-adhering sheets consisting of rubberized asphalt embedded in inert fabric reinforcement laminated to a reflective geotextile protective topping with release liner on adhesive side.
c. 60-mil- (1.5-mm-) thick, self-adhering sheets consisting of rubberized asphalt embedded in nonwoven **OR** woven, **as directed**, fiberglass fabric reinforcement laminated to a 0.50-mil- (0.01-mm-) thick polyester mat with release liner on adhesive side.
d. Physical Properties:
1) Tensile Strength, Membrane: 50 lbf/in (8.75 kN/m) minimum; ASTM D 882.
2) Pliability: Unaffected when bent 180 degrees over a 1/4-inch (6.4-mm) mandrel at minus 15 deg F (minus 26 deg C); ASTM D 146.
3) Puncture Resistance, Mesh: 200 lbf (890 N) minimum; ASTM E 154.

C. Modified Bituminous Composite Panel Waterproofing

1. Modified Bituminous Composite Panel: 90-mil- (2.2-mm-) thick, multilaminated panel consisting of a protection course bonded to an asphalt saturated carrier sheet bonded to a rubberized asphalt waterproofing self-adhering membrane with release liner.

D. Adhesive-Coated HDPE Sheet Waterproofing
1. Adhesive-Coated HDPE Sheet for Vertical Applications: 32-mil- (0.8-mm-) thick, uniform, flexible sheets consisting of 16-mil- (0.4-mm-) thick, HDPE sheet coated with a pressure-sensitive rubber adhesive, a protective adhesive coating, and a release liner with the following physical properties:
   a. Tensile Strength, Film: 4000 psi (27.6 MPa) minimum; ASTM D 412.
   b. Low-Temperature Flexibility: Pass at minus 10 deg F (minus 23 deg C); ASTM D 1970.
   c. Peel Adhesion to Concrete: 5 lbf/in. (875 N/m); ASTM D 903, modified.
   d. Lap Adhesion: 2.5 lbf/in. (440 N/m); ASTM D 1876, modified.
   e. Hydrostatic-Head Resistance: 231 feet (70 m); ASTM D 5385, modified.
   f. Vapor Permeance: 0.01 perms (0.6 ng/Pa x s x sq. m); ASTM E 96, Water Method.
   g. Water Absorption: 0.5 percent; ASTM D 570.
2. Adhesive-Coated HDPE Sheet for Horizontal Applications: 46-mil- (1.2-mm-) thick, uniform, flexible sheets consisting of 30-mil- (0.76-mm-) thick, HDPE sheet coated with a pressure-sensitive rubber adhesive, a protective adhesive coating, a detackifying surface treatment, an uncoated self-adhering side lap strip, and a release liner with the following physical properties:
   a. Tensile Strength, Film: 4000 psi (27.6 MPa) minimum; ASTM D 412.
   b. Low-Temperature Flexibility: Pass at minus 10 deg F (minus 23 deg C); ASTM D 1970.
   c. Peel Adhesion to Concrete: 5 lbf/in. (875 N/m); ASTM D 903, modified.
   d. Lap Adhesion: 2.5 lbf/in. (440 N/m); ASTM D 1876, modified.
   e. Hydrostatic-Head Resistance: 231 feet (70 m); ASTM D 5385, modified.
   f. Vapor Permeance: 0.01 perms (0.6 ng/Pa x s x sq. m); ASTM E 96, Water Method.
   g. Water Absorption: 0.5 percent; ASTM D 570.

E. Auxiliary Materials
1. General: Furnish auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing.
   a. Furnish liquid-type auxiliary materials that comply with VOC limits of authorities having jurisdiction.
2. Primer: Liquid waterborne **OR** solvent-borne, **as directed**, primer recommended for substrate by manufacturer of sheet waterproofing material.
3. Surface Conditioner: Liquid, waterborne surface conditioner recommended for substrate by manufacturer of sheet waterproofing material.
4. Liquid Membrane: Elastomeric, two-component liquid, cold fluid applied, trowel grade or low viscosity.
5. Substrate Patching Membrane: Low-viscosity, two-component, asphalt-modified coating.
6. Sheet Strips: Self-adhering, rubberized-asphalt sheet strips of same material and thickness as sheet waterproofing.
7. Mastic, Adhesives, and Tape: Liquid mastic and adhesives, and adhesive tapes recommended by waterproofing manufacturer.
   a. Detail Tape: Two-sided, pressure-sensitive, self-adhering reinforced tape, 4-1/2 inches (114 mm) wide, with a tack-free protective adhesive coating on one side and release film on self-adhering side.
   b. Detail Strips: 62.5-mil- (1.58-mm-) thick, felt-reinforced self-adhesive strip, 9 inches (229 mm) wide, with release film on adhesive side.
8. Metal Termination Bars: Aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick, predrilled at 9-inch (229-mm) centers.
9. Protection Course: ASTM D 6506, semirigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners and as follows:
   a. Thickness: 1/8 inch (3 mm), nominal, for vertical applications; 1/4 inch (6 mm), nominal, elsewhere.
   b. Adhesive: Rubber-based solvent type recommended by waterproofing manufacturer for type of protection course.

10. Protection Course: Fan folded, with a core of extruded-polystyrene board insulation faced one side or both sides with plastic film, nominal thickness 1/4 inch (6 mm), with compressive strength of not less than 8 psi (55 kPa) per ASTM D 1621, and maximum water absorption by volume of 0.6 percent per ASTM C 272.
11. Protection Course: Unfaced, fan-folded, extruded-polystyrene board insulation, nominal thickness 1/4 inch (6 mm) with compressive strength of not less than 8 psi (55 kPa) per ASTM D 1621.
12. Protection Course: Extruded-polystyrene board insulation, unfaced, ASTM C 578, Type X, 1/2 inch (13 mm) thick.
13. Protection Course: Molded-polystyrene board insulation, ASTM C 578, Type I, 0.90-lb/cu. ft. (15-kg/cu. m) minimum density, 1-inch (25-mm) minimum thickness.

F. Molded-Sheet Drainage Panels
1. Molded-Sheet Drainage Panel: Comply with Division 02 Section "Subdrainage".
2. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel: Manufactured composite subsurface drainage panels consisting of a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 (0.21-mm) sieve laminated to one side with or without a polymeric film bonded to the other side of a studded, nonbiodegradable, molded-plastic-sheet drainage core, with a vertical flow rate of 9 to 15 gpm per ft. (112 to 188 L/min. per m).
3. Woven-Geotextile-Faced, Molded-Sheet Drainage Panel: Manufactured composite subsurface drainage panels consisting of a woven-geotextile facing with an apparent opening size not exceeding No. 40 (0.425-mm) sieve laminated to one side with or without a polymeric film bonded to the other side of a studded, nonbiodegradable, molded-plastic-sheet drainage core, with a horizontal flow rate not less than 2.8 gpm per ft. (35 L/min. per m).

G. Insulation
1. Board Insulation: Extruded-polystyrene board insulation complying with ASTM C 578, square or shiplap edged.
   a. Type IV, 25-psi (173-kPa) minimum compressive strength.
   b. Type VI, 40-psi (276-kPa) minimum compressive strength.
   c. Type VII, 60-psi (414-kPa) minimum compressive strength.
   d. Type V, 100-psi (690-kPa) minimum compressive strength.
2. Unfaced Wall Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type IV, 25-psi (173-kPa) or Type VI, 40-psi (276-kPa) minimum compressive strength; unfaced; fabricated with shiplap or channel edges and with 1 side having grooved drainage channels.
3. Geotextile-Faced Wall Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type IV, 25-psi (173-kPa) or Type VI, 40-psi (276-kPa) minimum compressive strength; fabricated with tongue-and-groove edges and with 1 side having grooved drainage channels faced with nonwoven geotextile filter fabric.
4. Unfaced Plaza Deck Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type VI, 40-psi (276-kPa) **OR** Type VII, 60-psi (414-kPa), **as directed**, minimum compressive strength; unfaced; fabricated with shiplapped or channel edges and with 1 side having ribbed drainage channels.
5. Geotextile-Faced Plaza Deck Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type VII, 60-psi (414-kPa) minimum compressive strength; fabricated with tongue-and-groove edges and with 1 side having grooved drainage channels faced with manufacturer's standard, nonwoven geotextile filter fabric.

H. Plaza Deck Pavers
1. Plaza Deck Pavers: Brick **OR** Concrete **OR** Asphalt-Block, **as directed**, pavers specified in Division 02 Section "Unit Pavers".
2. Plaza Deck Pavers: Granite **OR** Limestone **OR** Marble **OR** Quartz-Based Stone **OR** Slate, **as directed**, pavers specified in Division 09 Section "Stone Flooring".

3. Plaza Deck Pavers: Heavyweight, hydraulically pressed, concrete units, square edged **OR** with top edges beveled 3/16 inch (5 mm), **as directed**, manufactured for use as plaza deck pavers; minimum compressive strength 7500 psi (52 mpa) **or** 6500 psi (45 mpa), **as directed**, ASTM C 140; absorption not greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance according to ASTM C 67.
   a. Thickness: 1-5/8 inches (41 mm) **OR** 1-3/4 inches (45 mm) **OR** 2 inches (51 mm) **OR** 2-3/8 inches (60 mm), **as directed**.
   b. Face Size: 8-7/8 inches (225 mm) square **OR** 9 inches (229 mm) square **OR** 9 by 18 inches (229 by 457 mm) **OR** 12 inches (305 mm) square **OR** 12 by 24 inches (305 by 610 mm) **OR** 18 inches (457 mm) square **OR** 24 inches (610 mm) square **OR** As indicated, **as directed**.
   c. Color: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
4. Setting Bed: Provide aggregate **OR** mortar **OR** bituminous, **as directed**, setting-bed materials specified in Division 02 Section "Unit Pavers".
5. Paver Pedestals: Paver manufacturer's standard SBR rubber, HDPE, or polyurethane paver support assembly, including fixed-height **OR** adjustable or stackable, **as directed**, pedestals, shims, and spacer tabs for joint spacing of 1/8 inch (3 mm) **OR** 3/16 inch (5 mm) **OR** 1/8 to 3/16 inch (3 to 5 mm), **as directed**.
   a. Concrete Fill: ACI 301, compressive strength of 5000 psi (34 MPa) at 28 days and air content of 6 percent.

1.3 EXECUTION

A. Surface Preparation
1. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.
2. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.
3. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
4. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids.
5. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks according to ASTM D 4258.
   a. Install sheet strips and center over treated construction and contraction joints and cracks exceeding a width of 1/16 inch (1.6 mm) or 1/8 inch (3 mm) for modified bituminous deck paving waterproofing.
6. Bridge and cover isolation joints, expansion joints, and discontinuous deck-to-wall and deck-to-deck joints with overlapping sheet strips.
   a. Invert and loosely lay first sheet strip over center of joint. Firmly adhere second sheet strip to first and overlap to substrate.
7. Corners: Prepare, prime, and treat inside and outside corners according to ASTM D 6135.
   a. Install membrane strips centered over vertical inside corners. Install 3/4-inch (19-mm) fillets of liquid membrane on horizontal inside corners and as follows:
      1) At footing-to-wall intersections, extend liquid membrane each direction from corner or install membrane strip centered over corner.
      2) At plaza deck-to-wall intersections, extend liquid membrane or sheet strips onto deck waterproofing and to finished height of sheet flashing.
8. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through waterproofing and at drains and protrusions according to ASTM D 6135.

B. Modified Bituminous Sheet Waterproofing Application
1. Install modified bituminous sheets according to waterproofing manufacturer's written instructions and according to recommendations in ASTM D 6135.

2. Apply primer to substrates at required rate and allow to dry. Limit priming to areas that will be covered by sheet waterproofing in same day. Reprime areas exposed for more than 24 hours.
3. Apply and firmly adhere sheets over area to receive waterproofing. Accurately align sheets and maintain uniform 2-1/2-inch- (64-mm-) minimum lap widths and end laps. Overlap and seal seams and stagger end laps to ensure watertight installation.
   a. When ambient and substrate temperatures range between 25 and 40 deg F (minus 4 and plus 5 deg C), install self-adhering, modified bituminous sheets produced for low-temperature application. Do not use low-temperature sheets if ambient or substrate temperature is higher than 60 deg F (16 deg C).
4. Two-Ply Application: Install sheets to form a membrane with lap widths not less than 50 percent of sheet widths to provide a minimum of 2 thicknesses of sheet membrane over areas to receive waterproofing.
5. Horizontal Application: Apply sheets from low point to high point of decks to ensure that side laps shed water.
6. Apply continuous sheets over sheet strips bridging substrate cracks, construction, and contraction joints.
7. Seal exposed edges of sheets at terminations not concealed by metal counterflashings or ending in reglets with mastic.
8. Install sheet waterproofing and auxiliary materials to tie into adjacent waterproofing.
9. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending 6 inches (150 mm) beyond repaired areas in all directions.
10. Install protection course with butted joints over waterproofing membrane immediately.
    a. Molded-sheet drainage panels **OR** Insulation drainage panels **OR** Board insulation, **as directed**, may be used in place of a separate protection course to vertical applications when approved by waterproofing manufacturer and installed immediately.
11. Correct deficiencies in or remove sheet waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.

C. Modified Bituminous Deck Paving Sheet Waterproofing Application
1. Install modified bituminous deck paving sheets according to waterproofing manufacturer's written instructions.
2. Apply primer to substrates at required rate and allow to dry. Limit priming to areas that will be covered by sheet waterproofing in same day. Reprime areas exposed for more than 24 hours.
3. Apply and firmly adhere sheets over areas to receive waterproofing. Accurately align sheets and maintain uniform 2-1/2-inch- (64-mm-) minimum lap widths and 6-inch (150-mm) end laps. Overlap and seal seams and stagger end laps to ensure watertight installation.
4. Apply sheet waterproofing from low point to high point of decks to ensure that side laps shed water.
5. Apply continuous sheets over sheet strips bridging substrate cracks, construction, and contraction joints.
6. Seal edges of sheet waterproofing terminations with mastic.
7. Install sheet waterproofing and auxiliary materials to tie into adjacent waterproofing.
8. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending 6 inches (150 mm) beyond repaired areas in all directions.
9. Correct deficiencies in or remove sheet waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.

D. Modified Bituminous Composite Panel Waterproofing Application
1. Install modified bituminous composite panels according to waterproofing manufacturer's written instructions.
2. Apply primer to substrate at required rate and allow to dry. Limit priming to areas that will be covered by waterproofing in same day. Reprime areas exposed for more than 24 hours.

3. Install and firmly adhere composite panels over area to receive waterproofing. Accurately align and butt vertical and horizontal joints.
4. Seal vertical and horizontal butt joints and exposed top, side, and bottom edges at composite panel waterproofing terminations with detail strips.
5. Correct deficiencies in or remove composite panel waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair detail strips.

E. Adhesive-Coated HDPE Sheet Waterproofing Application
1. Install adhesive-coated HDPE sheets according to manufacturer's written instructions.
2. Place and secure molded-sheet drainage panels over substrate. Lap edges and ends of geotextile to maintain continuity.
3. Vertical Applications: Install adhesive-coated HDPE sheet with HDPE face against substrate. Accurately align sheets and maintain uniform 3-inch- (75-mm-) minimum lap widths and end laps. Overlap and seal seams and stagger and tape end laps to ensure watertight installation. Mechanically fasten to substrate.
   a. Securely fasten top termination of membrane with continuous metal termination bar anchored into substrate and cover with detailing tape.
4. Horizontal Applications: Install adhesive-coated HDPE sheet with HDPE face against substrate. Accurately align sheets and maintain uniform 3-inch- (75-mm-) minimum lap widths and end laps. Overlap and seal seams. Overlap, stagger, and seal end laps with detail tape to ensure watertight installation.
5. Corners: Seal lapped terminations and cut edges of sheet waterproofing at inside and outside corners with detail tape.
6. Seal penetrations through sheet waterproofing to provide watertight seal with detail tape patches or wraps and a liquid-membrane troweling.
7. Install sheet waterproofing and auxiliary materials to produce a continuous watertight tie into adjacent waterproofing.
8. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Tape perimeter of damaged or nonconforming area extending 6 inches (150 mm) beyond repaired areas in all directions. Apply a patch of sheet waterproofing and firmly secure with detail tape.
9. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.

F. Molded-Sheet Drainage Panel Installation
1. Place and secure molded-sheet drainage panels, with geotextile facing away from wall or deck substrate, according to manufacturer's written instructions. Use adhesives or mechanical fasteners that do not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.
   a. For vertical applications, install board insulation **OR** protection course, **as directed**, before installing drainage panels.

G. Insulation Installation
1. Install one or more layers of board insulation to achieve required thickness and insulation drainage panels over waterproofed surfaces. Cut and fit to within 3/4 inch (19 mm) of projections and penetrations.
2. On vertical surfaces, set insulation units in adhesive or tape applied according to manufacturer's written instructions.
3. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

H. Plaza Deck Paver Installation
1. Setting Bed: Install setting bed in locations and of thickness indicated to comply with requirements in Division 02 Section(s) "Unit Pavers" OR Division 09 Section(s) "Stone Flooring", **as directed**.
2. Install concrete pavers in locations indicated according to manufacturer's written instructions.

3. Accurately install fixed **OR** adjustable, **as directed**,-height paver pedestals and accessories in locations and to elevations required. Adjust for final level and slope with shims.
   a. Fill paver pedestal with concrete mix, strike smooth with top of pedestal, and cure according to ACI 301.
4. Loosely lay pavers on pedestals, maintaining a uniform open joint width. Tightly seat pavers against spacers to eliminate lateral movement or drift of paving assembly. Align joint patterns parallel in each direction.
   a. Lay out pavers to avoid less-than-half-width pavers at perimeter or other terminations.
5. Install pavers to not vary more than 1/16 inch (1.6 mm) in elevation between adjacent pavers or more than 1/16 inch (1.6 mm) from surface plane elevation of individual paver.
6. Maintain tolerances of paving installation within 1/4 inch in 10 feet (1:48) of surface plane in any direction.

I. Field Quality Control
1. Flood Testing: Flood test each deck area for leaks, according to recommendations in ASTM D 5957, after completing waterproofing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.
   a. Flood to an average depth of 2-1/2 inches (64 mm) with a minimum depth of 1 inch (25 mm) and not exceeding a depth of 4 inches (100 mm). Maintain 2 inches (51 mm) of clearance from top of sheet flashings.
   b. Flood each area for 24 **OR** 48 **OR** 72, **as directed**, hours.
   c. After flood testing, repair leaks, repeat flood tests, and make further repairs until waterproofing installation is watertight.
2. Engage an independent testing agency to observe flood testing and examine underside of decks and terminations for evidence of leaks during flood testing.

J. Protection And Cleaning
1. Do not permit foot or vehicular traffic on unprotected membrane.
2. Protect waterproofing from damage and wear during remainder of construction period.
3. Protect installed board insulation **OR** insulation drainage panels, **as directed**, from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation will be subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.
4. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07130a

SECTION 07130b - ELASTOMERIC SHEET WATERPROOFING

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for elastomeric sheet waterproofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
   a. Butyl rubber sheet waterproofing.
   b. EPDM rubber sheet waterproofing.
   c. Molded-sheet drainage panels.
   d. Insulation.
   e. Plaza deck pavers and paver pedestals.

C. Submittals
1. Product Data: Include manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, and tested physical and performance properties of waterproofing.
2. Shop Drawings: Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.
3. Product test reports.
4. Special warranties.

D. Quality Assurance
1. Installer Qualifications: A firm that is approved or licensed by **OR** acceptable to, **as directed**, waterproofing manufacturer for installation of units required for this Project.
2. Preinstallation Conference: Conduct conference at Project site.
   a. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs.

E. Delivery, Storage, And Handling
1. Deliver liquid materials to Project site in original packages with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing and mixing with other components.
2. Store liquid materials in their original undamaged packages in a clean, dry, protected location and within temperature range required by waterproofing manufacturer.
3. Remove and replace liquid materials that cannot be applied within their stated shelf life.
4. Store rolls according to manufacturer's written instructions.
5. Protect stored materials from direct sunlight.

F. Project Conditions
1. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate.

G. Warranty

1. Special Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to replace waterproofing material that does not comply with requirements or that fails to remain watertight within 10 **OR** 20, **as directed**, years from date of Substantial Completion.

1.2 PRODUCTS

A. Sheet Waterproofing
1. Butyl Rubber Sheet: ASTM D 6134, Type II, 60-mil- (1.5-mm-) **OR** 90-mil- (2.3-mm-) **OR** 120-mil- (3.0-mm-), **as directed**, thick flexible sheet, unreinforced, formed from isobutylene-isoprene rubber.
2. EPDM Rubber Sheet: ASTM D 6134, Type I, 60-mil- (1.5-mm-) thick flexible sheet, unreinforced, formed from EPDM.

B. Auxiliary Materials
1. General: Furnish auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing.
   a. Furnish liquid-type auxiliary materials that comply with VOC limits of authorities having jurisdiction.
2. Concealed Sheet Flashing: Same material, construction, and thickness as sheet waterproofing or 60-mil- (1.5-mm-) thick, uncured EPDM as required by manufacturer.
3. Exposed Sheet Flashing: 60-mil- (1.5-mm-) thick EPDM, cured or uncured, as required by manufacturer.
4. Bonding Adhesives: Adhesive for bonding polymeric sheets and sheet flashings to substrates and projections.
5. Splicing Cement and Cleaner: Single-component butyl splicing cement and solvent-based splice cleaner.
   a. Butyl Gum Tape: 30-mil- (0.76-mm-) thick-by-6-1/4-inch- (160-mm-) wide, uncured butyl with polyethylene release film.
6. Lap Sealant: Single-component sealant.
7. In-Seam Sealant: Single-component sealant.
8. Water Cutoff Mastic: Butyl mastic sealant.
9. Waterproofing and Sheet Flashing Accessories: Provide sealants, pourable sealers, cone and vent flashings, inside and outside corner flashings, termination reglets, and other accessories recommended by waterproofing manufacturer for intended use.
10. Metal Termination Bars: Manufacturer's standard aluminum bars, approximately 1 inch (25 mm) wide, prepunched, with zinc-alloy-body fasteners and stainless-steel pins.
11. Protection Course: ASTM D 6506, semirigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners and as follows:
    a. Thickness: 1/8 inch (3 mm), nominal, for vertical applications; 1/4 inch (6 mm), nominal, elsewhere.
    b. Adhesive: Rubber-based solvent type recommended by waterproofing manufacturer for type of protection course.
12. Protection Course:
    a. Faced, fan folded, with a core of extruded-polystyrene board insulation sandwiched between 2 sheets of plastic film, nominal thickness 1/4 inch (6 mm), with compressive strength of not less than 8 psi (55 kPa) per ASTM D 1621, and maximum water absorption by volume of 0.6 percent per ASTM C 272.
    b. Unfaced, fan-folded, extruded-polystyrene board insulation, nominal thickness 1/4 inch (6 mm) with compressive strength of not less than 8 psi (55 kPa) per ASTM D 1621.
    c. Extruded-polystyrene board insulation, unfaced, ASTM C 578, Type X, 1/2 inch (13 mm) thick.
    d. Molded-polystyrene board insulation, ASTM C 578, Type I, 0.90-lb/cu. ft. (15-kg/cu. m) minimum density, 1-inch (25-mm) minimum thickness.

C. Molded-Sheet Drainage Panels
   1. Molded-Sheet Drainage Panel: Comply with Division 02 Section "Subdrainage".
   2. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel: Manufactured composite subsurface drainage panels consisting of a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 (0.21-mm) sieve laminated to one side with or without a polymeric film bonded to the other side of a studded, nonbiodegradable, molded-plastic-sheet drainage core, with a vertical flow rate of 9 to 15 gpm per ft. (112 to 188 L/min. per m).
   3. Woven-Geotextile-Faced, Molded-Sheet Drainage Panel: Manufactured composite subsurface drainage panels consisting of a woven-geotextile facing with an apparent opening size not exceeding No. 40 (0.425-mm) sieve laminated to one side with or without a polymeric film bonded to the other side of a studded, nonbiodegradable, molded-plastic-sheet drainage core, with a horizontal flow rate not less than 2.8 gpm per ft. (35 L/min. per m).

D. Insulation
   1. Board Insulation: Extruded-polystyrene board insulation complying with ASTM C 578, square or shiplap edged.
      a. Type IV, 25-psi (173-kPa) minimum compressive strength.
      b. Type VI, 40-psi (276-kPa) minimum compressive strength.
      c. Type VII, 60-psi (414-kPa) minimum compressive strength.
      d. Type V, 100-psi (690-kPa) minimum compressive strength.
   2. Unfaced Wall Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type IV, 25-psi (173-kPa) or Type VI, 40-psi (276-kPa) minimum compressive strength; unfaced; fabricated with shiplap or channel edges and with 1 side having grooved drainage channels.
   3. Geotextile-Faced Wall Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type IV, 25-psi (173-kPa) or Type VI, 40-psi (276-kPa) minimum compressive strength; fabricated with tongue-and-groove edges and with 1 side having grooved drainage channels faced with nonwoven geotextile filter fabric.
   4. Unfaced Plaza Deck Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type VI, 40-psi (276-kPa) **OR** Type VII, 60-psi (414-kPa), **as directed**, minimum compressive strength; unfaced; fabricated with shiplapped or channel edges and with 1 side having ribbed drainage channels.
   5. Geotextile-Faced Plaza Deck Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type VII, 60-psi (414-kPa) minimum compressive strength; fabricated with tongue-and-groove edges and with 1 side having grooved drainage channels faced with manufacturer's standard, nonwoven geotextile filter fabric.

E. Plaza Deck Pavers
   1. Plaza Deck Pavers: Brick **OR** Concrete **OR** Asphalt-block, **as directed**, pavers specified in Division 02 Section "Unit Pavers".
   2. Plaza Deck Pavers: Granite **OR** Limestone **OR** Marble **OR** Quartz-based stone **OR** Slate, **as directed**, pavers specified in Division 09 Section "Stone Flooring".
   3. Plaza Deck Pavers: Heavyweight, hydraulically pressed, concrete units, square edged **OR** with top edges beveled 3/16 inch (5 mm), **as directed**, manufactured for use as plaza deck pavers; minimum compressive strength 7500 psi (52 MPa) **OR** 6500 psi (45 MPa), **as directed**, ASTM C 140; absorption not greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance according to ASTM C 67.
      a. Color: As selected from manufacturer's full range.
   4. Setting Bed: Provide aggregate **OR** mortar **OR** bituminous, **as directed**, setting-bed materials specified in Division 02 Section "Unit Pavers".
   5. Paver Pedestals: Paver manufacturer's standard SBR rubber, HDPE, or polyurethane paver support assembly, including fixed-height **OR** adjustable or stackable, **as directed**, pedestals, shims, and spacer tabs for joint spacing of 1/8 inch (3 mm) **OR** 3/16 inch (5 mm) **OR** 1/8 to 3/16 inch (3 to 5 mm), **as directed**.
      a. Concrete Fill: ACI 301, compressive strength of 5000 psi (34 MPa) at 28 days and air content of 6 percent.

1.3 EXECUTION

A. Surface Preparation
1. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.
2. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.
3. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
4. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids.
5. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks according to ASTM D 4258.
6. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through waterproofing and at drains and protrusions.

B. Fully Adhered Sheet Installation
1. Install fully adhered sheets over entire area to receive waterproofing according to manufacturer's written instructions and recommendations in ASTM D 5843.
2. Accurately align sheets and maintain uniform side and end laps of minimum dimensions required. Stagger end laps.
3. Apply bonding adhesive to substrates at required rate and allow to partially dry.
4. Apply bonding adhesive to sheets and firmly adhere sheets to substrates. Do not apply bonding adhesive to splice area of sheet.
5. Install fully adhered sheets and auxiliary materials to tie into existing waterproofing.
6. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending beyond repaired areas in all directions.
7. Horizontal Application: Apply sheets with side laps shingled with slope of deck where possible.
   a. Spread sealant bed over deck drain flange at deck drains and securely seal sheet waterproofing in place with clamping ring.

C. Partially Adhered Sheet Installation
1. Install partially adhered sheets over entire area to receive waterproofing according to manufacturer's written instructions.
2. Accurately align sheets and maintain uniform side and end laps of minimum dimensions required. Stagger end laps.
3. Apply bonding adhesive to the following areas of substrates and to each sheet at required rate and allow to partially dry:
   a. Upper 25 percent of length of each sheet and 18 inches (457 mm) around perimeter of each sheet.
4. Firmly adhere sheets to substrate. Do not apply bonding adhesive to splice area of sheet.
5. Install partially adhered sheets and auxiliary materials to tie into existing waterproofing.
6. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending beyond repaired areas in all directions.

D. Compartmented, Loosely Laid Sheet Installation
1. Install compartmented, loosely laid sheets over entire area to receive waterproofing according to manufacturer's written instructions.
2. Accurately align sheets and maintain uniform side and end laps of minimum dimensions required. Stagger end laps.
3. Apply continuous beads of water cutoff mastic, of size recommended by waterproofing manufacturer, to substrates in a 60-by-60-inch (1500-by-1500-mm) grid pattern before installing sheet.

4. Apply sheets with side laps shingled with slope of deck where possible.
5. Spread sealant bed over deck drain flange at deck drains and securely seal sheet waterproofing in place with clamping ring.
6. Install compartmented, loosely laid sheets and auxiliary materials to tie into existing waterproofing.
7. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending beyond repaired areas in all directions.

E. Seam Installation
1. Cement Splice: Clean splice areas, apply splicing cement and in-seam sealant, and firmly roll side and end laps of overlapping sheets according to manufacturer's written instructions to produce a splice not less than 6 inches (150 mm) wide and to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet terminations.
2. Cement and Tape Splice: Clean splice areas, apply splicing cement and butyl gum tape, and firmly roll side and end laps of overlapping sheets according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet terminations.

F. Sheet Flashing Installation
1. Install sheet flashings and preformed flashing accessories and adhere to substrates according to waterproofing manufacturer's written instructions.
2. Form wall flashings using exposed sheet flashing.
3. Extend deck sheet waterproofing to form wall flashings.
   a. Flash penetrations and field-formed inside and outside corners with uncured sheet flashing.
   b. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.
4. Cover expansion joints and discontinuous deck-to-wall or deck-to-deck joints by extending deck sheet waterproofing over joints.
5. Terminate and seal top of sheet flashings with mechanically anchored termination bars.

G. Protection Course Installation
1. Install protection course over waterproofing membrane according to manufacturer's written instructions and before beginning subsequent construction operations. Minimize exposure of membrane.
   a. Molded-sheet drainage panels **OR** Insulation drainage panels **OR** Board insulation, **as directed**, may be used in place of a separate protection course to vertical applications when approved by waterproofing manufacturer.

H. Molded-Sheet Drainage Panel Installation
1. Place and secure molded-sheet drainage panels, with geotextile facing away from wall or deck substrate, according to manufacturer's written instructions. Use adhesives or mechanical fasteners that do not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.
   a. For vertical applications, install board insulation **OR** protection course, **as directed**, before installing drainage panels.

I. Insulation Installation
1. Install one or more layers of board insulation to achieve required thickness and insulation drainage panels over waterproofed surfaces. Cut and fit to within 3/4 inch (19 mm) of projections and penetrations.
2. On vertical surfaces, place and secure insulation units according to manufacturer's written instructions.

3. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

J. Plaza Deck Paver Installation
   1. Setting Bed: Install setting bed in locations and of thickness indicated to comply with requirements in Division 02 Section(s) "Unit Pavers" OR Division 09 Section(s) "Stone Flooring", **as directed**.
   2. Install concrete pavers in locations indicated according to manufacturer's written instructions.
   3. Accurately install fixed **OR** adjustable, **as directed**,-height paver pedestals and accessories in locations and to elevations required. Adjust for final level and slope with shims.
      a. Fill paver pedestal with concrete mix, strike smooth with top of pedestal, and cure according to ACI 301.
   4. Loosely lay pavers on pedestals, maintaining a uniform open joint width. Tightly seat pavers against spacers to eliminate lateral movement or drift of paving assembly. Align joint patterns parallel in each direction.
      a. Lay out pavers to avoid less-than-half-width pavers at perimeter or other terminations.
   5. Install pavers to not vary more than 1/16 inch (1.6 mm) in elevation between adjacent pavers or more than 1/16 inch (1.6 mm) from surface plane elevation of individual paver.
   6. Maintain tolerances of paving installation within 1/4 inch in 10 feet (1:48) of surface plane in any direction.

K. Protection And Cleaning
   1. Do not permit foot or vehicular traffic on unprotected membrane.
   2. Protect waterproofing from damage and wear during remainder of construction period.
   3. Protect installed board insulation **OR** insulation drainage panels, **as directed**, from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation will be subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.
   4. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07130b

Task	Specification	Specification Description
07130	07110	Bituminous Dampproofing
07131	07130b	Elastomeric Sheet Waterproofing
07140	07110a	Cold Fluid-Applied Waterproofing
07140	07110b	Hot Fluid-Applied Rubberized Asphalt Waterproofing

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SECTION 07160 - MODIFIED CEMENT WATERPROOFING

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for modified cement waterproofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes polymer-modified cement waterproofing for positive or negative-side application to concrete, concrete unit masonry, and clay masonry.

C. Submittals
1. Product Data: For each type of product indicated. Include construction details, material descriptions and installation instructions for polymer-modified cement waterproofing.
2. Samples: For each type of polymer-modified cement waterproofing indicated.
3. Qualification Data: For Applicator.
4. Product Certificates: For waterproofing, patching, and plugging materials, from manufacturer.
5. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for each type of polymer-modified cement waterproofing.
6. Field quality-control reports.

D. Quality Assurance
1. Applicator Qualifications: A firm experienced in applying polymer-modified cement waterproofing similar in material, design, and extent to that indicated for this Project, whose work has resulted in applications with a record of successful in-service performance, and that employs workers trained and approved by manufacturer.
2. Preinstallation Conference: Conduct conference at Project site.

E. Project Conditions
1. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit polymer-modified cement waterproofing to be performed according to manufacturer's written instructions.
2. Proceed with waterproofing work only after pipe sleeves, vents, curbs, inserts, drains, and other projections through the substrate to be waterproofed have been completed. Proceed only after substrate defects, including honeycombs, voids, and cracks, have been repaired to provide a sound substrate free of forming materials, including reveal inserts.
3. Ambient Conditions: Proceed with waterproofing work only if temperature is maintained at 40 deg F (4.4 deg C) or above during work and cure period, and space is well ventilated and kept free of water.

1.2 PRODUCTS

A. Field-Mixed, Polymer-Modified Cement Waterproofing
1. Admixture for Field Mixing: Manufacturer's standard polymer admixture for mixing with portland cement and sand to produce a waterproof coating that is suitable for vertical and horizontal applications below or above grade, is breathable, resists positive-side **OR** negative-side, **as directed**, hydrostatic pressure, has VOC content complying with limits of authorities having jurisdiction, and has properties meeting or exceeding the criteria specified below.

a. Water Permeability: Maximum zero for water at 30 feet (9 m) when tested according to CE CRD-C 48.
b. Compressive Strength: Minimum 4000 psi (27.6 MPa) at 28 days when tested according to ASTM C 109/C 109M.
c. Flexural Strength: Minimum 710 psi (4.8 MPa) at 28 days when tested according to ASTM C 348.
d. Bond Strength: Minimum 220 psi (1.5 MPa) at 14 days when tested according to ASTM C 321.

B. Prepackaged, Polymer-Modified Cement Waterproofing
1. Negative-Side, Polymer-Modified Cement Waterproofing: Manufacturer's proprietary blend of dry cementitious and other ingredients for mixing with potable water **OR** polymer admixture, **as directed**, to produce a waterproof coating that is suitable for vertical and horizontal applications below or above grade, is breathable, resists negative-side hydrostatic pressure, has VOC content complying with limits of authorities having jurisdiction, and has properties meeting or exceeding the criteria specified below.
a. Water Permeability: Maximum zero for water at 30 feet (9 m) when tested according to CE CRD-C 48.
b. Compressive Strength: Minimum 4000 psi (27.6 MPa) at 28 days when tested according to ASTM C 109/C 109M.
c. Flexural Strength: Minimum 710 psi (4.8 MPa) at 28 days when tested according to ASTM C 348.
d. Bond Strength: Minimum 220 psi (1.5 MPa) at 14 days when tested according to ASTM C 321.
e. Color: White **OR** Gray **OR** As selected from full range **OR** As indicated in a color schedule, **as directed**.
2. Positive-Side, Polymer-Modified Cement Waterproofing: Manufacturer's proprietary blend of dry cementitious and other ingredients for mixing with potable water or polymer admixture to produce a waterproof coating that is suitable for vertical and horizontal applications below or above grade, is breathable, resists positive-side hydrostatic pressure, has VOC content complying with limits of authorities having jurisdiction, and has properties meeting or exceeding the criteria specified below.
a. Water Permeability: Maximum zero for water at 30 feet (9 m) when tested according to CE CRD-C 48.
b. Compressive Strength: Minimum 4000 psi (27.6 MPa) at 28 days when tested according to ASTM C 109/C 109M.
c. Flexural Strength: Minimum 710 psi (4.8 MPa) at 28 days when tested according to ASTM C 348.
d. Bond Strength: Minimum 220 psi (1.5 MPa) at 14 days when tested according to ASTM C 321.
e. Color: White **OR** Gray **OR** As selected from full range **OR** As indicated in a color schedule, **as directed**.

C. Accessory Materials
1. Patching Compound: Factory-premixed cementitious repair mortar, crack filler, or sealant recommended by waterproofing manufacturer for filling and patching tie holes, honeycombs, reveals, and other imperfections; compatible with substrate and other materials indicated; and VOC content complying with limits of authorities having jurisdiction.
2. Plugging Compound: Factory-premixed cementitious compound with hydrophobic properties and recommended by waterproofing manufacturer; resistant to water and moisture but vapor permeable for all standard applications (vertical, overhead, and horizontal surfaces not exposed to vehicular traffic); compatible with substrate and other materials indicated; and VOC content complying with limits of authorities having jurisdiction.
3. Portland Cement: ASTM C 150, Type I.
4. Slurry-Coat and Protective-Topping Sand: ASTM C 144.

5. Trowel-Coat Sand: ASTM C 33, fine aggregate.
6. Polymer Admixture for Protective Topping: Polymer bonding agent and admixture designed to improve adhesion to prepared substrates and to not create a vapor barrier.
7. Water: Potable.

D. Mixes
1. Field-Mixed, Polymer-Modified Cement Waterproofing: Add polymer admixture to portland cement and sand according to manufacturer's written instructions. Blend together with mechanical mixer or by hand to required consistency.
OR
Prepackaged, Polymer-Modified Cement Waterproofing: Add prepackaged dry ingredients to mixing liquid according to manufacturer's written instructions. Mix together with mechanical mixer or by hand to required consistency.
2. Protective Topping: Measure, batch, and mix portland cement and sand in the proportion of 1:3 and water gaged with a polymer admixture. Blend together with mechanical mixer to required consistency.

1.3 EXECUTION

A. Examination
1. Examine substrates, areas, and conditions, with Applicator present, for suitable conditions where waterproofing is to be applied.
2. Proceed with application only after unsatisfactory conditions have been corrected.
3. Notify the Owner in writing of active leaks or defects that would affect system performance.

B. Preparation
1. Protect other work from damage caused by cleaning, preparation, and application of waterproofing. Provide temporary enclosure to confine spraying operation and to ensure adequate ambient temperatures and ventilation conditions for application.
2. Do not allow waterproofing, patching, and plugging materials to enter reveals or annular spaces intended for resilient sealants or gaskets, such as joint spaces between pipes and pipe sleeves.
3. Stop active water leaks with plugging compound according to waterproofing manufacturer's written instructions.
4. Repair damaged or unsatisfactory substrate with patching compound according to manufacturer's written instructions.
   a. At holes and cracks in substrate, remove loosened chips and cut reveal with sides perpendicular to surface, not tapered, and approximately 1 inch (25.4 mm) deep. Fill reveal with patching compound flush with surface.
5. Surface Preparation: Comply with waterproofing manufacturer's written instructions to remove efflorescence, chalk, dust, dirt, mortar spatter, grease, oils, paint, curing compounds, and form-release agents to ensure that waterproofing bonds to surfaces.
   a. Clean concrete surfaces according to ASTM D 4258.
      1) Scratch- and Float-Finished Concrete: Etch with 10 percent muriatic (hydrochloric) acid solution according to ASTM D 4260.
      2) Prepare smooth-formed and trowel-finished concrete by mechanical abrading or abrasive-blast cleaning according to ASTM D 4259.
   b. Clean concrete unit masonry surfaces according to ASTM D 4261.
      1) Lightweight Concrete Unit Masonry: Etch with 10 percent muriatic (hydrochloric) acid solution or abrade surface by wire brushing. Remove acid residue until pH readings of water after rinse are not more than 1.0 pH lower or 2.0 pH higher than pH of water before rinse.
      2) Medium- and Normal-Weight Concrete Unit Masonry: Sandblast or bushhammer to a depth of 1/16 inch (1.6 mm).
   c. Clean clay masonry surfaces according to ASTM D 5703.

d. Concrete Joints: Clean reveals according to waterproofing manufacturer's written instructions.

C. Application
1. General: Comply with waterproofing manufacturer's written instructions for application and curing.
   a. Saturate surface with water for several hours prior to application with water and maintain damp condition until applying waterproofing. Remove standing water.
   b. Apply waterproofing to surfaces indicated on Drawings.
   c. Number of Coats: Number required for specified water permeability **OR** Two **OR** Three, **as directed**.
      1) Coating Thickness: Maximum application thickness of 47 mils (1.2 mm) per coat for total thickness as required for specified water permeability **OR** of 100 mils (2.5 mm), **as directed**.
      2) Apply first coat as a slurry with brush or roller, and apply subsequent coats with brush, roller, spray, or trowel.
      3) Vigorously work first coat onto the substrate, forcing the material into surface voids. Apply each subsequent coat into full contact with previous coat.
      4) Allow manufacturer's recommended time between coats. Dampen surface between coats.
2. Final Coat Finish: Smooth troweled **OR** Brushed **OR** Textured, **as directed**.
3. Curing: Air-cure waterproofing for not less than five days immediately after application and prior to being placed in service.
4. Curing: Moist-cure waterproofing for not less than three days immediately after application has set, followed by air drying prior to being placed in service unless otherwise recommended in writing by manufacturer.
5. Waterproofing Treatment Extensions: Extend waterproofing treatment as follows:
   a. Onto columns integral with treated walls.
   b. Onto interior nontreated walls intersecting exterior treated walls, for a distance of 24 inches (600 mm) for cast-in-place concrete and 48 inches (1200 mm) for masonry.
   c. Onto exterior walls and onto both exterior and interior columns, for a height of 12 inches (300 mm), where floors, but not walls, are treated.
   d. Onto every substrate in areas indicated for treatment, including pipe trenches, pipe chases, pits, sumps, and similar offsets and features.
6. Protective Floor Topping: Apply 1-inch- (25.4-mm-) thick, protective topping over floor surfaces.

D. Field Quality Control
1. Inspection: Engage manufacturer's representative to inspect completed application and provide a written report that application complies with manufacturer's written instructions.

END OF SECTION 07160

SECTION 07160a - CRYSTALLINE WATERPROOFING

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for crystalline waterproofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes crystalline waterproofing for positive or negative-side application to concrete and concrete unit masonry.

C. Submittals
1. Product Data: For each type of product indicated. Include construction details, material descriptions and installation instructions for crystalline waterproofing.
2. Qualification Data: For Applicator.
3. Product Certificates: For waterproofing, patching, and plugging materials, from manufacturer.
4. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for crystalline waterproofing.
5. Field quality-control reports.

D. Quality Assurance
1. Applicator Qualifications: A firm experienced in applying crystalline waterproofing similar in material, design, and extent to that indicated for this Project, whose work has resulted in applications with a record of successful in-service performance, and that employs workers trained and approved by manufacturer.
2. Preinstallation Conference: Conduct conference at Project site.

E. Project Conditions
1. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit crystalline waterproofing to be performed according to manufacturer's written instructions.
2. Proceed with waterproofing work only after pipe sleeves, vents, curbs, inserts, drains, and other projections through the substrate to be waterproofed have been completed. Proceed only after substrate defects, including honeycombs, voids, and cracks, have been repaired to provide a sound substrate free of forming materials, including reveal inserts.
3. Ambient Conditions: Proceed with waterproofing work only if temperature is maintained at 40 deg F (4.4 deg C) or above during work and cure period, and space is well ventilated and kept free of water.

1.2 PRODUCTS

A. Waterproofing Materials
1. Crystalline Waterproofing: Prepackaged, gray-colored **OR** white-colored, **as directed**, proprietary blend of portland cement, specially treated sand, and active chemicals that, when mixed with water and applied, penetrates into concrete and concrete unit masonry and reacts chemically with the byproducts of cement hydration in the presence of water to develop crystalline growth within substrate capillaries to produce an impervious, dense, waterproof substrate; that has VOC content complying with limits of authorities having jurisdiction; with properties meeting or exceeding the criteria specified below.

a. Water Permeability: Maximum zero for water at 30 feet (9 m) when tested according to CE CRD-C 48.
b. Compressive Strength: Minimum 4000 psi (27.6 MPa) at 28 days when tested according to ASTM C 109/C 109M.

B. Accessory Materials
1. Patching Compound: Factory-premixed cementitious repair mortar, crack filler, or sealant recommended by waterproofing manufacturer for filling and patching tie holes, honeycombs, reveals, and other imperfections; compatible with substrate and other materials indicated; and VOC content complying with limits of authorities having jurisdiction.
2. Plugging Compound: Factory-premixed cementitious compound with hydrophobic properties and recommended by waterproofing manufacturer; resistant to water and moisture but vapor permeable for all standard applications (vertical, overhead, and horizontal surfaces not exposed to vehicular traffic); compatible with substrate and other materials indicated; and VOC content complying with limits of authorities having jurisdiction.
3. Portland Cement: ASTM C 150, Type I.
4. Sand: ASTM C 144.
5. Polymer Admixture for Protective Topping: Polymer bonding agent and admixture designed to improve adhesion to prepared substrates and not to create a vapor barrier.
6. Water: Potable.

C. Mixes
1. Crystalline Waterproofing: Add prepackaged dry ingredients to water according to manufacturer's written instructions. Mix together with mechanical mixer or by hand to required consistency.
2. Protective Topping: Measure, batch, and mix portland cement and sand in the proportion of 1:3 and water gaged with a polymer admixture. Blend together with mechanical mixer to required consistency.

1.3 EXECUTION

A. Examination
1. Examine substrates, areas, and conditions, with Applicator present, for suitable conditions where waterproofing is to be applied.
2. Proceed with application only after unsatisfactory conditions have been corrected.
3. Notify the Owner in writing of active leaks or defects that would affect system performance.

B. Preparation
1. Protect other work from damage caused by cleaning, preparation, and application of waterproofing. Provide temporary enclosure to confine spraying operation and to ensure adequate ambient temperatures and ventilation conditions for application.
2. Do not allow waterproofing, patching, and plugging materials to enter reveals or annular spaces intended for resilient sealants or gaskets, such as joint spaces between pipes and pipe sleeves.
3. Stop active water leaks with plugging compound according to waterproofing manufacturer's written instructions.
4. Repair damaged or unsatisfactory substrate with patching compound according to manufacturer's written instructions.
a. At holes and cracks in substrate, remove loosened chips and cut reveal with sides perpendicular to surface, not tapered, and approximately 1 inch (25.4 mm) deep. Fill reveal with patching compound flush with surface.
5. Surface Preparation: Comply with waterproofing manufacturer's written instructions to remove efflorescence, chalk, dust, dirt, mortar spatter, grease, oils, paint, curing compounds, and form-release agents to ensure that waterproofing bonds to surfaces.
a. Clean concrete surfaces according to ASTM D 4258.

1) Scratch- and Float-Finished Concrete: Etch with 10 percent muriatic (hydrochloric) acid solution according to ASTM D 4260.
2) Prepare smooth-formed and trowel-finished concrete by mechanical abrading or abrasive-blast cleaning according to ASTM D 4259.

b. Clean concrete unit masonry surfaces according to ASTM D 4261.
1) Lightweight Concrete Unit Masonry: Etch with 10 percent muriatic (hydrochloric) acid solution or abrade surface by wire brushing. Remove acid residue until pH readings of water after rinse are not more than 1.0 pH lower or 2.0 pH higher than pH of water before rinse.
2) Medium- and Normal-Weight Concrete Unit Masonry: Sandblast or bushhammer to a depth of 1/16 inch (1.6 mm).

c. Concrete Joints: Clean reveals according to waterproofing manufacturer's written instructions.

C. Application
1. General: Comply with waterproofing manufacturer's written instructions for application and curing.
a. Saturate surface with water for several hours prior to application and maintain damp condition until applying waterproofing. Remove standing water.
b. Apply waterproofing to surfaces indicated on Drawings.
c. Number of Coats: Number required for specified water permeability **OR** Two **OR** Three, **as directed**.
d. Application Method: Brush **OR** Spray, **as directed**. Apply to ensure that each coat fills voids and is in full contact with substrate or previous coat.
e. Dampen surface between coats.
2. Final Coat Finish: Smooth **OR** Brushed **OR** Spray Textured, **as directed**.
3. Curing: Moist-cure waterproofing for three, **as directed**, days immediately after final coat has set, followed by air drying, unless otherwise recommended in writing by manufacturer.
4. Waterproofing Treatment Extensions: Extend waterproofing treatment as follows:
a. Onto columns integral with treated walls.
1) Onto interior nontreated walls intersecting exterior treated walls, for a distance of 24 inches (600 mm) for cast-in-place concrete and 48 inches (1200 mm) for masonry.
2) Onto exterior walls and onto both exterior and interior columns, for a height of 12 inches (300 mm), where floors, but not walls, are treated.
3) Onto every substrate in areas indicated for treatment, including pipe trenches, pipe chases, pits, sumps, and similar offsets and features.
5. Protective Topping: Apply 1-inch- (25.4-mm-) thick, protective topping over floor surfaces.

D. Field Quality Control
1. Inspection: Engage manufacturer's representative to inspect completed application and provide a written report that application complies with manufacturer's written instructions.

END OF SECTION 07160a

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SECTION 07160b - METAL-OXIDE WATERPROOFING

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for metal-oxide waterproofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes metal-oxide waterproofing for positive or negative-side application to concrete, concrete unit masonry, and clay masonry.

C. Submittals
1. Product Data: For each type of product indicated. Include construction details, material descriptions and installation instructions for metal-oxide waterproofing.
2. Qualification Data: For Applicator.
3. Product Certificates: For waterproofing, patching, and plugging materials, from manufacturer.
4. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for metal-oxide waterproofing.
5. Field quality-control reports.

D. Quality Assurance
1. Applicator Qualifications: A firm experienced in applying metal-oxide waterproofing similar in material, design, and extent to that indicated for this Project, whose work has resulted in applications with a record of successful in-service performance, and that employs workers trained and approved by manufacturer.
2. Preinstallation Conference: Conduct conference at Project site.

E. Project Conditions
1. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit metal-oxide waterproofing to be performed according to manufacturer's written instructions.
2. Proceed with waterproofing work only after pipe sleeves, vents, curbs, inserts, drains, and other projections through the substrate to be waterproofed have been completed. Proceed only after substrate defects, including honeycombs, voids, and cracks, have been repaired to provide a sound substrate free of forming materials, including reveal inserts.
3. Ambient Conditions: Proceed with waterproofing work only if temperature is maintained at 40 deg F (4.4 deg C) or above during work and cure period, and space is well ventilated and kept free of water.

1.2 PRODUCTS

A. Waterproofing Materials
1. Metal-Oxide Waterproofing Compound: A product specifically formulated for waterproofing concrete and masonry substrates; containing pulverized iron and a chemical oxidizing agent to cause the iron particles to rust and grow in size in the presence of water; with VOC content complying with limits of authorities having jurisdiction.

B. Accessory Materials
1. Patching Compound: Factory-premixed cementitious repair mortar, crack filler, or sealant recommended by waterproofing manufacturer for filling and patching tie holes, honeycombs,

reveals, and other imperfections; compatible with substrate and other materials indicated; and VOC content complying with limits of authorities having jurisdiction.

2. Plugging Compound: Factory-premixed cementitious compound with hydrophobic properties and recommended by waterproofing manufacturer; resistant to water and moisture but vapor permeable for all standard applications (vertical, overhead, and horizontal surfaces not exposed to vehicular traffic); compatible with substrate and other materials indicated; and VOC content complying with limits of authorities having jurisdiction.
3. Portland Cement: ASTM C 150, Type I.
4. Sand: ASTM C 144.
5. Water: Potable.

C. Mixes
1. Metal-Oxide Coats: Add metal-oxide waterproofing compound to portland cement, sand, and water according to manufacturer's written instructions. Blend together with mechanical mixer or by hand to required consistency for each coat.
2. Protection Coat: Field mix protection coat consisting of portland cement and sand as recommended by same manufacturer as metal-oxide waterproofing according to manufacturer's written instructions for application over waterproofing. Measure, batch, and mix materials with potable water. Blend together with mechanical mixer to required consistency.

1.3 EXECUTION

A. Examination
1. Examine substrates, areas, and conditions, with Applicator present, for suitable conditions where waterproofing is to be applied.
2. Proceed with application only after unsatisfactory conditions have been corrected.
3. Notify the Owner in writing of active leaks or defects that would affect system performance.

B. Preparation
1. Protect other work from damage caused by cleaning, preparation, and application of waterproofing. Provide temporary enclosure to confine spraying operation and to ensure adequate ambient temperatures and ventilation conditions for application.
2. Do not allow waterproofing, patching, and plugging materials to enter reveals or annular spaces intended for resilient sealants or gaskets, such as joint spaces between pipes and pipe sleeves.
3. Stop active water leaks with plugging compound according to waterproofing manufacturer's written instructions.
4. Repair damaged or unsatisfactory substrate with patching compound according to manufacturer's written instructions.
    a. At holes and cracks in substrate, remove loosened chips and cut reveal with sides perpendicular to surface, not tapered, and approximately 1 inch (25.4 mm) deep. Fill reveal with patching compound flush with surface.
5. Surface Preparation: Comply with waterproofing manufacturer's written instructions to remove efflorescence, chalk, dust, dirt, mortar spatter, grease, oils, paint, curing compounds, and form-release agents to ensure that waterproofing bonds to surfaces.
    a. Clean concrete surfaces according to ASTM D 4258.
        1) Scratch- and Float-Finished Concrete: Etch with 10 percent muriatic (hydrochloric) acid solution according to ASTM D 4260.
        2) Prepare smooth-formed and trowel-finished concrete by mechanical abrading or abrasive-blast cleaning according to ASTM D 4259.
    b. Clean concrete unit masonry surfaces according to ASTM D 4261.
        1) Lightweight Concrete Unit Masonry: Etch with 10 percent muriatic (hydrochloric) acid solution or abrade surface by wire brushing. Remove acid residue until pH readings of water after rinse are not more than 1.0 pH lower or 2.0 pH higher than pH of water before rinse.

2) Medium- and Normal-Weight Concrete Unit Masonry: Sandblast or bushhammer to a depth of 1/16 inch (1.6 mm).

c. Clean clay masonry surfaces according to ASTM D 5703.

d. Concrete Joints: Clean reveals according to waterproofing manufacturer's written instructions.

C. Application

1. General: Comply with waterproofing manufacturer's written instructions for application and curing.
   a. Saturate surface for several hours prior to application with water and maintain damp condition until applying waterproofing. Remove standing water.
   b. Apply waterproofing to surfaces indicated on Drawings.
   c. Number of Metal-Oxide Coats: Number required for specified water permeability **OR** Two **OR** Three, **as directed**.
   d. Application Method: Brush apply the waterproofing, vigorously working first coat onto the substrate and forcing the material into surface voids. Brush each subsequent coat into full contact with previous coat.
   e. Dampen surface between coats.
   f. Allow each coat to set for 24 hours between coats.
   g. Protection Coat: Apply to a thickness of 1/8 inch (3 mm) **OR** 1/4 inch (6 mm), **as directed**, for walls and 1 inch (25 mm) for floors.
2. Final Coat Finish: Smooth **OR** Brushed **OR** Textured, **as directed**.
3. Curing: Moist-cure waterproofing for three days immediately after final coat has set, followed by air drying prior to being placed in service, unless otherwise recommended in writing by manufacturer.
4. Waterproofing Treatment Extensions: Extend waterproofing treatment as follows:
   a. Onto columns integral with treated walls.
   b. Onto interior nontreated walls intersecting exterior treated walls, for a distance of 24 inches (600 mm) for cast-in-place concrete and 48 inches (1200 mm) for masonry.
   c. Onto exterior walls and onto both exterior and interior columns, for a height of 12 inches (300 mm), where floors, but not walls, are treated.
   d. Onto every substrate in areas indicated for treatment, including pipe trenches, pipe chases, pits, sumps, and similar offsets and features.

D. Field Quality Control

1. Inspection: Engage manufacturer's representative to inspect completed application and provide a written report that application complies with manufacturer's written instructions.

END OF SECTION 07160b

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SECTION 07170 - BENTONITE WATERPROOFING

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for bentonite waterproofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Bentonite waterproofing.
   b. Molded-sheet drainage panels.
   c. Insulation.

C. Submittals
1. Product Data: For each type of product indicated. Include product specifications and manufacturer's written installation instructions.
2. Shop Drawings: Show installation details for interface with other work.
3. Samples: For each of the following products, in sizes indicated:
   a. Waterproofing: 6 inches (150 mm) square.
   b. Drainage Panels: 6 inches (150 mm) square.
   c. Insulation: 6 inches (150 mm) square.
4. Material Certificates: For each type of bentonite waterproofing, from manufacturer.
5. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency **OR** a qualified testing agency, **as directed**, for bentonite waterproofing.
6. Field quality-control reports.
7. Warranty: Sample of special warranty.

D. Quality Assurance
1. Source Limitations: Obtain bentonite waterproofing system from single source from single manufacturer. Obtain accessory products used with bentonite waterproofing from sources acceptable to bentonite waterproofing manufacturer.
2. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
1. Deliver materials to Project site in manufacturer's original unopened and undamaged containers.
2. Store materials in a dry, well-ventilated space.
3. Remove and replace bentonite materials that have been prematurely exposed to moisture.

F. Project Conditions
1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit bentonite waterproofing to be installed according to manufacturers' written instructions and warranty requirements.
   a. Do not apply waterproofing materials to surfaces where ice or frost is visible. Do not apply bentonite waterproofing materials in areas with standing water.
   b. Placing bentonite clay products in panel or composite form on damp surfaces is allowed if approved in writing by manufacturer.

G. Warranty

1. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree(s) to repair or replace components of bentonite waterproofing system that fail in materials or workmanship within specified warranty period.
   a. Warranty Period: Five years from date of Substantial Completion.

1.2 PRODUCTS

A. Geotextile/Bentonite Sheets
1. Geotextile/Bentonite Waterproofing: Minimum of 1.0 lb/sq. ft. (5 kg/sq. m) of bentonite clay granules between two layers of geotextile polypropylene fabric, one woven and one nonwoven, needle punched and heat fused together.
   a. Grab Tensile Strength: 95 lbf (422 N) according to ASTM D 4632.
2. Contaminant-Resistant Geotextile/Bentonite Waterproofing: Minimum of 1.0 lb/sq. ft. (5 kg/sq. m) of bentonite clay granules specially formulated for use in saltwater or contaminated ground water, between two layers of geotextile polypropylene fabric, one woven and one nonwoven, needle punched and heat fused together.
   a. Grab Tensile Strength: 95 lbf (422 N) according to ASTM D 4632.
3. Geotextile-Geomembrane/Bentonite Waterproofing: Minimum of 1.0 lb/sq. ft. (5 kg/sq. m) of bentonite clay granules between two layers of geotextile polypropylene fabric, one woven and one nonwoven, needle punched and heat fused together; and the woven fabric coated with a low-permeable polypropylene geomembrane.
   a. Grab Tensile Strength: 95 lbf (422 N) according to ASTM D 4632.
4. Composite Geotextile-HDPE/Bentonite Membrane: Minimum of 1.1 lb/sq. ft. (5.4 kg/sq. m) of bentonite clay granules bonded to nonwoven geotextile polypropylene fabric, with HDPE bonded to surface of nonwoven fabric.
   a. Grab Tensile Strength: 120 lbf (534 N) according to ASTM D 4632.
   b. Puncture Resistance: 140 lbf (620 N) according to ASTM D 4833.
   c. Vapor Permeance: 0.03 perms according to ASTM E 96.
5. Contaminant-Resistant Composite Geotextile-HDPE/Bentonite Membrane: Minimum of 1.1 lb/sq. ft. (5.4 kg/sq. m) of bentonite clay granules specially formulated for use in saltwater or contaminated ground water, bonded to nonwoven geotextile polypropylene fabric, with HDPE bonded to surface of nonwoven fabric.
   a. Grab Tensile Strength: 120 lbf (534 N) according to ASTM D 4632.
   b. Puncture Resistance: 140 lbf (620 N) according to ASTM D 4833.
   c. Vapor Permeance: 0.03 perms according to ASTM E 96.

B. Composite HDPE/Bentonite Membrane
1. Composite HDPE/Bentonite Membrane: Minimum 90-mil- (2.3-mm-) thick membrane consisting of a 12-mil- (0.5-mm-) thick, HDPE geomembrane liner bonded to a layer of bentonite clay granules 78 mils (1.9 mm) thick.
   a. Puncture Resistance: 169 lbf (752 N) according to ASTM E 154.
   b. Vapor Permeance: 0.03 perms according to ASTM E 96.
2. Composite HDPE/Bentonite Membrane with Protective Facing: Minimum 170-mil- (4.3-mm-) thick membrane consisting of HDPE geomembrane liner bonded to a layer of bentonite clay granules and with a spun polypropylene facing.
   a. Puncture Resistance: 169 lbf (752 N) according to ASTM E 154.
   b. Vapor Permeance: 0.03 perms according to ASTM E 96.
3. Composite HDPE/Bentonite-Polymer Membrane: Minimum 200-mil- (5-mm-) thick membrane consisting of HDPE geomembrane liner bonded to a layer of bentonite-polymer clay granules.
   a. Puncture Resistance: 75 lbf (334 N) according to ASTM D 4833.
   b. Vapor Permeance: 0.005 perms according to ASTM E 96.
4. Composite Gastight HDPE/Bentonite Membrane: Minimum 150-mil- (3.8-mm-) thick membrane consisting of a 60-mil- (1.5-mm-) thick, HDPE geomembrane liner bonded to a layer of bentonite clay.

a. Puncture Resistance: 169 lbf (752 N) according to ASTM E 154.
b. Vapor Permeance: 0.03 perms according to ASTM E 96.

5. Composite Saline/Alkaline HDPE/Bentonite Membrane: Minimum 150-mil- (3.8-mm-) thick membrane consisting of a 60-mil- (1.5-mm-) thick, HDPE geomembrane liner bonded to a layer of bentonite clay granules.
   a. Puncture Resistance: 169 lbf (752 N) according to ASTM E 154.
   b. Vapor Permeance: 0.03 perms according to ASTM E 96.

C. Composite Geotextile-HDPE/Bentonite Membrane
1. Geotextile/Bentonite-Polymer Waterproofing: Minimum 250-mil- (6.4-mm-) thick membrane of bentonite-polymer clay granules between two layers of geotextile polypropylene fabric, one woven and one nonwoven, needle punched and heat fused together.
   a. Puncture Resistance: 75 lbf (334 N) according to ASTM D 4833.
   b. Vapor Permeance: 0.005 perms according to ASTM E 96.

D. Bentonite Panels
1. Standard Panels: 3/16-inch- (5-mm-) thick, corrugated kraft-paper panels with a minimum of 1.0 lb/sq. ft. (5 kg/sq. m) of bentonite confined in corrugations of boards.
2. Coated Panels: 3/16-inch- (5-mm-) thick, corrugated kraft-paper panels specially coated to resist premature hydration due to incidental moisture; filled with a minimum of 1.0 lb/sq. ft. (5 kg/sq. m) of bentonite.
3. Contaminant-Resistant Panels: 3/16-inch- (5-mm-) thick, corrugated kraft-paper panels with a minimum of 1.0 lb/sq. ft. (5 kg/sq. m) of contaminant-resistant granular bentonite specially formulated for use in contaminated ground-water conditions; confined in corrugations of boards.

E. Installation Accessories
1. Granular Bentonite: Sodium bentonite clay containing a minimum of 90 percent montmorillonite (hydrated aluminum silicate), with a minimum of 90 percent passing a No. 20 (0.85-mm) sieve.
2. Bentonite Mastic: Trowelable consistency, bentonite compound, specifically formulated for application at joints and penetrations.
3. Granular Bentonite Tubes: Manufacturer's standard 2-inch- (50-mm-) diameter, water-soluble tube containing approximately 1.5 lb/ft. (2.2 kg/m) of bentonite; hermetically sealed; designed specifically for placing on wall footings at line of joint with exterior base of wall.
4. Termination Bar: Extruded-aluminum or formed-stainless-steel bars with upper flange to receive sealant.
5. Plastic Protection Sheet: Polyethylene sheeting complying with ASTM D 4397; thickness recommended by waterproofing manufacturer to suit application but at least 6 mils (0.15 mm) thick.
6. Cement Grout Patching Material: Manufacturer's recommended grout mix compatible with substrate being patched.
7. Masonry Fasteners: Case-hardened nails or hardened-steel, powder-actuated fasteners. Depending on manufacturer's written requirements, provide 1/2- or 1-inch- (13- or 25-mm-) diameter washers under fastener heads.
8. Sealants: As recommended in writing by waterproofing manufacturer. Comply with requirements specified in Division 7 Section "Joint Sealants."
9. Tapes: Waterproofing manufacturer's recommended tape for joints between sheets, membranes, or panels.
10. Adhesive: Water-based adhesive used to secure waterproofing to both vertical and horizontal surfaces.
11. Protection Course: ASTM D 6506, semirigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners, and as follows:
    a. Thickness: 1/8 inch (3 mm), nominal, for vertical applications; 1/4 inch (6 mm), nominal, elsewhere.
12. Geotextile Protection Course: As recommended by waterproofing manufacturer.
13. Molded-Sheet Drainage Panel: Comply with Division 02 Section "Subdrainage".

14. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel: Manufactured composite subsurface drainage panels consisting of a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 (0.21-mm) sieve laminated to one side with **OR** without, **as directed**, a polymeric film bonded to the other side of a studded, nonbiodegradable, molded-plastic-sheet drainage core, with a vertical flow rate of 9 to 15 gpm per foot (112 to 188 L/min. per m).
15. Woven-Geotextile-Faced, Molded-Sheet Drainage Panel: Manufactured composite subsurface drainage panels consisting of a woven-geotextile facing with an apparent opening size not exceeding No. 40 (0.425-mm) sieve laminated to one side with **OR** without, **as directed**, a polymeric film bonded to the other side of a studded, nonbiodegradable, molded-plastic-sheet drainage core, with a horizontal flow rate not less than 2.8 gpm per foot (35 L/min. per m).
16. Board Insulation: Extruded-polystyrene board insulation complying with ASTM C 578, square **OR** shiplap, **as directed**, edged.
    a. Type VI, 40-psi (276-kPa) minimum compressive strength.
    b. Type VII, 60-psi (414-kPa) minimum compressive strength.
    c. Type V, 100-psi (690-kPa) minimum compressive strength.
17. Unfaced Wall Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type VI, 40-psi (276-kPa) minimum compressive strength; unfaced; fabricated with shiplap or channel edges and with one side having grooved drainage channels.
18. Geotextile-Faced Wall Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type VI, 40-psi (276-kPa) minimum compressive strength; fabricated with tongue-and-groove edges and with one side having grooved drainage channels faced with nonwoven geotextile filter fabric.
19. Unfaced Plaza Deck Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type VI, 40-psi (276-kPa) **OR** Type VII, 60-psi (414-kPa), **as directed**, minimum compressive strength; unfaced; fabricated with shiplapped or channel edges and with one side having ribbed drainage channels.

1.3 EXECUTION

A. Examination
1. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrate preparations affecting performance of bentonite waterproofing.
2. Verify that substrate is complete and that work that will penetrate waterproofing is complete and rigidly installed.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Coordinate work in the vicinity of waterproofing to ensure proper conditions for installing the waterproofing system and to prevent damage to waterproofing after installation.
2. Formed Concrete Surfaces: Remove fins and projections. Fill voids, rock pockets, form-tie holes, and other defects with bentonite mastic or cement grout patching material according to manufacturer's written instructions.
3. Horizontal Concrete Surfaces: Remove debris, standing water, oily substances, mud, and similar substances that could impair the bonding ability of concrete or the effectiveness of waterproofing. Fill voids, cracks greater than 1/8 inch (3 mm), honeycomb areas, and other defects with bentonite mastic or cement grout patching material according to manufacturer's written instructions.
4. Excavation Support and Protection System: If water is seeping, use plastic protection sheets or other suitable means to prevent wetting the bentonite waterproofing. Fill minor gaps and spaces 1/8 inch (3 mm) wide or wider with wood, metal, concrete, or other appropriate filling material. Cover or fill large voids and crevices with cement mortar according to manufacturer's written instructions.

C. Installation, General
   1. Install waterproofing and accessories according to manufacturer's written instructions.
      a. Apply granular bentonite around penetrations in horizontal surfaces and changes in plane according to manufacturer's details in preparation for granular bentonite tubes and mastic.
      b. Apply granular bentonite tubes, bentonite mastic, or both at changes of plane, construction joints in substrate, projections, and penetrations.
   2. Apply granular bentonite tubes continuously on footing against base of wall to be waterproofed according to manufacturer's written instructions.
   3. Protect waterproofing from damage and wetting before and during subsequent construction operations. Repair punctures, tears, and cuts according to manufacturer's written instructions.
   4. Install protection course before backfilling or placing overburden when recommended by waterproofing manufacturer.

D. Geotextile/Bentonite Sheet Installation
   1. General: Install a continuous layer of waterproofing sheets directly against concrete to be waterproofed. Lap ends and edges a minimum of 4 inches (100 mm) on horizontal and vertical substrates. Stagger end joints between sheets a minimum of 24 inches (600 mm). Fasten seams by stapling to adjacent sheet or nailing to substrate.
   2. Below Structural Slabs-on-Grade: Place waterproofing sheets on compacted substrate with ends and edges lapped and stapled.
      a. Install a layer of waterproofing sheets under footings, grade beams, and pile caps; or continue waterproofing through key joints between footings and foundation walls, and extend a minimum of 8 inches (200 mm) up or beyond perimeter slab forms.
   3. Concrete Walls: Starting at bottom of wall, apply waterproofing sheets horizontally with primary backing side against wall. Secure with masonry fasteners spaced according to manufacturer's written instructions. Extend to bottom of footing, grade beam, or wall, and secure.
      a. Termination at Grade: Extend waterproofing sheets to within 2 inches (50 mm) of finish grade unless otherwise indicated. Secure top edge with termination bar. Apply sealant to top edge of termination bar.

         OR

         Termination at Grade: Fasten top edge of waterproofing sheets to wall and protect top edge with sheet metal counterflashing. Cover waterproofing with a lapped course of plastic protection sheets if backfilling does not proceed immediately.
   4. Excavation Support and Protection (Permanent Shoring): Encase tieback rods, nuts, and plates, using bentonite mastic and waterproofing sheets, according to waterproofing manufacturer's written instructions for each configuration.
      a. Install a layer of waterproofing sheets, with ends and edges lapped and nailed to shoring. Cover waterproofing with plastic protection sheets if needed for protection from precipitation; remove plastic sheets before placing concrete.
      b. Inspect and repair waterproofing after reinforcing steel has been placed. Coordinate and control concrete placement to avoid damage to waterproofing.

E. Composite HDPE/Bentonite Membrane Installation
   1. General: Install a continuous layer of waterproofing membrane with ends and edges lapped a minimum of 3 inches (75 mm). Stagger end joints between membranes. Seal joints with permanent seam tape.
   2. Below Structural Slabs-on-Grade: Apply waterproofing membrane with HDPE side down and staple ends and edges.
      a. Install under footings, grade beams, and pile caps; or continue waterproofing through key joints between footings and foundation walls, and extend a minimum of 8 inches (200 mm) up or beyond perimeter slab forms.
      b. Protect waterproofing from damage caused by reinforcing bar supports with sharp edges.
   3. Slabs: Starting at lowest point, install a continuous layer of waterproofing membrane, with ends and edges lapped a minimum of 2 inches (50 mm).
   4. Vertical Concrete or Masonry Walls: Apply mastic around penetrations and form continuous 2-inch (50-mm) cant at intersection of footings and walls with mastic.

a. Starting at lowest point, install a layer of waterproofing membrane horizontally, extending a minimum of 6 inches (150 mm) onto the footing. Lap membrane ends and edges a minimum of 2 inches (50 mm).
b. Secure membrane to wall with adhesive or washer-headed fasteners, and tape terminations of membrane at grade.

5. Excavation Support and Protection: Cut, clean, and treat tiebacks and similar projections. Encase tieback rods, nuts, and plates. If water is present, cover shoring and lagging with plastic protection sheets.
   a. Starting at lowest point, install a layer of waterproofing membrane, with ends and edges lapped and nailed to shoring.
6. Horizontal Roofs, Plazas, and between Slabs: Starting at lowest point, install a layer of waterproofing membrane, with ends and edges lapped and taped a minimum of 3 inches (75 mm).
   a. Prime concrete substrates. Primer may be omitted on concrete surfaces that comply with requirements for dryness, surface texture, and freedom from imperfections.
   b. Install bentonite side of membrane against the material to be waterproofed.
   c. Terminations at Vertical Surfaces: Provide a fillet or cant at intersection of horizontal and vertical substrates. Extend waterproofing membrane to top of curb or to a minimum of 6 inches (150 mm) above plane of waterproofing; secure with manufacturer's recommended tape.
   d. Cover waterproofing with a plastic slip-sheet.

F. Composite Geotextile-HDPE/Bentonite Membrane Installation
1. General: Install a continuous layer of waterproofing membrane with ends and edges lapped a minimum of 3 inches (75 mm). Stagger end joints between membranes. Seal joints with permanent seam tape.
2. Below Structural Slabs-on-Grade: Apply waterproofing membrane with HDPE side down and staple ends and edges.
   a. Install under footings, grade beams, and pile caps; or continue waterproofing through key joints between footings and foundation walls, and extend a minimum of 8 inches (200 mm) up or beyond perimeter slab forms.
   b. Protect waterproofing from damage caused by reinforcing bar supports with sharp edges.
3. Concrete Walls: Starting at bottom of wall, apply waterproofing membrane with HDPE side facing Installer; overlap sheets 3 inches (75 mm). Secure with powder-actuated fasteners or case-hardened nails. Extend to bottom of footing, grade beam, or wall, and secure.
   a. Termination at Grade: Extend waterproofing membrane to within 2 inches (50 mm) of finish grade unless otherwise indicated. Secure top edge with termination bar. Apply sealant to top edge of termination bar.
4. Excavation Support and Protection (Permanent Shoring): Cut, clean, and treat tiebacks and similar projections. Encase tieback rods, nuts, and plates. If water is present, cover shoring and lagging with plastic protection sheets; remove plastic sheets before placing concrete.
   a. Starting at lowest point, install a layer of waterproofing membrane, with ends and edges lapped and mechanically secured to shoring.
   b. Inspect and repair waterproofing membrane after reinforcing steel has been placed. Coordinate and control concrete placement to avoid damage to waterproofing.
5. Horizontal Slabs, Roofs, and Plazas: Starting at lowest point, install a layer of waterproofing membrane, with ends and edges lapped and taped a minimum of 3 inches (75 mm).
   a. Clean overlap area and apply waterproof tape, rolling the exposed edge to seal to sheet below.
   b. Turn edges up and seal to vertical surfaces.
   c. Cover waterproofing with a plastic slip-sheet.

G. Bentonite Panel Installation

1. General: Install a continuous layer of bentonite waterproofing panels with ends and edges lapped a minimum of 1-1/2 inches (38 mm) unless otherwise indicated. Stagger joints in adjoining panel rows.
   a. Install a double layer of waterproofing panels, with ends and edges butted instead of lapped and with second layer of joints staggered over first. Staple panels together to hold them in place.
2. Concrete Walls: Starting at bottom of wall, apply waterproofing panels with ends and edges lapped and with vertical joints staggered. Secure with fasteners or adhesive recommended in writing by manufacturer. Extend to bottom of footing, grade beam, or wall.
   a. Horizontal-to-Vertical Transitions: Install granular bentonite tubes immediately before backfilling and compact backfill over the joint.
   b. Termination at Grade: Extend waterproofing panels to within 2 inches (50 mm) of finish grade unless otherwise indicated. Secure top edge with termination bar. Apply sealant to top edge of termination bar.
      OR
      Termination at Grade: Fasten top edge of waterproofing panels to wall and protect top edge with sheet metal counterflashing.
   c. Cover waterproofing panels with a lapped course of plastic protection sheets; remove plastic sheets before backfilling.

H. Molded-Sheet Drainage Panel Installation
1. Place and secure molded-sheet drainage panels, with geotextile facing away from wall or deck substrate. Use adhesives or mechanical fasteners that do not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.
   a. For vertical applications, install board insulation **OR** protection course, **as directed**, before installing drainage panels.

I. Insulation Installation
1. Install one or more layers of board insulation to achieve required thickness and insulation drainage panels over waterproofed surfaces. Cut and fit to within 3/4 inch (19 mm) of projections and penetrations.
2. On vertical surfaces, set insulation units in adhesive or tape applied according to manufacturer's written instructions.
3. On horizontal surfaces, loosely lay insulation units. Stagger end joints and tightly abut insulation units.

J. Field Quality Control
1. Inspection: Arrange for manufacturer's representative to inspect completed waterproofing installation before covering with other construction and provide written report that installation complies with manufacturer's written instructions.
   a. Remove and replace applications of bentonite waterproofing where inspection indicates that it does not comply with specified requirements.
2. Flood Testing: Flood test each deck area for leaks, according to recommendations in ASTM D 5957, after completing waterproofing but before overlaying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.
   a. Flood to an average depth of 2-1/2 inches (64 mm) with a minimum depth of 1 inch (25 mm) but not exceeding a depth of 4 inches (100 mm). Maintain 2 inches (50 mm) of clearance from top of membrane flashings.
   b. Flood each area for 24 **OR** 48, **as directed**, hours.
   c. After flood testing, repair leaks, repeat flood test, and make further repairs until waterproofing installation is watertight.
3. Perform additional testing and inspecting, at Contractor's expense, to determine compliance of replaced or additional work with specified requirements.

END OF SECTION 07170

SECTION 07190 - WATER REPELLENTS

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for water repellents. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes penetrating and film-forming water-repellent coatings for the following vertical and horizontal surfaces:
   a. Concrete (unpainted).
   b. Cast stone.
   c. Brick masonry.
   d. Concrete unit masonry (unpainted and unglazed).
   e. Portland cement plaster (stucco).
   f. Stonework.

C. Performance Requirements
1. Performance Testing: Provide water repellents that comply with test-performance requirements indicated, as evidenced by reports of tests performed by manufacturer **OR** based on Project-specific preconstruction testing, **as directed**, by a qualified independent testing agency on manufacturer's standard products applied to substrates simulating those on Project using same application methods to be used for Project.
   a. Engage testing agency to perform preconstruction tests on laboratory mockups.
   b. Select sizes and configurations of assemblies to adequately demonstrate capability of water repellents to comply with performance requirements.
   c. Notify the Owner seven days in advance of the dates and times when assemblies will be constructed.
2. Absorption: Minimum 80 **OR** 90, **as directed**, percent reduction of absorption after 24 hours in comparison of treated and untreated specimens.
   a. Brick: ASTM C 67.
   b. Stone: ASTM C 97.
   c. Concrete Unit Masonry: ASTM C 140.
   d. Hardened Concrete: ASTM C 642.
3. Water-Vapor Transmission: Maximum 10 percent reduction in rate of vapor transmission in comparison of treated and untreated specimens, per ASTM E 96.
4. Permeability: Minimum 80 percent water-vapor transmission in comparison of treated and untreated specimens, per ASTM D 1653.
5. Water Penetration and Leakage through Masonry: Maximum 90 percent reduction in leakage rate in comparison of treated and untreated specimens, per ASTM E 514.
6. Durability: Maximum 5 percent loss of water repellency after 2500 hours of weathering in comparison to specimens before weathering, per ASTM G 154.
   a. Reduction of Water Absorption: 80 percent.
   b. Reduction in Chloride Content: 80 percent.

D. Submittals
1. Product Data: For each type of product indicated.
2. Product test reports.

E. Quality Assurance
1. Installer Qualifications: An employer of workers trained and approved by manufacturer.

F. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer and Applicator agree(s) to repair or replace materials that fail to maintain water repellency specified in Part 1.1 "Performance Requirements" Article within specified warranty period.
a. Warranty Period: Two **OR** Five, **as directed**, years from date of Substantial Completion.

1.2 PRODUCTS

A. Penetrating Water Repellents
1. Silane, Penetrating Water Repellent: Clear, monomeric compound containing 20 percent or more solids of alkyltrialkoxysilanes; with alcohol, mineral spirits, water, or other proprietary solvent carrier; and with 3.3 lb/gal. (400 g/L) or less of VOCs.
2. Silane, Penetrating Water Repellent: Clear, monomeric compound containing 20 percent or more solids of alkyltrialkoxysilanes; with alcohol, mineral spirits, water, or other proprietary solvent carrier; and with 5 lb/gal. (600 g/L) or less of VOCs.
3. Silane, Penetrating Water Repellent: Pigmented, monomeric compound containing 20 percent or more solids of alkyltrialkoxysilanes; with alcohol, mineral spirits, water, or other proprietary solvent carrier; and with 5 lb/gal. (600 g/L) or less of VOCs.
4. Silane, Penetrating Water Repellent: Clear, monomeric compound containing 20 percent or more solids of alkyltrialkoxysilanes; with alcohol, mineral spirits, water, or other proprietary solvent carrier; and with more than 5 lb/gal. (600 g/L) of VOCs.
5. Siloxane, Penetrating Water Repellent: Clear, oligomerous alkylalkoxysiloxanes containing 10 percent or more solids; with alcohol, ethanol, mineral spirits, water, or other proprietary solvent carrier; and with 3.3 lb/gal. (400 g/L) or less of VOCs.
6. Siloxane, Penetrating Water Repellent: Clear, oligomerous alkylalkoxysiloxanes containing 10 percent or more solids; with alcohol, ethanol, mineral spirits, water, or other proprietary solvent carrier; and with 5 lb/gal. (600 g/L) or less of VOCs.
7. Siloxane, Penetrating Water Repellent: Clear, oligomerous alkylalkoxysiloxanes containing 10 percent or more solids; with alcohol, ethanol, mineral spirits, water, or other proprietary solvent carrier; and with more than 5 lb/gal. (600 g/L) of VOCs.
8. Silane/Siloxane-Blend, Penetrating Water Repellent: Clear, silane and siloxane blends with 3.3 lb/gal. (400 g/L) or less of VOCs.
9. Silane/Siloxane-Blend, Penetrating Water Repellent: Clear, silane and siloxane blends with 5 lb/gal. (600 g/L) or less of VOCs.
10. Proprietary-Blend, Penetrating Water Repellent: Clear, consisting of 1 or several different resins (silanes or siloxanes), polymers, stearates, or oils plus other compounds or products of components; and with 3.3 lb/gal. (400 g/L) or less of VOCs.
11. Proprietary-Blend, Penetrating Water Repellent: Clear, consisting of 1 or several different resins (silanes or siloxanes), polymers, stearates, or oils plus other compounds or products of components; and with 5 lb/gal. (600 g/L) or less of VOCs.

B. Film-Forming Water Repellents
1. Silicone Sealer, Film-Forming Water Repellent: Clear, polymerized, silicone-resin water repellent for dense substrates; with a solvent- or water-based solution containing not less than 3 and up to 5 percent solids by weight; and with 3.3 lb/gal. (400 g/L) or less of VOCs.
2. Silicone-Sealer, Film-Forming Water Repellent: Clear, polymerized, silicone-resin water repellent for dense substrates; with a solvent- or water-based solution containing not less than 3 and up to 5 percent solids by weight; and with 5 lb/gal. (600 g/L) or less of VOCs.
3. Proprietary-Blend, Film-Forming Water Repellent: Clear, consisting of 1 or several different resins, acrylics, polymers, stearates, or oils plus other compounds or products of components; and with 3.3 lb/gal. (400 g/L) or less of VOCs.
4. Proprietary-Blend, Film-Forming Water Repellent: Clear, consisting of 1 or several different resins, acrylics, polymers, stearates, or oils plus other compounds or products of components; and with 5 lb/gal. (600 g/L) or less of VOCs.

5. Siliconate, Film-Forming Water Repellent: Clear, with 3.3 lb/gal. (400 g/L) or less of VOCs.
6. Acrylic, Film-Forming Water Repellent: Clear **OR** Pigmented, **as directed**, breathing coating of acrylic resins; with a water-based, solvent-based, or acrylic emulsion solution containing less than 15 percent solids by volume; and with 3.3 lb/gal. (400 g/L) or less of VOCs.
   a. Colors: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
7. Acrylic, Film-Forming Water Repellent: Pigmented, with 5 lb/gal. (600 g/L) or less of VOCs.
   a. Colors: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

1.3 EXECUTION

A. Preparation
1. Clean substrate of substances that might interfere with penetration or performance of water repellents. Test for moisture content, according to water-repellent manufacturer's written instructions, to ensure that surface is dry enough.
   a. Cast-in-Place Concrete: Remove oil, curing compounds, laitance, and other substances that could prevent adhesion or penetration of water repellents.
   b. Clay Brick Masonry: Clean clay brick masonry per ASTM D 5703.
2. Test for pH level, according to water-repellent manufacturer's written instructions, to ensure chemical bond to silicate minerals.
3. Protect adjoining work, including sealant bond surfaces, from spillage or blow-over of water repellent. Cover adjoining and nearby surfaces of aluminum and glass if there is the possibility of water repellent being deposited on surfaces. Cover live plants and grass.
4. Coordination with Sealants: Do not apply water repellent until sealants for joints adjacent to surfaces receiving water-repellent treatment have been installed and cured.
   a. Water-repellent work may precede sealant application only if sealant adhesion and compatibility have been tested and verified using substrate, water repellent, and sealant materials identical to those used in the work.
5. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Application
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect the substrate before application of water repellent and to instruct Applicator on the product and application method to be used.
2. Apply a heavy-saturation spray coating of water repellent on surfaces indicated for treatment using low-pressure spray equipment. Comply with manufacturer's written instructions for using airless spraying procedure, unless otherwise indicated.
   a. Precast Concrete: At Contractor's option, first application of water repellent on precast concrete units may be completed before installing units. Mask sealant-bond surfaces to prevent water repellent from migrating onto joint surfaces.
3. Apply a second saturation spray coating, as directed, repeating first application. Comply with manufacturer's written instructions for limitations on drying time between coats and after rainstorm wetting of surfaces between coats. Consult manufacturer's technical representative if written instructions are not applicable to Project conditions.

C. Cleaning
1. Immediately clean water repellent from adjoining surfaces and surfaces soiled or damaged by water-repellent application as work progresses. Repair damage caused by water-repellent application. Comply with manufacturer's written cleaning instructions.

END OF SECTION 07190

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SECTION 07210 - BUILDING INSULATION

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for building insulation. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Perimeter insulation under slabs-on-grade.
b. Perimeter wall insulation (supporting backfill).
c. Cavity-wall insulation.
d. Concealed building insulation.
e. Exposed building insulation.
f. Loose-fill building insulation.
g. Self-supported, spray-applied cellulosic insulation.
h. Radiant barriers.
i. Vapor retarders.
j. Sound attenuation insulation.

C. Definitions
1. Mineral-Fiber Insulation: Insulation composed of rock-wool fibers, slag-wool fibers, or glass fibers; produced in boards and blanket with latter formed into batts (flat-cut lengths) or rolls.

D. Performance Requirements
1. Plenum Rating: Provide glass-fiber **OR** slag-wool-fiber/rock-wool-fiber, **as directed**, insulation where indicated in ceiling plenums whose test performance is rated as follows for use in plenums as determined by testing identical products per "Erosion Test" and "Mold Growth and Humidity Test" described in UL 181, or on comparable tests from another standard acceptable to authorities having jurisdiction.
a. Erosion Test Results: Insulation shows no visible evidence of cracking, flaking, peeling, or delamination of interior surface of duct assembly, after testing for 4 hours at 2500-fpm (13-m/s) air velocity.
b. Mold Growth and Humidity Test Results: Insulation shows no evidence of mold growth, delamination, or other deterioration due to the effects of high humidity, after inoculation with Chaetomium globosium on all surfaces and storing for 60 days at 100 percent relative humidity in the dark.

E. Submittals
1. Product Data: For each type of product indicated.
2. Samples: Full-size units for each type of exposed insulation indicated.
3. LEED Submittal:
a. Product Data for Credit MR 4.1 and MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
1) Include statement indicating costs for each product having recycled content.
4. Product test reports.
5. Research/Evaluation Reports: For foam-plastic insulation.

F. Quality Assurance

1. Fire-Test-Response Characteristics: Provide insulation and related materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
   a. Surface-Burning Characteristics: ASTM E 84.
   b. Fire-Resistance Ratings: ASTM E 119.
   c. Combustion Characteristics: ASTM E 136.

G. Delivery, Storage, And Handling
1. Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
2. Protect plastic insulation as follows:
   a. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
   b. Protect against ignition at all times. Do not deliver plastic insulating materials to Project site before installation time.
   c. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.2 PRODUCTS

A. Foam-Plastic Board Insulation
1. Extruded-Polystyrene Board Insulation: ASTM C 578, of type and density indicated below, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively:
   a. Type IV, 1.60 lb/cu. ft. (26 kg/cu. m), unless otherwise indicated.
   b. Type X, 1.30 lb/cu. ft. (21 kg/cu. m).
   c. Type VI, 1.80 lb/cu. ft. (29 kg/cu. m).
   d. Type VII, 2.20 lb/cu. ft. (35 kg/cu. m).
   e. Type V, 3.00 lb/cu. ft. (48 kg/cu. m).
2. Extruded-Polystyrene Drainage Panels: ASTM C 578, of type and density indicated below and fabricated with one side having a matrix of drainage and edge channels.
   a. Type IV, 1.60 lb/cu. ft. (26 kg/cu. m).
   b. Type VI, 1.80 lb/cu. ft. (29 kg/cu. m).
   c. Type VII, 2.20 lb/cu. ft. (35 kg/cu. m).
3. Fabric-Faced, Extruded-Polystyrene Drainage Panels: ASTM C 578, Type VI, with a density of 1.80 lb/cu. ft. (29 kg/cu. m), faced with insulation manufacturer's standard nonwoven filtration fabric and fabricated with 1 side having a matrix of drainage and edge channels.
4. Molded-Polystyrene Board Insulation: ASTM C 578, of type and density indicated below, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively:
   a. Type I, 0.90 lb/cu. ft. (15 kg/cu. m).
   b. Type VIII, 1.15 lb/cu. ft. (18 kg/cu. m).
   c. Type II, 1.35 lb/cu. ft. (22 kg/cu. m).
5. Foil-Faced, Polyisocyanurate Board Insulation: ASTM C 1289, Type I, Class 1 **OR** 2, **as directed**, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, based on tests performed on unfaced core on thicknesses up to 4 inches (101 mm).

B. Cellular-Glass Insulation
1. Cellular-Glass Insulation: ASTM C 552 Type I (flat block) **OR** IV (board) faced on both sides with manufacturer's special kraft-paper sheets laminated to glass block with asphalt, **as directed**, with unfaced insulation passing ASTM E 136 for combustion characteristics.

C. Glass-Fiber Board Insulation

1. Unfaced, Flexible Glass-Fiber Board Insulation: ASTM C 612, Type IA; ASTM C 553, Types I, II, and III; or ASTM C 665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, passing ASTM E 136 for combustion characteristics; and of the following nominal density and thermal resistivity:
   a. Nominal density of 1.0 lb/cu. ft. (16 kg/cu. m), thermal resistivity of 3.7 deg F x h x sq. ft./Btu x in. at 75 deg F (25.7 K x m/W at 24 deg C).
   b. Nominal density of not less than 1.5 lb/cu. ft. (24 kg/cu. m) nor more than 1.7 lb/cu. ft. (27 kg/cu. m), thermal resistivity of 4 deg F x h x sq. ft./Btu x in. at 75 deg F (27.7 K x m/W at 24 deg C).
2. Foil-Faced, Flexible Glass-Fiber Board Insulation: ASTM C 612, Type IA or ASTM C 553, Types I, II, and III; faced on 1 side with foil-scrim-kraft vapor retarder; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; and of the following nominal density and thermal resistivity:
   a. Nominal density of 1.0 lb/cu. ft. (16 kg/cu. m), thermal resistivity of 3.7 deg F x h x sq. ft./Btu x in. at 75 deg F (25.7 K x m/W at 24 deg C).
   b. Nominal density of not less than 1.5 lb/cu. ft. (24 kg/cu. m) nor more than 1.7 lb/cu. ft. (27 kg/cu. m), thermal resistivity of 4 deg F x h x sq. ft./Btu x in. at 75 deg F (27.7 K x m/W at 24 deg C).
3. Unfaced, Glass-Fiber Board Insulation: ASTM C 612, Type IA or Types IA and IB; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics; and of the following nominal density and thermal resistivity:
   a. Nominal density of 2.25 lb/cu. ft. (36 kg/cu. m), thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F (29.8 K x m/W at 24 deg C).
   b. Nominal density of 3 lb/cu. ft. (48 kg/cu. m), thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F (29.8 K x m/W at 24 deg C).
   c. Nominal density of 4.25 lb/cu. ft. (68 kg/cu. m), thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F (29.8 K x m/W at 24 deg C).
   d. Nominal density of 6 lb/cu. ft. (96 kg/cu. m), thermal resistivity of 4.4 deg F x h x sq. ft./Btu x in. at 75 deg F (30.5 K x m/W at 24 deg C).
4. Foil-Faced, Glass-Fiber Board Insulation: ASTM C 612, Type IA or Types IA and IB; faced on 1 side with foil-scrim-kraft or foil-scrim-polyethylene vapor retarder, with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; and of the following nominal density and thermal resistivity:
   a. Nominal density of 2.25 lb/cu. ft. (36 kg/cu. m), thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F (29.8 K x m/W at 24 deg C).
   b. Nominal density of 3 lb/cu. ft. (48 kg/cu. m), thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F (29.8 K x m/W at 24 deg C).
   c. Nominal density of 4.25 lb/cu. ft. (68 kg/cu. m), thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F (29.8 K x m/W at 24 deg C).
   d. Nominal density of 6 lb/cu. ft. (96 kg/cu. m), thermal resistivity of not less than 4.34 deg F x h x sq. ft./Btu x in. at 75 deg F (30.1 K x m/W at 24 deg C).
5. Glass-Mat-Faced, Glass-Fiber Board Insulation: ASTM C 612, Type IA or Types IA and IB; faced on 1 side with black glass-fiber mat or black polymer finish; maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; and of the following nominal density and thermal resistivity:
   a. Nominal density of 1.5 lb/cu. ft. (24 kg/cu. m), thermal resistivity of 4.2 deg F x h x sq. ft./Btu x in. at 75 deg F (29.1 K x m/W at 24 deg C).
   b. Nominal density of 2.25 lb/cu. ft. (36 kg/cu. m), thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F (29.8 K x m/W at 24 deg C).
   c. Nominal density of 3 lb/cu. ft. (48 kg/cu. m), thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F (29.8 K x m/W at 24 deg C).
   d. Nominal density of 6 lb/cu. ft. (96 kg/cu. m), thermal resistivity of 4.5 deg F x h x sq. ft./Btu x in. at 75 deg F (31.2 K x m/W at 24 deg C).

D. Slag-Wool-Fiber/Rock-Wool-Fiber Board Insulation

1. Unfaced, Slag-Wool-Fiber/Rock-Wool-Fiber Board Insulation: ASTM C 612, maximum flame-spread and smoke-developed indexes of 15 and 0, respectively; passing ASTM E 136 for combustion characteristics; and of the following nominal density and thermal resistivity:
   a. Nominal density of 4 lb/cu. ft. (64 kg/cu. m), Types IA and IB, thermal resistivity of 4 deg F x h x sq. ft./Btu x in. at 75 deg F (27.7 K x m/W at 24 deg C).
   b. Nominal density of 6 lb/cu. ft. (96 kg/cu. m), Type II, thermal resistivity of 4.16 deg F x h x sq. ft./Btu x in. at 75 deg F (28.8 K x m/W at 24 deg C).
   c. Nominal density of 8 lb/cu. ft. (128 kg/cu. m), Type III, thermal resistivity of 4.35 deg F x h x sq. ft./Btu x in. at 75 deg F (30.2 K x m/W at 24 deg C).
   d. Fiber Color: Regular color, unless otherwise indicated.
   e. Fiber Color: Darkened, where indicated.
2. Foil-Faced, Slag-Wool-Fiber/Rock-Wool-Fiber Board Insulation: ASTM C 612; faced on 1 side with foil-scrim or foil-scrim-polyethylene vapor retarder; with maximum flame-spread and smoke-developed indexes of 25 and 5, respectively; and of the following nominal density and thermal resistivity:
   a. Nominal density of 4 lb/cu. ft. (64 kg/cu. m), Types IA and IB, thermal resistivity of 4 deg F x h x sq. ft./Btu x in. at 75 deg F (27.7 K x m/W at 24 deg C).
   b. Nominal density of 6 lb/cu. ft. (96 kg/cu. m), Type II, thermal resistivity of 4.16 deg F x h x sq. ft./Btu x in. at 75 deg F (28.8 K x m/W at 24 deg C).
   c. Nominal density of 8 lb/cu. ft. (128 kg/cu. m), Type III, thermal resistivity of 4.35 deg F x h x sq. ft./Btu x in. at 75 deg F (30.2 K x m/W at 24 deg C).

E. Glass-Fiber Blanket Insulation
1. Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.
2. Faced, Glass-Fiber Blanket Insulation: ASTM C 665, Type III (blankets with reflective membrane facing), Class A (membrane-faced surface with a flame-spread index of 25 or less); Category 1 (membrane is a vapor barrier), faced with foil-scrim-kraft, foil-scrim, or foil-scrim-polyethylene **OR** polypropylene-scrim-kraft, **as directed**, vapor-retarder membrane on 1 face.
3. Where glass-fiber blanket insulation is indicated by the following thicknesses, provide blankets in batt or roll form with thermal resistances indicated:
   a. 3-1/2 inches (89 mm) thick with a thermal resistance of 11 deg F x h x sq. ft./Btu at 75 deg F (1.9 K x sq. m/W at 24 deg C) **OR** 13 deg F x h x sq. ft./Btu at 75 deg F (2.3 K x sq. m/W at 24 deg C), **as directed**.
   b. 3-5/8 inches (92 mm) thick with a thermal resistance of 11 deg F x h x sq. ft./Btu at 75 deg F (1.9 K x sq. m/W at 24 deg C).
   c. 5-1/2 inches (140 mm) thick with a thermal resistance of 19 deg F x h x sq. ft./Btu at 75 deg F (3.3 K x sq. m/W at 24 deg C).
   d. 6-1/2 inches (165 mm) thick with a thermal resistance of 21 deg F x h x sq. ft./Btu at 75 deg F (3.7 K x sq. m/W at 24 deg C).
   e. 9-1/2 inches (241 mm) **OR** 10 inches (254 mm) **OR** 10-1/4 inches (260 mm), **as directed,** thick with a thermal resistance of 30 deg F x h x sq. ft./Btu at 75 deg F (5.2 K x sq. m/W at 24 deg C).

F. Slag-Wool-Fiber/Rock-Wool-Fiber Blanket Insulation
1. Unfaced, Slag-Wool-Fiber/Rock-Wool-Fiber Blanket Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.
2. Faced, Slag-Wool-Fiber/Rock-Wool-Fiber Blanket Insulation: ASTM C 665, Type III (blankets with reflective membrane facing), Class A (membrane-faced surface with a flame spread of 25 or less); Category 1 (membrane is a vapor barrier), faced with foil-scrim-kraft, foil-scrim, or foil-scrim-polyethylene vapor-retarder membrane on 1 face.

3. Where slag-wool-fiber/rock-wool-fiber blanket insulation is indicated by the following thicknesses, provide blankets in batt form with thermal resistances indicated:
   a. 1-1/2 inches (38 mm) thick with a thermal resistance of 6 deg F x h x sq. ft./Btu at 75 deg F (1 K x sq. m/W at 24 deg C).
   b. 3-1/2 inches (89 mm) thick with a thermal resistance of 13 deg F x h x sq. ft./Btu at 75 deg F (2.3 K x sq. m/W at 24 deg C).
   c. 4 inches (101 mm) thick with a thermal resistance of 16 deg F x h x sq. ft./Btu at 75 deg F (2.8 K x sq. m/W at 24 deg C).
   d. 5-1/4 inches (133 mm) thick with a thermal resistance of 19 deg F x h x sq. ft./Btu at 75 deg F (3.3 K x sq. m/W at 24 deg C).
   e. 6 inches (152 mm) thick with a thermal resistance of 22 deg F x h x sq. ft./Btu at 75 deg F (3.9 K x sq. m/W at 24 deg C).

G. Loose-Fill Insulation
1. Cellulosic-Fiber Loose-Fill Insulation: ASTM C 739, chemically treated for flame-resistance, processing, and handling characteristics.
2. Glass-Fiber Loose-Fill Insulation: ASTM C 764, Type I for pneumatic application or Type II for poured application; with maximum flame-spread and smoke-developed indexes of 5.

H. Spray-Applied Cellulosic Insulation
1. Self-Supported, Spray-Applied Cellulosic Insulation: ASTM C 1149, Type I (materials applied with liquid adhesive; suitable for either exposed or enclosed applications), **OR** Type II (materials containing a dry adhesive activated by water during installation; intended only for enclosed or covered applications), **OR** Type III (materials containing an adhesive mixed with water during application; intended for application on attic floors), **as directed**, chemically treated for flame-resistance, processing, and handling characteristics.

I. Radiant Barriers
1. Interior Radiation Control Coating: ASTM C 1321. Silver-colored, not thickness-dependent, low-emissivity solvent-based **OR** water-based, **as directed**, coating, formulated for adherence to substrates indicated and with a surface emittance value of 0.25 or less as measured per ASTM C 1371.
2. Sheet Radiant Barriers: ASTM C 1313 and as follows:
   a. Sheet Construction: Foil on one side of substrate **OR** Foil on both sides of substrate **OR** Vacuum metallizing on substrate, **as directed**.
   b. Surface-Burning Characteristics: Maximum flame-spread and smoke-developed indexes of 5 and 10, respectively.
   c. Water-Vapor Transmission: 1 perm, maximum **OR** 5 perms or greater, **as directed**.

J. Vapor Retarders
1. Polyethylene Vapor Retarders: ASTM D 4397, 6 mils (0.15 mm) thick, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).
2. Reinforced-Polyethylene Vapor Retarders: 2 outer layers of polyethylene film laminated to an inner reinforcing layer consisting of either nylon cord or polyester scrim and weighing not less than 25 lb/1000 sq. ft. (12 kg/100 sq. m), with maximum permeance rating of 0.0507 perm (2.9 ng/Pa x s x sq. m).
3. Fire-Retardant, Reinforced-Polyethylene Vapor Retarders: 2 outer layers of polyethylene film laminated to an inner reinforcing layer consisting of either nonwoven grid of nylon cord or polyester scrim and weighing not less than 22 lb/1000 sq. ft. (10 kg/100 sq. m), with maximum permeance rating of 0.1317 perm (7.56 ng/Pa x s x sq. m) and with flame-spread and smoke-developed indexes of not more than 5 and 60, respectively.
4. Foil-Polyester-Film Vapor Retarders: 2 layers of 0.5-mil- (0.013-mm-) thick polyester film laminated to an inner layer of 1-mil- (0.025-mm-) thick aluminum foil, with maximum water-vapor transmission rate in flat condition of 0.0 g/h x sq. m and with maximum flame-spread and smoke-developed indexes of 5.

5. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
6. Vapor-Retarder Fasteners: Pancake-head, self-tapping steel drill screws; with fender washers.
7. Single-Component Nonsag Urethane Sealant: ASTM C 920, Type I, Grade NS, Class 25, Use NT related to exposure, and Use O related to vapor-barrier-related substrates.
8. Adhesive for Vapor Retarders: Product recommended by vapor-retarder manufacturer and with demonstrated capability to bond vapor retarders securely to substrates indicated.

K. Auxiliary Insulating Materials
1. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by insulation manufacturers for sealing joints and penetrations in vapor-retarder facings.
2. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates indicated without damaging insulation and substrates.
3. Asphalt Coating for Cellular-Glass Block Insulation: Cutback asphalt or asphalt emulsion of type recommended by manufacturer of cellular-glass block insulation.
4. Eave Ventilation Troughs: Preformed, rigid fiberboard or plastic sheets designed and sized to fit between roof framing members and to provide cross ventilation between insulated attic spaces and vented eaves.

L. Insulation Fasteners
1. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of thickness indicated securely in position indicated with self-locking washer in place; and complying with the following requirements:
   a. Plate: Perforated galvanized carbon-steel sheet, 0.030 inch (0.762 mm) thick by 2 inches (50 mm) square.
   b. Spindle: Copper-coated, low carbon steel; fully annealed; 0.105 inch (2.67 mm) in diameter; length to suit depth of insulation indicated.
2. Adhesively Attached, Angle-Shaped, Spindle-Type Anchors: Angle welded to projecting spindle; capable of holding insulation of thickness indicated securely in position indicated with self-locking washer in place; and complying with the following requirements:
   a. Angle: Formed from 0.030-inch- (0.762-mm-) thick, perforated, galvanized carbon-steel sheet with each leg 2 inches (50 mm) square.
   b. Spindle: Copper-coated, low carbon steel; fully annealed; 0.105 inch (2.67 mm) in diameter; length to suit depth of insulation indicated.
3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick galvanized steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches (38 mm) square or in diameter.
   a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in the following locations:
      1) Crawlspaces.
      2) Ceiling plenums.
      3) Attic spaces.
      4) Where indicated.
4. Insulation Standoff: Spacer fabricated from galvanized mild-steel sheet for fitting over spindle of insulation anchor to maintain air space of 1 inch (25 mm) **OR** 2 inches (50 mm) **OR** 3 inches (76 mm), **as directed**, between face of insulation and substrate to which anchor is attached.
5. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates indicated without damaging insulation, fasteners, and substrates.

1.3 EXECUTION

A. Preparation
1. Clean substrates of substances harmful to insulation or vapor retarders, including removing projections capable of puncturing vapor retarders or of interfering with insulation attachment.

B. Installation, General
   1. Comply with insulation manufacturer's written instructions applicable to products and application indicated.
   2. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed at any time to ice, rain, and snow.
   3. Extend insulation in thickness indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
   4. Water-Piping Coordination: If water piping is located within insulated exterior walls, coordinate location of piping to ensure that it is placed on warm side of insulation and insulation encapsulates piping.
   5. For preformed insulating units, provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

C. Installation Of Perimeter And Under-Slab Insulation
   1. On vertical surfaces, set insulation units in adhesive applied according to manufacturer's written instructions. Use adhesive recommended by insulation manufacturer.
      a. If not otherwise indicated, extend insulation a minimum of 24 inches (610 mm) below exterior grade line.
   2. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.
   3. Protect below-grade insulation on vertical surfaces from damage during backfilling by applying protection course with joints butted. Set in adhesive according to insulation manufacturer's written instructions.
   4. Protect top surface of horizontal insulation from damage during concrete work by applying protection course with joints butted.

D. Installation Of Cavity-Wall Insulation
   1. On units of foam-plastic board insulation, install pads of adhesive spaced approximately 24 inches (610 mm) o.c. both ways on inside face, and as recommended by manufacturer. Fit courses of insulation between wall ties and other obstructions, with edges butted tightly in both directions. Press units firmly against inside substrates indicated.
      a. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose and specified in Division 04 Section "Unit Masonry Assemblies".
   2. Install units of cellular-glass insulation with closely fitting joints using method indicated:
      a. Gob Method: Apply 4 gobs of adhesive per unit and set units firmly against inside wythe of masonry or other construction as shown. Apply gobs at each corner; spread gobs to form pads 4 inches (101 mm) in diameter by 1/4 inch (6 mm) thick.
      b. Serrated-Trowel Method: Apply adhesive to entire surface of each cellular-glass insulation unit with serrated trowel complying with insulation manufacturer's written instructions.
      c. Coat edges of insulation units with full bed of adhesive to seal joints between insulation and between insulation and adjoining construction.
      d. Coat exterior face (cold face) of installed cellular-glass block insulation course with asphalt coating.

E. Installation Of General Building Insulation
   1. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.
   2. Seal joints between foam-plastic insulation units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.
   3. Set vapor-retarder-faced units with vapor retarder to warm-in-winter side **OR** in location indicated, **as directed**, of construction, unless otherwise indicated.

a. Tape joints and ruptures in vapor retarder, and seal each continuous area of insulation to surrounding construction to ensure airtight installation.

4. Install mineral-fiber insulation in cavities formed by framing members according to the following requirements:
   a. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill cavity, provide lengths that will produce a snug fit between ends.
   b. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
   c. Maintain 3-inch (76-mm) clearance of insulation around recessed lighting fixtures.
   d. Install eave ventilation troughs between roof framing members in insulated attic spaces at vented eaves.
   e. For metal-framed wall cavities where cavity heights exceed 96 inches (2438 mm), support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
   f. For wood-framed construction, install mineral-fiber blankets according to ASTM C 1320 and as follows:
      1) With faced blankets having stapling flanges, secure insulation by inset, stapling flanges to sides of framing members.
         OR
         With faced blankets having stapling flanges, lap blanket flange over flange of adjacent blanket to maintain continuity of vapor retarder once finish material is installed over it.
5. Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:
   a. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application indicated.
   b. Apply insulation standoffs to each spindle to create cavity width indicated between concrete substrate and insulation.
   c. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation below indicated thickness.
   d. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.
6. Install board insulation in curtain-wall construction where indicated on Drawings according to curtain-wall manufacturer's written instructions.
   a. Retain insulation in place by metal clips and straps or integral pockets within window frames, spaced at intervals recommended in writing by insulation manufacturer to hold insulation securely in place without touching spandrel glass. Maintain cavity width of dimension indicated between insulation and glass.
   b. Install insulation where it contacts perimeter fire-containment system to prevent insulation from bowing under pressure from perimeter fire-containment system.
7. Place loose-fill insulation into spaces indicated, by pouring **OR** by machine blowing, **as directed**, to comply with ASTM C 1015. Level horizontal applications to uniform thickness as indicated, lightly settle to uniform density, but do not compact excessively.
   a. For cellulosic-fiber loose-fill insulation, comply with the Cellulose Insulation Manufacturers Association's Special Report #3, "Standard Practice for Installing Cellulose Insulation."
8. Apply self-supported, spray-applied cellulosic insulation according to manufacturer's written instructions. Do not apply insulation until installation of pipes, ducts, conduits, wiring, and electrical outlets in walls is completed and windows, electrical boxes, and other items not indicated to receive insulation are masked. After insulation is applied, make it flush with face of studs by using method recommended by insulation manufacturer.

9. Stuff glass-fiber loose-fill insulation into miscellaneous voids and cavity spaces where shown. Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft. (40 kg/cu. m).

F. Installation Of Insulation In Ceilings For Sound Attenuation
1. Install 3-inch- (76-mm-) thick, unfaced glass-fiber **OR** slag-wool-fiber/rock-wool-fiber, **as directed**, blanket insulation over suspended ceilings at partitions in a width that extends insulation 48 inches (1219 mm) on either side of partition.
OR
Install 1-1/2-inch- (38-mm-) thick, unfaced glass-fiber **OR** slag-wool-fiber/rock-wool-fiber, **as directed**, blanket insulation over suspended ceilings so that insulation extends over entire ceiling.

G. Installation Of Radiant Barriers
1. Install interior radiation control coating system according to ASTM C 1321.
2. Install sheet radiant barriers in locations indicated according to ASTM C 1158.

H. Installation Of Vapor Retarders
1. General: Extend vapor retarder to extremities of areas to be protected from vapor transmission. Secure in place with adhesives or other anchorage system as indicated. Extend vapor retarder to cover miscellaneous voids in insulated substrates, including those filled with loose-fiber insulation.
2. Seal vertical joints in vapor retarders over framing by lapping not less than two wall studs. Fasten vapor retarders to wood framing at top, end, and bottom edges; at perimeter of wall openings; and at lap joints. Space fasteners 16 inches (400 mm) o.c.
3. Before installing vapor retarder, apply urethane sealant to flanges of metal framing including runner tracks, metal studs, and framing around door and window openings. Seal overlapping joints in vapor retarders with vapor-retarder tape according to vapor-retarder manufacturer's written instructions. Seal butt joints with vapor-retarder tape. Locate all joints over framing members or other solid substrates.
4. Firmly attach vapor retarders to metal framing and solid substrates with vapor-retarder fasteners as recommended by vapor-retarder manufacturer.
5. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor-retarder tape to create an airtight seal between penetrating objects and vapor retarder.
6. Repair tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarder.

I. Protection
1. Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 07210

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Task	Specification	Specification Description
07211	07210	Building Insulation

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SECTION 07212 - BUILT-UP ASPHALT ROOFING

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for built-up asphalt roofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Built-up asphalt roofing.
   b. Vapor retarder.
   c. Roof insulation.
2. Section includes the installation of insulation strips in ribs of acoustical roof deck. Insulation strips are furnished under Division 5 Section "Steel Deck."

C. Definitions
1. Roofing Terminology: See ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to built-up roofing.
2. Hot Roofing Asphalt: Roofing asphalt heated to its equiviscous temperature, the temperature at which its viscosity is 125 centipoise for mop-applied roofing asphalt and 75 centipoise for mechanical spreader-applied roofing asphalt, within a range of plus or minus 25 deg F (14 deg C), measured at the mop cart or mechanical spreader immediately before application.

D. Performance Requirements
1. General Performance: Installed built-up roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Built-up roofing and base flashings shall remain watertight.
2. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by built-up roofing manufacturer based on testing and field experience.
3. Roofing System Design: Provide built-up roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.
4. FM Approvals Listing: Provide built-up roofing, base flashings, and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a built-up roofing system, and that are listed in FM Approvals' "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals markings.
   a. Fire/Windstorm Classification: Class 1A-60 **OR** Class 1A-75 **OR** Class 1A-90 **OR** Class 1A-105 **OR** Class 1A-120, **as directed**.
   b. Hail Resistance Rating: MH **OR** SH, **as directed**.
5. Energy Performance (for LEED-NC Credit SS 7.2): Provide roofing system with initial Solar Reflectance Index not less than 78 when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency.
6. Energy Performance: Provide roofing system that is listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.
7. Energy Performance (for roofs that must comply with California Energy Commission's CEC-Title 24): Provide roofing system with initial solar reflectance not less than 0.70 and emissivity not less than 0.75 when tested according to CRRC-1.

E. Submittals

1. Product Data: For each type of product indicated.
2. LEED Submittals:
   a. Product Test Reports for Credit SS 7.2: For roof materials, indicating that roof materials comply with Solar Reflectance Index requirement.
   b. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
3. Shop Drawings: For built-up roofing. Include plans, elevations, sections, details, and attachments to other work.
   a. Base flashings and built-up terminations.
   b. Tapered insulation, including slopes.
   c. Crickets, saddles, and tapered edge strips, including slopes.
   d. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
4. Samples: For the following products:
   a. Built-up roofing materials, including base sheet, ply sheet, cap sheet, and flashing sheet, of color specified.
   b. Roof insulation.
   c. 3 lb (1.5 kg) of aggregate surfacing material in gradation and color indicated.
   d. Roof paver, full sized, in each color and texture required.
   e. Walkway pads.
   f. Six insulation fasteners of each type, length, and finish.
5. Qualification Data: For qualified Installer and manufacturer.
6. Manufacturer Certificates: Signed by roofing manufacturer certifying that built-up roofing complies with requirements specified in "Performance Requirements" Article.
   a. Submit evidence of compliance with performance requirements.
7. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of built-up roofing.
8. Research/Evaluation Reports: For components of built-up roofing, from the ICC-ES.
9. Maintenance Data: For built-up roofing to include in maintenance manuals.
10. Warranties: Sample of special warranties.

F. Quality Assurance
1. Manufacturer Qualifications: A qualified manufacturer that is UL listed **OR** FM Approvals approved, **as directed**, for built-up roofing identical to that used for this Project.
2. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by built-up roofing manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
3. Source Limitations: Obtain components including roof insulation and fasteners for built-up roofing from same manufacturer as built-up roofing or approved by built-up roofing manufacturer.
4. Exterior Fire-Test Exposure: ASTM E 108, Class A **OR** Class B **OR** Class C, **as directed**; for application and roof slopes indicated, as determined by testing identical built-up roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.
5. Fire-Resistance Ratings: Where indicated, provide fire-resistance-rated roof assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
6. Preinstallation Roofing Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
2. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing manufacturer. Protect stored liquid material from direct sunlight.

a. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

3. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
4. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

H. Project Conditions
1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing to be installed according to manufacturer's written instructions and warranty requirements.

I. Warranty
1. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of built-up roofing that fail in materials or workmanship within specified warranty period.
   a. Special warranty includes built-up roofing membrane, base flashings, roof insulation, fasteners, cover boards, substrate board, roofing accessories, roof pavers, and other components of built-up roofing.
   b. Warranty Period: 10 **OR** 15, **as directed**, years from date of Substantial Completion.
2. Special Project Warranty: Submit roofing Installer's warranty, signed by Installer, covering the Work of this Section, including all components of built-up roofing such as built-up roofing membrane, base flashing, roof insulation, fasteners, cover boards, substrate boards, vapor retarders, roof pavers, and walkway products, for the following warranty period:
   a. Warranty Period: Two years from date of Substantial Completion.

1.2 PRODUCTS

A. Built-Up Roofing Manufacturers

B. Base-Sheet Materials
1. Sheathing Paper: Red-rosin type, minimum 3 lb/100 sq. ft. (0.16 kg/sq. m).
2. Base Sheet: ASTM D 4601, Type II, SBS-modified, asphalt-impregnated and -coated sheet, with glass-fiber-reinforcing mat, dusted with fine mineral surfacing on both sides.
   a. Weight: 25 lb/100 sq. ft. (1.2 kg/sq. m) **OR** 40 lb/100 sq. ft. (1.95 kg/sq. m) **OR** 50 lb/100 sq. ft. (2.4 kg/sq. m) **OR** 60 lb/100 sq. ft. (3.0 kg/sq. m) **OR** 75 lb/100 sq. ft. (3.7 kg/sq. m), **as directed**, minimum.

   OR

   Base Sheet: ASTM D 4601, Type I **OR** II, **as directed**, nonperforated, asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.

   OR

   Base Sheet: ASTM D 4897, Type II, venting, nonperforated, heavyweight, asphalt-impregnated and -coated, glass-fiber base sheet with coarse granular surfacing or embossed venting channels on bottom surface.

   OR

   Base Sheet: ASTM D 2626, asphalt-saturated and -coated organic felt, dusted with fine mineral surfacing on both sides.

C. Roofing Membrane Plies
1. Ply Sheet: ASTM D 2178, Type IV **OR** VI, **as directed**, asphalt-impregnated, glass-fiber felt.
2. Cap Sheet: ASTM D 3909, asphalt-impregnated and -coated, glass-fiber cap sheet, with white coarse mineral-granule top surfacing and fine mineral surfacing on bottom surface.

D. Base Flashing Sheet Materials

1. Backer Sheet: ASTM D 2178, Type IV **OR** VI, **as directed**, asphalt-impregnated, glass-fiber felt.
   OR
   Backer Sheet: ASTM D 4601, Type I **OR** II, **as directed**, asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.
   OR
   Backer Sheet: ASTM D 2626, asphalt-saturated and -coated organic felt, dusted with fine mineral surfacing on both sides.
2. Granule-Surfaced Flashing Sheet: ASTM D 6164, Grade G, Type I or II, polyester-reinforced **OR** ASTM D 6163, Grade G, Type I or II, glass-fiber-reinforced **OR** ASTM D 6162, Grade G, Type I or II, composite polyester-reinforced and glass-fiber-reinforced, **as directed**, SBS-modified asphalt sheet; granular surfaced; suitable for application method specified, and as follows:
   a. Granule Color: White **OR** Gray **OR** Tan, **as directed**.
3. Metal-Foil-Surfaced Flashing Sheet: ASTM D 6298, glass-fiber-reinforced, SBS-modified asphalt sheet; metal-foil surfaced; suitable for application method specified, and as follows:
   a. Foil Surfacing: Aluminum **OR** Copper **OR** Stainless steel **OR** Aluminum, fluoropolymer coated finish, of color and gloss selected from manufacturer's full range, **as directed**.
4. Smooth-Surfaced Flashing Sheet: ASTM D 6222, Grade S, Type I or II, polyester-reinforced **OR** ASTM D 6223, Grade S, Type I or II, composite polyester-reinforced and glass-fiber-reinforced, **as directed**, APP-modified asphalt sheet; smooth surfaced; suitable for application method specified.
   OR
   Granule-Surfaced Flashing Sheet: ASTM D 6222, Grade G, Type I or II, polyester-reinforced **OR** ASTM D 6223, Grade G, Type I or II, composite polyester-reinforced and glass-fiber-reinforced, **as directed**, APP-modified asphalt sheet; granular surfaced; suitable for application method specified, and as follows:
   a. Granule Color: White **OR** Gray **OR** Tan, **as directed**.
5. Glass-Fiber Fabric: Woven glass-fiber cloth, treated with asphalt, complying with ASTM D 1668, Type I.

E. Asphalt Materials
1. Asphalt Primer: ASTM D 41.
2. Roofing Asphalt: ASTM D 312, Type III **OR** IV **OR** III or IV as recommended by built-up roofing manufacturer for application, **as directed**.
3. Roofing Asphalt: ASTM D 6152, SEBS modified.

F. Auxiliary Built-Up Roofing Materials
1. General: Auxiliary materials recommended by roofing manufacturer for intended use and compatible with built-up roofing.
   a. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
   b. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
      1) Plastic Foam Adhesives: 50 g/L.
      2) Gypsum Board and Panel Adhesives: 50 g/L.
      3) Multipurpose Construction Adhesives: 70 g/L.
      4) Fiberglass Adhesives: 80 g/L.
      5) Contact Adhesives: 80 g/L.
      6) Other Adhesives: 250 g/L.
      7) Nonmembrane Roof Sealants: 300 g/L.
      8) Sealant Primers for Nonporous Substrates: 250 g/L.
      9) Sealant Primers for Porous Substrates: 775 g/L.
2. Cold-Applied Adhesive: Roofing manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive specially formulated for compatibility and use with built-up base flashings.

3. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required by roofing manufacturer for application.
4. Mastic Sealant: Polyisobutylene, plain or modified bitumen, nonhardening, nonmigrating, nonskinning, and nondrying.
5. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening built-up roofing components to substrate, tested by manufacturer for required pullout strength, and acceptable to roofing manufacturer.
6. Metal Flashing Sheet: Metal flashing sheet is specified in Division 7 Section "Sheet Metal Flashing and Trim."
7. Aggregate Surfacing: ASTM D 1863, No. 6 or No. 67, clean, dry, opaque, water-worn gravel or crushed stone, free of sharp edges **OR** crushed slag, free of sharp edges, **as directed**.
8. Miscellaneous Accessories: Provide miscellaneous accessories recommended by built-up roofing manufacturer.

G. Substrate Boards
1. Substrate Board: ASTM C 1396/C 1396M, Type X gypsum board, 5/8 inch (16 mm) thick.
   OR
   Substrate Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** Type X, 5/8 inch (16 mm), **as directed**, thick, factory primed, **as directed**.
   OR
   Substrate Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.
   OR
   Substrate Board: ASTM C 728, perlite board, 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick, seal coated.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

H. Vapor Retarder
1. Polyethylene Film: ASTM D 4397, 6 mils (0.15 mm) thick, minimum, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).
   a. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
      OR
      Adhesive: Manufacturer's standard lap adhesive, FM Approvals approved for vapor-retarder application.
2. Laminated Sheet: Kraft paper/polyethylene laminate, two layers, reinforced with woven fiberglass yarn, laminated and edge reinforced, with maximum permeance rating of 0.50 perm (29 ng/Pa x s x sq. m) and with manufacturer's standard adhesive, **as directed**.
3. Self-Adhering Sheet Vapor Retarder: ASTM D 1970, minimum of 40-mil- (1.0-mm-) thick, polyethylene film laminated to layer of rubberized asphalt adhesive; maximum permeance rating of 0.1 perm (6 ng/Pa x s x sq. m); cold-applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.
   OR
   Self-Adhering Sheet Vapor Retarder: 30- to 40-mil- (0.76- to 1.0-mm-) thick, polyethylene film laminated to layer of butyl rubber adhesive; maximum permeance rating of 0.1 perm (6 ng/Pa x s x sq. m); cold-applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.
4. Glass-Fiber Felts: ASTM D 2178, Type IV, asphalt impregnated.

I. Roof Insulation

1. General: Preformed roof insulation boards manufactured or approved by roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Approvals-approved roof insulation, **as directed**.
2. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.6-lb/cu. ft. (26-kg/cu. m) **OR** X, 1.3-lb/cu. ft. (21-kg/cu. m), **as directed**, minimum density, square edged.
3. Molded-Polystyrene Board Insulation: ASTM C 578 Type II, 1.35-lb/cu. ft. (22-kg/cu. m) **OR** VIII, 1.15-lb/cu. ft. (18-kg/cu. m) **OR** IX, 1.8-lb/cu. ft. (29-kg/cu. m), **as directed**, minimum density.
4. Composite Molded-Polystyrene Board Insulation: ASTM C 578, Type II, 1.35-lb/cu. ft. (22-kg/cu. m) **OR** Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) **OR** Type IX, 1.8-lb/cu. ft. (29-kg/cu. m), **as directed**, minimum density, with factory-applied facings, as follows:
   a. Facer: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, asphalt coated, 1/2 inch (13 mm) thick.
      OR
      Facer: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.
5. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2 **OR** Type II, Class I, Grade 3, **as directed**, felt or glass-fiber mat facer on both major surfaces.
6. Composite Polyisocyanurate Board Insulation: ASTM C 1289, with factory-applied facing board on one major surface as indicated below by type, and felt or glass-fiber mat facer on the other surface.
   a. Type IV, cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch (13 mm) thick.
   b. Type V, OSB facer, 7/16 inch (11 mm) thick.
   c. Type VII, glass mat faced gypsum board facer, 1/4 inch (6 mm) thick.
7. Perlite Board Insulation: ASTM C 728, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.
8. Cellulosic-Fiber Board Insulation: ASTM C 208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.
9. Cellular-Glass Board Insulation: ASTM C 552, Type IV, rigid, cellular-glass thermal board insulation faced with manufacturer's standard kraft-paper sheets.
10. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches (1:48) unless otherwise indicated.
11. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

J. Insulation Accessories
   1. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatible with built-up roofing.
   2. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation to substrate and acceptable to roofing manufacturer.
   3. Modified Asphaltic Insulation Adhesive: Insulation manufacturer's recommended modified asphaltic, asbestos-free, cold-applied adhesive formulated to attach roof insulation to substrate or to another insulation layer.
      OR
      Bead-Applied Insulation Adhesive: Insulation manufacturer's recommended bead-applied, low-rise, one- or multicomponent urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
      OR
      Full-Spread Applied Insulation Adhesive: Insulation manufacturer's recommended spray-applied, low-rise, two-component urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
   4. Insulation Cant Strips: ASTM C 728, perlite insulation board.
   5. Insulation Cant Strips: ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board.

6. Wood Nailer Strips: Comply with requirements in Division 6 Section "Rough Carpentry" **OR** "Miscellaneous Carpentry", **as directed**.
7. Tapered Edge Strips: ASTM C 728, perlite insulation board.
   OR
   Tapered Edge Strips: ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board.
8. Cover Board: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, 1/2 inch (13 mm) thick.
   OR
   Cover Board: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.
   OR
   Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick, factory primed, **as directed**.
   OR
   Cover Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.
9. Substrate Joint Tape: 6- or 8-inch- (150- or 200-mm-) wide, coated, glass fiber.

K. Coating Materials
1. Roof Coating: ASTM D 1227, Type II Class 1, mineral-colloid-emulsified, fibered **OR** 2, chemically emulsified, filled or fibered, **as directed**, asphalt emulsion, asbestos free.
   OR
   Roof Coating: ASTM D 1227, Type III, Class 1, mineral-colloid-emulsified **OR** 2, chemically emulsified, **as directed**, asphalt emulsion, nonfibered.
   OR
   Roof Coating: ASTM D 2824, Type I, nonfibered **OR** III, fibered, asbestos-free, **as directed**, aluminum-pigmented asphaltic coating.
   OR
   Roof Coating: Acrylic elastomer emulsion coating, formulated for use on bituminous roof surfaces and complying with ASTM D 6083 **OR** the following, **as directed**:
   a. Initial Percent Elongation (Break): Not less than 60 percent at 0 deg F (-18 deg C) and 200 percent at 73 deg F (23 deg C) when tested according to ASTM D 2370.
   b. Initial Tensile Strength (Maximum Stress): Not less than 100 psi (1.38 MPa) at 73 deg F (23 deg C) and 200 psi (2.76 MPa) at 0 deg F (-18 deg C) when tested according to ASTM D 2370.
   c. Final Percent Elongation (Break) after Accelerated Weathering 1000 hrs.: Not less than 40 percent at 0 deg F (-18 deg C) and 100 percent at 73 deg F (23 deg C) when tested according to ASTM D 2370.
   d. Permeance: Not more than 50 perms when measured according to ASTM D 1653.
   e. Accelerated Weathering 1000 hrs.: No cracking or checking when tested according to ASTM D 4798.
   f. Color: White **OR** Gray **OR** Buff, **as directed**.

L. Walkways
1. Walkway Pads: Mineral-granule-surfaced, reinforced asphaltic composition **OR** Polymer-modified, reconstituted solid-rubber, surface-textured, **as directed**, slip-resisting pads, manufactured as a traffic pad for foot traffic and acceptable to roofing manufacturer, 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 3/4 inch (19 mm), **as directed**, thick, minimum.
2. Walkway Cap Sheet Strips: ASTM D 6164, Grade G, Type I or II, polyester-reinforced **OR** ASTM D 6163, Grade G, Type I or II, glass-fiber-reinforced **OR** ASTM D 6162, Grade G, Type I or II, composite polyester-reinforced and glass-fiber-reinforced, **as directed**, SBS-modified asphalt sheet; granular surfaced; suitable for application method specified, and as follows:
   a. Granule Color: White **OR** Gray **OR** Tan, **as directed**.
3. Roof Pavers: Heavyweight, hydraulically pressed, concrete units, square edged **OR** with top edges beveled 3/16 inch (5 mm), **as directed**, factory cast for use as roof pavers; absorption not

greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C 67; and as follows:

a. Size: 24 by 24 inches (600 by 600 mm). Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch (1.6 mm) in length, height, and thickness.
b. Compressive Strength: 7500 psi (52 MPa) **OR** 6500 psi (45 MPa), **as directed**, minimum; ASTM C 140.
c. Colors and Textures: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

1.3 EXECUTION

A. Examination
1. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:
a. Verify that roof openings and penetrations are in place and curbs are set and braced and that roof drain bodies are securely clamped in place.
b. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
c. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Division 05 Section "Steel Deck".
d. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of 1/16 inch (1.6 mm) out of plane relative to adjoining deck.
e. Verify that minimum concrete drying period recommended by roofing manufacturer has passed.
f. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
1) Test for moisture by pouring 1 pint (0.5 L) of hot roofing asphalt on deck at start of each day's work and at start of each roof area or plane. Do not proceed with roofing work if test sample foams or can be easily and cleanly stripped after cooling.
g. Verify that concrete curing compounds that will impair adhesion of roofing components to roof deck have been removed.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing manufacturer's written instructions. Remove sharp projections.
2. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
3. Prime surface of concrete deck with asphalt primer at a rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.
4. Install insulation strips in ribs of acoustical roof decks according to acoustical roof deck manufacturer's written instructions.

C. Substrate Board Installation
1. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
a. Fasten substrate board to top flanges of steel deck according to recommendations in FM Approvals' "RoofNav" and FM Global Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.
OR
Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to built-up roofing manufacturer's written instructions.

D. Vapor-Retarder Installation
1. Polyethylene Film: Loosely lay polyethylene-film vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.
   a. Continuously seal side and end laps with tape **OR** adhesive, **as directed**.

   OR

   Laminate Sheet: Install laminate-sheet vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively. Bond vapor retarder to substrate as follows:
   a. Apply adhesive at rate recommended by vapor-retarder manufacturer. Seal laps with adhesive.

      OR

      Apply ribbons of hot roofing asphalt at spacing, temperature, and rate recommended by vapor-retarder manufacturer. Seal laps with hot roofing asphalt.

   OR

   Self-Adhering Sheet Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of 3-1/2 inches (90 mm) and 6 inches (150 mm), respectively. Seal laps by rolling.

   OR

   Built-up Vapor Retarder: Install two glass-fiber felt plies lapping each felt 19 inches (483 mm) over preceding felt. Embed each felt in a solid mopping of hot roofing asphalt. Glaze-coat completed surface with hot roofing asphalt. Apply hot roofing asphalt within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
2. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into built-up roofing.

E. Insulation Installation
1. Comply with built-up roofing manufacturer's written instructions for installing roof insulation.
2. Install one lapped base sheet course and mechanically fasten to substrate according to built-up roofing manufacturer's written instructions.
3. Nailer Strips: Mechanically fasten 4-inch nominal- (89-mm actual-) width wood nailer strips of same thickness as insulation perpendicular to sloped roof deck at the following spacing:
   a. 16 feet (4.88 m) apart for roof slopes greater than 1 inch per 12 inches (1:12) but less than 3 inches per 12 inches (3:12).
   b. 48 inches (1220 mm) apart for roof slopes greater 3 inches per 12 inches (3:12).
4. Insulation Cant Strips: Install and secure preformed 45-degree insulation cant strips at junctures of built-up roofing with vertical surfaces or angle changes greater than 45 degrees.
5. Install tapered insulation under area of roofing to conform to slopes indicated.
6. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
   a. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
7. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches (68 mm) or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.
   a. Where installing composite and noncomposite board insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
8. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
9. Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.
10. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
    a. Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.

b. Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
c. Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
OR
Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

11. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
a. If Project is FM Global insured or if FM Approvals requirements are proposed as a performance standard, fasten insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
b. If number of fasteners will be based on ASCE/SEI 7's uplift pressure, fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.
12. Mechanically Fastened and Adhered Insulation: Install first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
a. If Project is FM Global insured or if FM Approvals requirements are proposed as a performance standard, fasten first layer of insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
b. If number of fasteners will be based on ASCE/SEI 7's uplift pressure, fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
c. Set each subsequent layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
OR
Set each subsequent layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
OR
Set each subsequent layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
13. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction. Loosely butt cover boards together and fasten to roof deck, **as directed**. Tape joints if required by roofing manufacturer.
a. Fasten cover boards according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
b. Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.
c. Apply hot roofing asphalt to underside and immediately bond cover board to substrate.

F. Built-Up Roofing Installation, General
1. Install roofing membrane according to roofing manufacturer's written instructions and applicable recommendations of ARMA/NRCA's "Quality Control Guidelines for the Application of Built-up Roofing."
a. Install roofing system BU-3 **OR** 4 **OR** 5, **as directed**,-N **OR** I **OR** C, **as directed**,-A-A **OR** S **OR** M, **as directed**, according to roof assembly identification matrix and roof assembly layout illustrations in NRCA's "The NRCA Roofing and Waterproofing Manual" and requirements in this Section.
OR
Install roofing membrane according to roofing manufacturer's written instructions and applicable recommendations of ARMA/NRCA's "Quality Control Guidelines for the Application of Built-up Roofing" and as follows:
a. Deck Type: N (nailable) **OR** I (insulated) **OR** C (concrete or nonnailable), **as directed**.
b. Base Sheet: 1 **OR** 1, installed over sheathing paper, **as directed**.
c. Number of Ply Sheets: 2 **OR** 3 **OR** 4, **as directed**.

d. Surfacing Type: A (aggregate) **OR** S (asphalt surfacing or coating) **OR** M (mineral-granule-surfaced cap sheet), **as directed**.
   1) Mineral-granule-surfaced cap sheet is in addition to number of ply sheets specified.

2. Start installation of built-up roofing in presence of manufacturer's technical personnel.
3. Where roof slope exceeds 1/2 inch per 12 inches (1:24) **OR** 3/4 inch per 12 inches (1:18), **as directed**, install built-up roofing sheets parallel with slope.
   a. Backnail built-up roofing sheets to nailer strips **OR** substrate, **as directed**, according to roofing manufacturer's written instructions.
4. Cooperate with testing agencies engaged or required to perform services for installing roofing.
5. Coordinate installation of roofing so insulation and other components of built-up roofing not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.
   a. Provide tie-offs at end of each day's work to cover exposed built-up roofing sheets and insulation with a course of coated felt set in roofing cement or hot roofing asphalt with joints and edges sealed.
   b. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing.
   c. Remove and discard temporary seals before beginning work on adjoining roofing.
6. Asphalt Heating: Do not raise roofing asphalt temperature above equiviscous temperature range more than one hour before time of application. Do not exceed roofing asphalt manufacturer's recommended temperature limits during roofing asphalt heating. Do not heat roofing asphalt within 25 deg F (14 deg C) of flash point. Discard roofing asphalt maintained at a temperature exceeding finished blowing temperature for more than 4 hours.
   OR
   Asphalt Heating: Heat and apply SEBS-modified roofing asphalt according to roofing manufacturer's written instructions.
7. Substrate-Joint Penetrations: Prevent roofing asphalt and adhesives from penetrating substrate joints, entering building, or damaging built-up roofing components or adjacent building construction.

G. Roofing Membrane Installation
1. Loosely lay one course of sheathing paper, lapping edges and ends a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.
2. Install lapped base sheet course, extending sheet over and terminating beyond cants. Attach base sheet as follows:
   a. Mechanically fasten to substrate.
      OR
      Spot- or strip-mop to substrate with hot roofing asphalt.
      OR
      Adhere to substrate in a solid mopping of hot roofing asphalt, **as directed**.
3. Install two **OR** three **OR** four, **as directed**, ply sheets starting at low point of roofing. Align ply sheets without stretching. Shingle side laps of ply sheets uniformly to achieve required number of plies throughout thickness of roofing membrane. Shingle in direction to shed water. Extend ply sheets over and terminate beyond cants.
   a. Embed each ply sheet in a solid mopping of hot roofing asphalt applied at rate required by roofing manufacturer, to form a uniform membrane without ply sheets touching.
4. Cap Sheet: Install lapped granulated cap sheet starting at low point of roofing. Offset laps from laps of preceding ply sheets and align cap sheet without stretching. Lap in direction to shed water. Extend cap sheet over and terminate beyond cants.
   a. Embed cap sheet in a solid mopping of hot roofing asphalt applied at rate required by built-up roofing manufacturer.
5. Aggregate Surfacing: Promptly after installing and testing roofing membrane, base flashing, and stripping, flood-coat roof surface with 60 lb/100 sq. ft. (3.0 kg/sq. m) of hot roofing asphalt. While flood coat is hot and fluid, cast the following average weight of aggregate in a uniform course:
   a. Aggregate Weight: 400 lb/100 sq. ft. (20 kg/sq. m) **OR** 300 lb/100 sq. ft. (15 kg/sq. m), **as directed**.

b. If aggregate surfacing is delayed, promptly apply glaze coat of hot roofing asphalt at a rate of 10 lb/100 sq. ft. (0.5 kg/sq. m).

6. Glaze-coat roofing membrane surface with hot roofing asphalt applied at a rate of 10 to 15 lb/100 sq. ft. (0.5 to 0.75 kg/sq. m).

H. Flashing And Stripping Installation

1. Install base flashing over cant strips and other sloping and vertical surfaces, at roof edges, and at penetrations through roof, and secure to substrates according to built-up roofing manufacturer's written instructions and as follows:
   a. Prime substrates with asphalt primer if required by built-up roofing manufacturer.
   b. Backer Sheet Application: Mechanically fasten backer sheet to walls or parapets. Adhere backer sheet over built-up roofing at cants in a solid mopping of hot roofing asphalt **OR** cold-applied adhesive, **as directed**.
      OR
      Backer Sheet Application: Adhere backer sheet to substrate in a solid mopping of hot roofing asphalt **OR** cold-applied adhesive, **as directed**.
   c. Flashing Sheet Application: Adhere flashing sheet to substrate in a solid mopping of hot roofing asphalt applied at not less than 425 deg F (218 deg C). Apply hot roofing asphalt to back of flashing sheet if recommended by roofing manufacturer.
      OR
      Flashing Sheet Application: Adhere flashing sheet to substrate in cold-applied adhesive at rate required by roofing manufacturer.
      OR
      Flashing Sheet Application: Adhere flashing sheet to substrate in asphalt roofing cement at rate required by roofing manufacturer.
      OR
      Flashing Sheet Application: Torch apply flashing sheet to substrate.
2. Extend base flashing up walls or parapets a minimum of 8 inches (200 mm) above built-up roofing and 4 inches (100 mm) onto field of built-up roofing.
3. Mechanically fasten top of base flashing securely at terminations and perimeter of roofing.
   a. Seal top termination of base flashing with a strip of glass-fiber fabric set in asphalt roofing cement.
4. Install stripping, according to roofing manufacturer's written instructions, where metal flanges and edgings are set on built-up roofing.
   a. Flashing-Sheet Stripping: Install flashing-sheet stripping in a continuous coating of asphalt roofing cement or in a solid mopping of hot roofing asphalt applied at not less than 425 deg F (218 deg C), and extend onto roofing membrane.
      OR
      Flashing-Sheet Stripping: Install flashing-sheet stripping by heat welding and extend onto roofing membrane.
      OR
      Built-up Stripping: Install stripping of not less than two roofing membrane ply sheets, setting each ply in a continuous coating of asphalt roofing cement or in a solid mopping of hot roofing asphalt, and extend onto roofing membrane 4 inches (100 mm) and 6 inches (150 mm), respectively.
5. Roof Drains: Set 30-by-30-inch (760-by-760-mm) metal flashing in bed of asphalt roofing cement on completed built-up roofing. Cover metal flashing with built-up roofing cap-sheet stripping and extend a minimum of 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, beyond edge of metal flashing onto field of built-up roofing. Clamp built-up roofing, metal flashing, and stripping into roof-drain clamping ring.
   a. Install stripping according to roofing manufacturer's written instructions.

I. Coating Installation

1. Apply coating to built-up roofing and base flashings according to manufacturer's written instructions, by spray, roller, or other suitable application method to provide a dry film thickness of not less than 20 mils (0.5 mm).

J. Walkway Installation
   1. Walkway Pads: Install walkway pads using units of size indicated or, if not indicated, of manufacturer's standard size, according to walkway pad manufacturer's written instructions.
      a. Set walkway pads in additional pour coat of hot roofing asphalt after sweeping away loose aggregate surfacing.
   2. Walkway Cap Sheet Strips: Install walkway cap sheet strips, approximately 36 inches (900 mm) wide and in lengths not exceeding 10 feet (3 m), leaving a space of 6 inches (150 mm) between strips, over built-up roofing. Adhere in hot roofing asphalt.
   3. Roof-Paver Walkways: Install walkway roof pavers according to roofing manufacturer's written instructions in locations indicated, to form walkways. Leave 3 inches (75 mm) of space between adjacent roof pavers.

K. Field Quality Control
   1. Testing Agency: Perform roof tests and inspections and to prepare test reports.
   2. Test Cuts: Test specimens will be removed to evaluate problems observed during quality-assurance inspections of built-up roofing as follows:
      a. Approximate quantities of components within built-up roofing will be determined according to ASTM D 3617.
      b. Test specimens will be examined for interply voids according to ASTM D 3617 and to comply with criteria established in Appendix 3 of ARMA/NRCA's "Quality Control Guidelines for the Application of Built-up Roofing."
      c. Repair areas where test cuts were made according to roofing manufacturer's written instructions.
   3. Repair or remove and replace components of built-up roofing where test results or inspections indicate that they do not comply with specified requirements.
      a. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

L. Protecting And Cleaning
   1. Protect built-up roofing from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.
   2. Correct deficiencies in or remove built-up roofing that does not comply with requirements, repair substrates, and repair or reinstall roofing to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
   3. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07212

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SECTION 07212a - BUILT-UP COAL-TAR ROOFING

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for built-up coal-tar roofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Built-up coal-tar roofing.
   b. Vapor retarder.
   c. Roof insulation.
2. Section includes the installation of insulation strips in ribs of acoustical roof deck. Insulation strips are furnished under Division 05 Section "Steel Deck".

C. Definitions
1. Roofing Terminology: See ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to built-up roofing.
2. Bitumen: A generic term for either asphalt or coal-tar pitch.
3. Hot Coal-Tar Pitch: Coal-tar pitch heated to its equiviscous temperature, the temperature at which its viscosity is 25 centipoise for either mopping or mechanical application, within a range of plus or minus 25 deg F (14 deg C), measured at the mop cart or mechanical spreader immediately before application.
4. Hot Roofing Asphalt: Roofing asphalt heated to its equiviscous temperature, the temperature at which its viscosity is 125 centipoise for mop-applied roofing asphalt and 75 centipoise for mechanical spreader-applied roofing asphalt, within a range of plus or minus 25 deg F (14 deg C), measured at the mop cart or mechanical spreader immediately before application.

D. Performance Requirements
1. General Performance: Installed built-up roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Built-up roofing and base flashings shall remain watertight.
2. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by built-up roofing manufacturer based on testing and field experience.
3. Roofing System Design (if built-up roofing system is to be designed to withstand uplift pressure established by ASCE/SEI 7): Provide built-up roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.
   a. Corner Uplift Pressure: as directed by the Owner.
   b. Perimeter Uplift Pressure: as directed by the Owner.
   c. Field-of-Roof Uplift Pressure: as directed by the Owner.
4. FM Approvals Listing (if Project is FM Global insured or if FM Approvals requirements will set a minimum quality standard): Provide built-up roofing, base flashings, and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a built-up roofing system, and that are listed in FM Approvals' "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals markings.
   a. Fire/Windstorm Classification: Class 1A-60 **OR** Class 1A-75 **OR** Class 1A-90 **OR** Class 1A-105 **OR** Class 1A-120, **as directed**.
   b. Hail Resistance Rating: MH **OR** SH, **as directed**.

5. Energy Performance (if required for LEED-NC Credit SS 7.2): Provide roofing system with initial Solar Reflectance Index not less than 78 when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency.
6. Energy Performance (for roofs that must comply with the DOE's ENERGY STAR requirements): Provide roofing system that is listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.
7. Energy Performance (for roofs that must comply with California Energy Commission's CEC-Title 24): Provide roofing system with initial solar reflectance not less than 0.70 and emissivity not less than 0.75 when tested according to CRRC-1.

E. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
   a. Product Test Reports for Credit SS 7.2: For roof materials, indicating that roof materials comply with Solar Reflectance Index requirement.
   b. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
3. Shop Drawings: For built-up roofing. Include plans, elevations, sections, details, and attachments to other work.
   a. Base flashings and built-up terminations.
   b. Tapered insulation, including slopes.
   c. Crickets, saddles, and tapered edge strips, including slopes.
   d. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
4. Samples: For the following products:
   a. Built-up roofing materials, including base sheet, ply sheet and flashing sheet, of color specified.
   b. Roof insulation.
   c. 3 lb (1.5 kg) of aggregate surfacing material in gradation and color indicated.
   d. Walkway pads.
   e. Six insulation fasteners of each type, length, and finish.
5. Qualification Data: For qualified Installer and manufacturer.
6. Manufacturer Certificates: Signed by roofing manufacturer certifying that built-up roofing complies with requirements specified in "Performance Requirements" Article.
   a. Submit evidence of compliance with performance requirements.
7. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of built-up roofing.
8. Research/Evaluation Reports: For components of built-up roofing, from the ICC-ES **OR** other applicable model code organization, **as directed**.
9. Maintenance Data: For built-up roofing to include in maintenance manuals.
10. Warranties: Sample of special warranties.

F. Quality Assurance
1. Manufacturer Qualifications: A qualified manufacturer that is UL listed **OR** FM Approvals approved, **as directed**, for built-up roofing identical to that used for this Project.
2. Installer Qualifications (if Project is FM Global insured and if a certified roofing installer is required): A qualified firm that is approved, authorized, or licensed by built-up roofing manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
3. Source Limitations (if required to comply with FM Approvals, UL, or another building code, or to comply with provisions of manufacturer's special warranty): Obtain components including roof insulation and fasteners for built-up roofing from same manufacturer as built-up roofing or approved by built-up roofing manufacturer.
4. Exterior Fire-Test Exposure: ASTM E 108, Class A **OR** Class B **OR** Class C, **as directed**; for application and roof slopes indicated, as determined by testing identical built-up roofing materials

by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.

5. Fire-Resistance Ratings: Where indicated, provide fire-resistance-rated roof assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
6. Preinstallation Roofing Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling

1. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
2. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing manufacturer. Protect stored liquid material from direct sunlight.
   a. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
3. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
4. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

H. Project Conditions

1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing to be installed according to manufacturer's written instructions and warranty requirements.

I. Warranty

1. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of built-up roofing that fail in materials or workmanship within specified warranty period.
   a. Special warranty includes built-up roofing membrane, base flashings, roof insulation, fasteners, cover boards, substrate board, roofing accessories, roof pavers, and other components of built-up roofing.
   b. Warranty Period: 10 **OR** 15, **as directed**, years from date of Substantial Completion.

1.2 PRODUCTS

A. Base-Sheet Materials

1. Sheathing Paper: Red-rosin type, minimum 3 lb/100 sq. ft. (0.16 kg/sq. m).
2. Base Sheet: ASTM D 4601, Type I **OR** II, **as directed**, nonperforated, asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.

   OR

   Base Sheet: ASTM D 4897, Type II, venting, nonperforated, heavyweight, asphalt-impregnated and -coated, glass-fiber base sheet with coarse granular surfacing or embossed venting channels on bottom surface.

   OR

   Base Sheet: ASTM D 2626, asphalt-saturated and -coated organic felt, dusted with fine mineral surfacing on both sides.

B. Roofing Membrane Plies

1. Ply Sheet: ASTM D 227, coal-tar-saturated organic felt.

   OR

   Ply Sheet: ASTM D 4990, Type I, coal-tar-impregnated, glass-fiber felt and the physical properties of ASTM D 2178, Type IV **OR** VI, **as directed**.

C. Base Flashing Sheet Materials
1. Backer Sheet: ASTM D 2178, Type IV, asphalt-impregnated, glass-fiber felt.
OR
Backer Sheet: Roofing manufacturer's standard spun-bonded, nonwoven, polyester-reinforced fabric, of standard color and weight, suitable for application method specified.
2. Granule-Surfaced Flashing Sheet: ASTM D 6164, Grade G, Type I or II, polyester-reinforced, SBS-modified asphalt sheet; granular surfaced base flashing; suitable for application method specified, and as follows:
a. Granule Color: White **OR** Gray **OR** Tan, **as directed**.
3. Polyester Flashing Sheet: Roofing manufacturer's standard asphalt-coated, polyester-reinforced fabric, base flashing, suitable for application method specified.
4. Fabric Termination: Roofing manufacturer's standard polyester cloth, suitable for application and for reinforcing top seal of base flashing.

D. Bitumen Materials
1. Asphalt Primer: ASTM D 41.
OR
Coal-Tar Primer: ASTM D 43.
2. Coal-Tar Pitch: ASTM D 450, Type I.
3. Roofing Asphalt: ASTM D 312, Type III **OR** IV **OR** III or IV as recommended by built-up roofing manufacturer for application, **as directed**.
OR
Roofing Asphalt: ASTM D 6152, SEBS modified.

E. Auxiliary Built-Up Roofing Materials
1. General: Auxiliary materials recommended by built-up roofing manufacturer for intended use and compatible with built-up roofing.
a. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
b. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
1) Plastic Foam Adhesives: 50 g/L.
2) Gypsum Board and Panel Adhesives: 50 g/L.
3) Multipurpose Construction Adhesives: 70 g/L.
4) Fiberglass Adhesives: 80 g/L.
5) Contact Adhesives: 80 g/L.
6) Other Adhesives: 250 g/L.
7) Nonmembrane Roof Sealants: 300 g/L.
8) Sealant Primers for Nonporous Substrates: 250 g/L.
9) Sealant Primers for Porous Substrates: 775 g/L.
2. Cold-Applied Adhesive: Roofing manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive specially formulated for compatibility and use with built-up base flashings.
3. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required by roofing manufacturer for application.
4. SBS-Modified Asphalt Flashing Cement: Roofing manufacturer's standard, asbestos free, of consistency required for application.
5. Coal-Tar Roofing Cement: ASTM D 5643, coal-tar-based roofing cement, asbestos free.
6. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening built-up roofing components to substrate, tested by manufacturer for required pullout strength, and acceptable to roofing manufacturer.
7. Metal Flashing Sheet: Metal flashing sheet is specified in Division 07 Section "Sheet Metal Flashing And Trim".

8. Metal Termination Bars: Roofing manufacturer's standard predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.
9. Roof Coatings: ASTM D 2824, Type I, nonfibered **OR** III, fibered, asbestos-free, **as directed**, aluminum-pigmented asphaltic coating.
   OR
   Roof Coatings: ASTM D 6083, acrylic elastomer emulsion coating, formulated for use on bituminous roof surfaces.
   a. Color: White **OR** Gray **OR** Buff, **as directed**.
10. Aggregate Surfacing: ASTM D 1863, No. 6 or No. 67, clean, dry, opaque, water-worn gravel or crushed stone, free of sharp edges **OR** crushed slag, free of sharp edges, **as directed**.
11. Walkway Pads: Mineral-granule-surfaced, reinforced asphaltic composition **OR** Polymer-modified, reconstituted solid-rubber, surface-textured, **as directed**, slip-resisting pads, manufactured as a traffic pad for foot traffic and acceptable to built-up roofing manufacturer, 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 3/4 inch (19 mm), **as directed**, thick, minimum.
12. Miscellaneous Accessories: Provide miscellaneous accessories recommended by built-up roofing manufacturer.

F. Substrate Boards
1. Substrate Board: ASTM C 1396/C 1396M, Type X gypsum board, 5/8 inch (16 mm) thick.
   OR
   Substrate Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** Type X, 5/8 inch (16 mm), **as directed**, thick, factory primed, **as directed**.
   OR
   Substrate Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.
   OR
   Substrate Board: ASTM C 728, perlite board, 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick, seal coated.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

G. Vapor Retarder
1. Polyethylene Film: ASTM D 4397, 6 mils (0.15 mm) thick, minimum, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).
   a. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
      OR
      Adhesive: Manufacturer's standard lap adhesive, FM Approvals approved for vapor-retarder application.
2. Laminated Sheet: Kraft paper/polyethylene laminate, two layers, reinforced with woven fiberglass yarn, laminated and edge reinforced, with maximum permeance rating of 0.50 perm (29 ng/Pa x s x sq. m) and with manufacturer's standard adhesive, **as directed**.
3. Self-Adhering Sheet Vapor Retarder: ASTM D 1970, minimum of 40-mil- (1.0-mm-) thick, polyethylene film laminated to layer of rubberized asphalt adhesive; maximum permeance rating of 0.1 perm (6 ng/Pa x s x sq. m); cold-applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.
   OR
   Self-Adhering Sheet Vapor Retarder: 30- to 40-mil- (0.76- to 1.0-mm-) thick, polyethylene film laminated to layer of butyl rubber adhesive; maximum permeance rating of 0.1 perm (6 ng/Pa x s x sq. m); cold-applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.
4. Glass-Fiber Felts: ASTM D 2178, Type IV, asphalt impregnated.

H. Roof Insulation

1. General: Preformed roof insulation boards manufactured or approved by roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Approvals-approved roof insulation, **as directed**.
2. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2 **OR** Type II, Class I, Grade 3, **as directed**, felt or glass-fiber mat facer on both major surfaces.
3. Composite Polyisocyanurate Board Insulation: ASTM C 1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber mat facer on the other surface.
   a. Type IV, cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch (13 mm) thick.
   b. Type V, OSB facer, 7/16 inch (11 mm) thick.
   c. Type VII, glass mat faced gypsum board facer, 1/4 inch (6 mm) thick.
4. Perlite Board Insulation: ASTM C 728, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.
5. Cellulosic-Fiber Board Insulation: ASTM C 208, Type II, Grade 1, fibrous-felted, rigid insulation boards of wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.
6. Cellular-Glass Board Insulation: ASTM C 552, Type IV, rigid, cellular-glass thermal board insulation faced with manufacturer's standard kraft-paper sheets.
7. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/8 inch per 12 inches (1:96) **OR** 1/4 inch per 12 inches (1:48), **as directed**, unless otherwise indicated.
8. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

I. Insulation Accessories
1. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatible with built-up roofing.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation to substrate and acceptable to roofing manufacturer.
3. Modified Asphaltic Insulation Adhesive: Insulation manufacturer's recommended modified asphaltic, asbestos-free, cold-applied adhesive formulated to attach roof insulation to substrate or to another insulation layer.
4. Bead-Applied Insulation Adhesive: Insulation manufacturer's recommended bead-applied, low-rise, one- or multicomponent urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
5. Full-Spread Applied Insulation Adhesive: Insulation manufacturer's recommended spray-applied, low-rise, two-component urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
6. Insulation Cant Strips: ASTM C 728, perlite insulation board.
   OR
   Insulation Cant Strips: ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board.
7. Wood Nailer Strips: Comply with requirements in Division 6 Section "Rough Carpentry" **OR** “Miscellaneous Carpentry", **as directed**.
8. Tapered Edge Strips: ASTM C 728, perlite insulation board.
   OR
   Tapered Edge Strips: ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board.
9. Cover Board: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, 1/2 inch (13 mm) thick.
   OR
   Cover Board: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.
   OR
   Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick, factory primed, **as directed**.
   OR

Cover Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.

10. Substrate Joint Tape: 6- or 8-inch- (150- or 200-mm-) wide, coated, glass fiber.

1.3 EXECUTION

A. Examination

1. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:
   a. Verify that roof openings and penetrations are in place and curbs are set and braced and that roof drain bodies are securely clamped in place.
   b. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
   c. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Division 5 Section "Steel Deck."
   d. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of 1/16 inch (1.6 mm) out of plane relative to adjoining deck.
   e. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
   f. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
      1) Test for moisture by pouring 1 pint (0.5 L) of hot roofing asphalt on deck at start of each day's work and at start of each roof area or plane. Do not proceed with roofing work if test sample foams or can be easily and cleanly stripped after cooling.
   g. Verify that concrete curing compounds that will impair adhesion of roofing components to roof deck have been removed.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation

1. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing manufacturer's written instructions. Remove sharp projections.
2. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
3. Prime surface of concrete deck with asphalt **OR** coal-tar, **as directed**, primer at a rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.
4. Install insulation strips in ribs of acoustical roof decks according to acoustical roof deck manufacturer's written instructions.

C. Substrate Board Installation

1. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
   a. Fasten substrate board to top flanges of steel deck according to recommendations in FM Approvals' "RoofNav" and FM Global Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.

      OR

      Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to built-up roofing manufacturers' written instructions.

D. Vapor-Retarder Installation

1. Polyethylene Film: Loosely lay polyethylene-film vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.
   a. Continuously seal side and end laps with tape **OR** adhesive, **as directed**.

2. Laminate Sheet: Install laminate-sheet vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively. Bond vapor retarder to substrate as follows:
   a. Apply adhesive at rate recommended by vapor-retarder manufacturer. Seal laps with adhesive.
      OR
      Apply ribbons of hot roofing asphalt at spacing, temperature, and rate recommended by vapor-retarder manufacturer. Seal laps with hot roofing asphalt.
3. Self-Adhering Sheet Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of 3-1/2 inches (90 mm) and 6 inches (150 mm), respectively. Seal laps by rolling.
4. Built-up Vapor Retarder: Install two glass-fiber felt plies lapping each felt 19 inches (483 mm) over preceding felt. Embed each felt in a solid mopping of hot roofing asphalt. Glaze-coat completed surface with hot roofing asphalt. Apply hot roofing asphalt within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
5. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into built-up roofing system.

E. Insulation Installation
1. Comply with built-up roofing manufacturer's written instructions for installing roof insulation.
2. Install one lapped base sheet course and mechanically fasten to substrate according to built-up roofing manufacturer's written instructions.
3. Nailer Strips: Mechanically fasten 4-inch nominal- (89-mm actual-) width wood nailer strips of same thickness as insulation perpendicular to sloped roof deck, spaced 16 feet (4.88 m) apart for roof slopes greater than 1/4 inch per 12 inches (1:48) **OR** 1/2 inch per 12 inches (1:24), **as directed**.
4. Insulation Cant Strips: Install and secure preformed 45-degree insulation cant strips at junctures of built-up roofing with vertical surfaces or angle changes greater than 45 degrees.
5. Install tapered insulation under area of roofing to conform to slopes indicated.
6. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
   a. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
7. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches (68 mm) or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.
   a. Where installing composite and noncomposite board insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
8. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
9. Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.
10. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
    a. Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.
    b. Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
       OR
       Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
       OR
       Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

11. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
    a. If Project is FM Global insured or if FM Approvals requirements are proposed as a performance standard, fasten insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
    b. If number of fasteners will be based on ASCE/SEI 7's uplift pressure, fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.
12. Mechanically Fastened and Adhered Insulation: Install first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
    a. If Project is FM Global insured or if FM Approvals requirements are proposed as a performance standard, fasten first layer of insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
    b. If fastening is calculated from ASCE/SEI 7's uplift pressure, fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
    c. Set each subsequent layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
       OR
       Set each subsequent layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
       OR
       Set each subsequent layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
13. If cover boards will be field installed over roof insulation and immediately below built-up roofing, install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction. Loosely butt cover boards together and fasten to roof deck, **as directed**. Tape joints if required by roofing manufacturer.
    a. Fasten cover boards according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
       OR
       Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.
    b. Apply hot roofing asphalt to underside and immediately bond cover board to substrate.

F. Built-Up Roofing Installation, General
1. If referencing NRCA's roof assembly identification matrix system, install roofing membrane according to roofing manufacturer's written instructions and applicable recommendations of ARMA/NRCA's "Quality Control Guidelines for the Application of Built-up Roofing."
    a. Install roofing system BU-3 **OR** 4 **OR** 5, **as directed**,-N **OR** I **OR** C, **as directed**,-A-A, according to roof assembly identification matrix and roof assembly layout illustrations in NRCA's "The NRCA Roofing and Waterproofing Manual" and requirements in this Section.
2. For roofing that exceeds requirements of NRCA's roof assemblies, install built-up roofing membrane according to roofing manufacturer's written instructions and applicable recommendations of ARMA/NRCA's "Quality Control Guidelines for the Application of Built-up Roofing" and as follows:
    a. Deck Type: N (nailable) **OR** I (insulated) **OR** C (concrete or nonnailable), **as directed**.
    b. Base Sheet: 1 **OR** 1, installed over sheathing paper, **as directed**.
    c. Number of Organic Felt Ply Sheets: 2 **OR** 3 **OR** 4, **as directed**.
    d. Number of Glass Fiber Ply Sheets: 1, top ply **OR** 2 **OR** 3 **OR** 4, **as directed**.
    e. Surfacing Type: A (aggregate).
3. Start installation of built-up roofing in presence of manufacturer's technical personnel.
4. Where roof slope exceeds 1/4 inch per 12 inches (1:48) **OR** 1/2 inch per 12 inches (1:24), **as directed**, install built-up roofing sheets parallel with slope.
    a. Backnail built-up roofing sheets to nailer strips **OR** substrate, **as directed**, according to roofing manufacturer's written instructions.

5. Cooperate with testing agencies engaged or required to perform services for installing roofing system.
6. Coordinate installation of built-up roofing so insulation and other components of built-up roofing not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.
   a. Provide tie-offs at end of each day's work to cover exposed built-up roofing sheets and insulation with a course of coated felt set in roofing cement or hot roofing asphalt with joints and edges sealed.
   b. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system.
   c. Remove and discard temporary seals before beginning work on adjoining roofing.
7. Bitumen Heating: Do not raise bitumen temperature above equiviscous temperature range more than one hour before time of application. Do not exceed bitumen manufacturer's recommended temperature limits during bitumen heating. Do not heat bitumen within 25 deg F (14 deg C) of flash point. Discard bitumen maintained for more than 4 hours at a temperature exceeding 325 deg F (163 deg C) for coal-tar pitch or finished blowing temperature for roofing asphalt, **as directed**.
   a. Mopping Weights: For interply and other moppings, unless otherwise indicated, apply solid moppings of hot coal-tar pitch between ply sheets at a minimum rate of 20 lb/100 sq. ft. (1 kg/sq. m).
8. SEBS-Asphalt Heating: Heat and apply SEBS-modified roofing asphalt according to roofing manufacturer's written instructions.
9. Substrate-Joint Penetrations: Prevent bitumen and adhesives from penetrating substrate joints, entering building, or damaging built-up roofing components or adjacent building construction.

G. Roofing Membrane Installation
1. If sheathing paper is required over wood decks by built-up roofing manufacturer, loosely lay one course of sheathing paper, lapping edges and ends a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.
2. Install lapped base sheet course, extending sheet over and terminating beyond cants. Attach base sheet as follows:
   a. Mechanically fasten to substrate, for nailable substrate.
      OR
      Spot- or strip-mop to substrate with hot roofing asphalt.
      OR
      Adhere to substrate in a solid mopping of hot roofing asphalt **OR** uniform coating of cold-applied adhesive, **as directed**, for nonnailable or insulated substrates.
3. Monolithic Membrane: Install two **OR** three **OR** four, **as directed**, ply sheets starting at low point of roofing system. Align ply sheets without stretching. Shingle side laps of ply sheets uniformly to achieve required number of plies throughout thickness of roofing membrane. Shingle in direction to shed water. Extend ply sheets over and terminate beyond cants. Embed each ply sheet in a solid mopping of hot coal-tar pitch to form a uniform membrane without ply sheets touching.
   OR
   Composite Membrane: Install two **OR** three **OR** four, **as directed**, organic felt ply sheets starting at low point of roofing system. Align organic felt ply sheets without stretching. Shingle side laps of organic felt ply sheets uniformly to achieve required number of plies throughout thickness of roofing membrane. Shingle in direction to shed water.
   a. Install finish layer of one lapped coal-tar, glass-fiber ply sheet course over shingled organic felt ply sheets, starting at low point of built-up roofing. Offset laps from laps of preceding ply sheets and align coal-tar, glass-fiber ply sheet without stretching. Lap in direction to shed water.
   b. Extend ply sheets over and terminate beyond cants.
   c. Embed each ply sheet in a solid mopping of hot coal-tar pitch applied at rate required by built-up roofing manufacturer, to form a uniform membrane without ply sheets touching.

4. If delayed flood coating and aggregate surfacing of coal-tar, glass-fiber membrane or finish layer are permitted, glaze-coat roofing membrane surface with hot coal-tar pitch applied at a rate of 10 to 15 lb/100 sq. ft. (0.5 to 0.75 kg/sq. m) if aggregate surfacing is not applied immediately.
5. Aggregate Surfacing: If surfacing roofing membrane with aggregate, promptly after installing and testing roofing membrane, base flashing, and stripping, flood-coat roof surface with 70 lb/100 sq. ft. (3.5 kg/sq. m) of hot coal-tar pitch. While flood coat is hot and fluid, cast the following average weight of aggregate in a uniform course:
    a. Aggregate Weight: 400 lb/100 sq. ft. (20 kg/sq. m) for gravel or crushed stone or 300 lb/100 sq. ft. (15 kg/sq. m) for slag.
    b. Sweep loose aggregate from roof surface and apply another flood coat of not less than 85 lb/100 sq. ft. (4.15 kg/sq. m) of hot coal-tar pitch. While flood coat is hot and fluid, apply a uniform course of aggregate at the following rate. Sweep away loose aggregate and fully embed aggregate by lightly rolling into finished roof surface.
        1) Aggregate Weight: 300 lb/100 sq. ft. (15 kg/sq. m) for gravel or crushed stone 200 lb/100 sq. ft. (10 kg/sq. m) for slag, average.
6. Walkway Pads: Install walkway pads using units of size indicated or, if not indicated, of manufacturer's standard size according to walkway pad manufacturer's written instructions.
    a. Sweep away loose aggregate surfacing and set walkway pads in additional flood coat of hot coal-tar pitch.

H. Flashing And Stripping Installation
1. Install base flashing over cant strips and other sloping and vertical surfaces, at roof edges, and at penetrations through roof, and secure to substrates according to built-up roofing manufacturer's written instructions and as follows:
    a. Prime substrates with asphalt primer if required by built-up roofing manufacturer.
    b. Backer Sheet Application: Install single backer sheet and adhere to substrate in a solid mopping of hot roofing asphalt **OR** asphalt roofing cement **OR** SBS-modified asphalt roofing cement **OR** cold-applied adhesive, **as directed**.
    OR
    Backer Sheet Application: Install two **OR** three, **as directed**, backer sheets and adhere to substrate in a solid mopping of hot roofing asphalt **OR** asphalt roofing cement, **as directed**.
    c. Flashing Sheet Application: Adhere flashing sheet to substrate in a solid mopping of hot roofing asphalt applied at not less than 425 deg F (218 deg C). Apply hot roofing asphalt to back of flashing sheet if recommended by roofing manufacturer.
    OR
    Flashing Sheet Application: Adhere flashing sheet to substrate in SBS-modified asphalt roofing cement **OR** asphalt roofing cement, **as directed**.
2. Extend base flashing up walls or parapets a minimum of 8 inches (200 mm) above built-up roofing and 4 inches (100 mm) onto field of built-up roofing.
3. Mechanically fasten top of base flashing securely at terminations and perimeter of roofing.
    a. Securely fasten top termination of base flashing with continuous metal termination bar anchored into substrate.
    b. Seal top termination of base flashing with a strip of glass-fiber fabric set in asphalt roofing cement, **as directed**.
4. Apply roof coatings to smooth base flashings according to manufacturer's written instructions, by spray, roller, or other suitable application method.
5. Install stripping, according to roofing system manufacturer's written instructions, where metal flanges and edgings are set on built-up roofing.
    a. Flashing-Sheet Stripping: Install flashing-sheet stripping in a cold-applied adhesive or in a solid mopping of hot coal-tar pitch and extend onto roofing membrane.
    OR
    Built-up Stripping: Install stripping of not less than two roofing membrane ply sheets, setting each ply in a continuous coal-tar roofing cement or in a solid mopping of hot coal-tar pitch, and extend onto roofing membrane 4 inches (100 mm) and 6 inches (150 mm), respectively.

6. Roof Drains: Set 30-by-30-inch (760-by-760-mm) metal flashing in bed of asphalt roofing cement on completed built-up roofing. Cover metal flashing with built-up roofing cap-sheet stripping and extend a minimum of 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, beyond edge of metal flashing onto field of built-up roofing. Clamp built-up roofing, metal flashing, and stripping into roof-drain clamping ring.
   a. Flashing-Sheet Stripping: Install flashing-sheet stripping in cold-applied adhesive or in a solid mopping of hot coal-tar pitch and extend onto roofing membrane.
      OR
      Built-up Stripping: Install stripping of not less than 2 roofing membrane ply sheets, setting each ply in a continuous coating of coal-tar roofing cement or in a solid mopping of hot coal-tar pitch, and extend onto roofing membrane 4 inches (100 mm) and 6 inches (150 mm), respectively.

I. Field Quality Control
1. Testing Agency: Perform roof tests and inspections, observe flood tests, and prepare test reports.
2. Test Cuts: Test specimens will be removed to evaluate problems observed during quality-assurance inspections of built-up roofing as follows:
   a. Approximate quantities of components within built-up roofing will be determined according to ASTM D 3617.
   b. Test specimens will be examined for interply voids according to ASTM D 3617 and to comply with criteria established in Appendix 3 of ARMA/NRCA's "Quality Control Guidelines for the Application of Built-up Roofing."
   c. Repair areas where test cuts were made according to built-up roofing manufacturer's written instructions.
3. Flood Testing: Flood test each roofing membrane area for leaks, according to recommendations in ASTM D 5957, after completing roofing and flashing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.
   a. Flood to an average depth of 2-1/2 inches (65 mm) with a minimum depth of 1 inch (25 mm) and not exceeding a depth of 4 inches (100 mm). Maintain 2 inches (50 mm) of clearance from top of base flashing.
   b. Flood each area for 24 **OR** 48 **OR** 72, **as directed**, hours.
   c. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.
4. Repair or remove and replace components of roofing system where test results or inspections indicate that they do not comply with specified requirements.
   a. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

J. Protecting And Cleaning
1. Protect built-up roofing from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to the Owner and Owner.
2. Correct deficiencies in or remove built-up roofing that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
3. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07212a

SECTION 07212b - EPDM MEMBRANE ROOFING

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for ethylene-propylene-diene-monomer (EPDM) roofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Adhered EPDM membrane roofing system.
   b. Mechanically fastened EPDM membrane roofing system.
   c. Loosely laid and ballasted EPDM membrane roofing system.
   d. Vapor retarder.
   e. Roof insulation.
2. Section includes the installation of acoustical roof deck rib insulation strips furnished under Division 05 Section "Steel Deck".

C. Definitions
1. Roofing Terminology: See ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definitions of terms related to roofing work in this Section.

D. Performance Requirements
1. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.
2. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.
3. Roofing System Design: Provide membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.
4. FM Approvals Listing: Provide membrane roofing, base flashings, and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a membrane roofing system, and that are listed in FM Approvals' "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals' markings.
   a. Fire/Windstorm Classification: Class 1A-60 **OR** Class 1A-75 **OR** Class 1A-90 **OR** Class 1A-105 **OR** Class 1A-120 **OR** Class 1A-135 **OR** Class 1A-150 **OR** Class 1A-165, **as directed**.
   b. Hail Resistance: MH **OR** SH, **as directed**.
5. Energy Performance (for “cool-roof” performance): Provide roofing system with initial Solar Reflectance Index not less than 78 **OR** 29, **as directed**, when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency, **as directed**.
6. Energy Performance: Provide roofing system that is listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low **OR** steep, **as directed**,-slope roof products, **as directed**.
7. Energy Performance (for roofs that must comply with California Energy Commission's CEC-Title 24): Provide roofing system with initial solar reflectance not less than 0.70 and emissivity not less than 0.75 when tested according to CRRC-1.

E. Submittals
1. Product Data: For each type of product indicated.

2. LEED Submittals:
   a. Product Test Reports for Credit SS 7.2: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirement.
   b. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
3. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.
4. Samples: For each product included in the roofing system.
5. Manufacturer Certificate: Signed by roofing manufacturer certifying that membrane roofing system complies with requirements specified in "Performance Requirements" Article.
   a. Submit evidence of complying with performance requirements.
6. Research/evaluation reports.
7. Field quality-control reports.
8. Maintenance data.
9. Warranties: Sample of special warranties.

F. Quality Assurance
1. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
2. Source Limitations: Obtain components for membrane roofing system from same manufacturer as membrane roofing or approved by membrane roofing manufacturer.
3. Exterior Fire-Test Exposure: ASTM E 108, Class A **OR** Class B **OR** Class C, **as directed**; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.
4. Fire-Resistance Ratings: Where indicated, provide fire-resistance-rated roof assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
5. Preinstallation Roofing Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
2. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
   a. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
3. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
4. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

H. Project Conditions
1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

I. Warranty
1. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail

in materials or workmanship within 10 **OR** 15 **OR** 20, **as directed**, years from date of Substantial Completion.

1.2 PRODUCTS

A. EPDM Membrane Roofing
1. EPDM: ASTM D 4637, Type I, non-reinforced, **OR** Type II, scrim or fabric internally reinforced, **as directed**, uniform, flexible EPDM sheet.
a. Thickness: 45 mils (1.1 mm) **OR** 60 mils (1.5 mm) **OR** 75 mils (1.9 mm) **OR** 90 mils (2.2 mm), **as directed**, nominal.
b. Exposed Face Color: Black **OR** White on black, **as directed**.
2. Fabric-Backed EPDM: ASTM D 4637, Type III, non-reinforced, uniform, flexible EPDM sheet, laminated to a nonwoven polyester fabric backing except at selvages.
a. Composite Thickness: 90 mils (2.3 mm) **OR** 100 mils (2.5 mm) **OR** 105 mils (2.7 mm) **OR** 115 mils (2.9 mm), **as directed**, nominal.
b. Exposed Face Color: Black **OR** White on black, **as directed**.

B. Auxiliary Membrane Roofing Materials
1. General: Auxiliary membrane roofing materials recommended by roofing system manufacturer for intended use and compatible with membrane roofing.
a. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
b. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
1) Plastic Foam Adhesives: 50 g/L.
2) Gypsum Board and Panel Adhesives: 50 g/L.
3) Multipurpose Construction Adhesives: 70 g/L.
4) Fiberglass Adhesives: 80 g/L.
5) Contact Adhesive: 80 g/L.
6) Single-Ply Roof Membrane Sealants: 450 g/L.
7) Nonmembrane Roof Sealants: 300 g/L.
8) Sealant Primers for Nonporous Substrates: 250 g/L.
9) Sealant Primers for Porous Substrates: 775 g/L.
10) Other Adhesives and Sealants: 250 g/L.
2. Sheet Flashing: 60-mil- (1.5-mm-) thick EPDM, partially cured or cured, according to application.
3. Protection Sheet: Epichlorohydrin or neoprene non-reinforced flexible sheet, 55- to 60-mil- (1.4- to 1.5-mm-) thick, recommended by EPDM manufacturer for resistance to hydrocarbons, non-aromatic solvents, grease, and oil.
4. Bonding Adhesive: Manufacturer's standard, water based, **as directed**.
5. Modified Asphaltic Fabric-Backed Membrane Adhesive: Roofing system manufacturer's standard modified asphalt, asbestos-free, cold-applied adhesive formulated for compatibility and use with fabric-backed membrane roofing.
6. Water-Based, Fabric-Backed Membrane Adhesive: Roofing system manufacturer's standard water-based, cold-applied adhesive formulated for compatibility and use with fabric-backed membrane roofing.
7. Low-Rise, Urethane, Fabric-Backed Membrane Adhesive: Roof system manufacturer's standard spray-applied, low-rise, two-component urethane adhesive formulated for compatibility and use with fabric-backed membrane roofing.
8. Seaming Material: Single-component, butyl splicing adhesive and splice cleaner **OR** Manufacturer's standard, synthetic-rubber polymer primer and 3-inch- (75-mm-) wide minimum, butyl splice tape with release film, **as directed**.
9. Lap Sealant: Manufacturer's standard, single-component sealant, colored to match membrane roofing, **as directed**.
10. Water Cutoff Mastic: Manufacturer's standard butyl mastic sealant.

11. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.
12. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick (25 mm wide by 1.3 mm thick), prepunched.
13. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening membrane to substrate, and acceptable to roofing system manufacturer.
14. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, reinforced EPDM securement strips, T-joint covers, in-seam sealants, termination reglets, cover strips, and other accessories.
15. Liquid coating, specifically formulated for coating EPDM membrane roofing, as follows:
    a. Type: Acrylic emulsion **OR** Hypalon, **as directed**.
    b. Color: White **OR** Gray **OR** Tan **OR** As selected from manufacturer's full range, **as directed**.

C. Substrate Boards
1. Substrate Board: ASTM C 1396/C 1396M, Type X gypsum board, 5/8 inch (16 mm) thick.
   OR
   Substrate Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** Type X, 5/8 inch (16 mm), **as directed**, thick.
   OR
   Substrate Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.
   OR
   Substrate Board: ASTM C 728, perlite board, 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick, seal coated.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate panel to roof deck.

D. Vapor Retarder
1. Polyethylene Film: ASTM D 4397, 6 mils (0.15 mm) thick, minimum, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).
   a. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
   b. Adhesive: Manufacturer's standard lap adhesive, FM Approvals approved for vapor-retarder application.
2. Laminated Sheet: Kraft paper, two layers, laminated with asphalt and edge reinforced with woven fiberglass yarn with maximum permeance rating of 0.50 perm (29 ng/Pa x s x sq. m) and with manufacturer's standard adhesive, **as directed**.
3. Glass-Fiber Felts: ASTM D 2178, Type IV, asphalt impregnated.

E. Roof Insulation
1. General: Preformed roof insulation boards manufactured or approved by EPDM membrane roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Approvals-approved roof insulation, **as directed**.
2. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.6-lb/cu. ft. (26-kg/cu. m) **OR** Type X, 1.3-lb/cu. ft. (21-kg/cu. m), **as directed**, minimum density, square edged.
3. Molded-Polystyrene Board Insulation: ASTM C 578, Type II, 1.35-lb/cu. ft. (22-kg/cu. m) **OR** Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) **OR** Type IX, 1.8-lb/cu. ft. (29-kg/cu. m), **as directed**, minimum density.
4. Composite Molded-Polystyrene Board Insulation: ASTM C 578, Type II, 1.35-lb/cu. ft. (22-kg/cu. m) **OR** Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) **OR** Type IX, 1.8-lb/cu. ft. (29-kg/cu. m), **as directed**, minimum density, with factory-applied facings, as follows:

a. Facer: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, asphalt coated, 1/2 inch (13 mm) thick.
OR
Facer: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.

5. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2 **OR** Type II, Class I, Grade 3, **as directed**, felt or glass-fiber mat facer on both major surfaces.
6. Composite Polyisocyanurate Board Insulation: ASTM C 1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber mat facer on the other.
   a. Type IV, cellulosic-fiber-insulation-board facer, Grade 2, 1/2 inch (13 mm) thick.
   b. Type V, OSB facer, 7/16 inch (11 mm) thick.
   c. Type VII, glass mat faced gypsum board facer, 1/4 inch (6 mm) thick.
7. Perlite Board Insulation: ASTM C 728, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.
8. Cellulosic-Fiber Board Insulation: ASTM C 208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.
9. Cellular-Glass Board Insulation: ASTM C 552, Type IV, rigid, cellular-glass thermal board insulation faced with manufacturer's standard kraft-paper sheets.
10. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches (1:48) unless otherwise indicated.
11. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

F. Insulation Accessories
1. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards, **as directed**, to substrate, and acceptable to roofing system manufacturer.
3. Modified Asphaltic Insulation Adhesive: Insulation manufacturer's recommended modified asphalt, asbestos-free, cold-applied adhesive formulated to attach roof insulation to substrate or to another insulation layer.
4. Bead-Applied Insulation Adhesive: Insulation manufacturer's recommended bead-applied, low-rise, one- or multicomponent urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
5. Full-Spread Applied Insulation Adhesive: Insulation manufacturer's recommended spray-applied, low-rise, two-component urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
6. Cover Board: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, 1/2 inch (13 mm) thick.
   OR
   Cover Board: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.
   OR
   Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick, factory primed, **as directed**.
   OR
   Cover Board: ASTM C 1278/C 1278M, cellulosic-fiber reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.
7. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric, water permeable and resistant to UV degradation, type and weight as recommended by roofing system manufacturer for application.

G. Asphalt Materials

1. Roofing Asphalt: ASTM D 312, Type III or Type IV **OR** ASTM D 6152, SEBS modified, **as directed**.
2. Asphalt Primer: ASTM D 41.

H. Aggregate Ballast (for loosely laid and aggregate-ballasted installations)
1. Aggregate Ballast: Provide aggregate ballast that will withstand weather exposure without significant deterioration and will not contribute to membrane degradation, of the following type and size:
   a. Aggregate Type: Smooth, washed, riverbed gravel or other acceptable smooth-faced stone **OR** Crushed gravel or crushed stone, **as directed**.
   b. Size: ASTM D 448, Size 4, ranging in size from 3/4 to 1-1/2 inches (19 to 38 mm).
      OR
      Size: ASTM D 448, Size 2, ranging in size from 1-1/2 to 2-1/2 inches (38 to 63 mm).
      OR
      Size: ASTM D 448, Size 3, ranging in size from 1 to 2 inches (25 to 50 mm).

I. Roof Pavers
1. Lightweight Roof Pavers: Interlocking, lightweight concrete units, specially factory cast for use as roof ballast; grooved back, with four-way drainage capability; beveled, doweled, or otherwise profiled; and as follows:
   a. Size: 8 by 16 inches (200 by 400 mm) **OR** 12 by 12 inches (300 by 300 mm) **OR** 12 by 16-1/2 inches (300 by 420 mm) **OR** 12 by 18 inches (300 by 450 mm), **as directed**.
   b. Weight: At least 10 lb/sq. ft. (50 kg/sq. m) but not exceeding 18 lb/sq. ft. (90 kg/sq. m).
   c. Compressive Strength: 2500 psi (17 MPa) **OR** 5000 psi (34 MPa), **as directed**, minimum.
   d. Colors and Textures: As selected from manufacturer's full range.
2. Rubber Roof Pavers: Interlocking, lightweight rubber units, 24 by 24 by 2-1/4 inches (600 by 600 by 57 mm), 6 lb/sq. ft. (30 kg/sq. m) specially manufactured for use as roof ballast; with grooved back for four-way drainage, beveled and doweled; and as follows:
   a. Perimeter Securement Strip: Manufacturer's standard coated steel sheet channel **OR** aluminum sheet channel **OR** mill-finish aluminum sheet hold down **OR** coated aluminum sheet hold down, color as selected, **as directed**, and fasteners.
   b. Color: Black **OR** Gray **OR** Terra cotta, **as directed**.
3. Heavyweight Roof Pavers: Heavyweight, hydraulically pressed, concrete units, square edged **OR** with top edges beveled 3/16 inch (5 mm), **as directed**, factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C 67; and as follows:
   a. Size: 12 by 12 inches (300 by 300 mm) **OR** 18 by 18 inches (450 by 450 mm) **OR** 24 by 24 inches (600 by 600 mm), **as directed**. Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch (1.6 mm) in length, height, and thickness.
   b. Weight: 18 lb/sq. ft. (90 kg/sq. m) **OR** 22 lb/sq. ft. (110 kg/sq. m), **as directed**.
   c. Compressive Strength: 7500 psi (52 MPa) **OR** 6500 psi (45 MPa), **as directed**, minimum.
   d. Colors and Textures: As selected from manufacturer's full range.

J. Walkways
1. Flexible Walkways: Factory-formed, nonporous, heavy-duty, solid-rubber, slip-resisting, surface-textured walkway pads **OR** rolls, **as directed**, approximately 3/16 inch (5 mm) thick, and acceptable to membrane roofing system manufacturer.
2. Walkway Roof Pavers: Heavyweight, hydraulically pressed, concrete units, square edged **OR** with top edges beveled 3/16 inch (5 mm), **as directed**, factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C 67; and as follows:
   a. Size: 12 by 12 inches (300 by 300 mm) **OR** 18 by 18 inches (450 by 450 mm) **OR** 24 by 24 inches (600 by 600 mm), **as directed**. Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch (1.6 mm) in length, height, and thickness.
   b. Weight: 18 lb/sq. ft. (90 kg/sq. m) **OR** 22 lb/sq. ft. (110 kg/sq. m), **as directed**.

c. Compressive Strength: 7500 psi (52 MPa) **OR** 6500 psi (45 MPa), **as directed**, minimum.
d. Colors and Textures: As selected from manufacturer's full range.

1.3 EXECUTION

A. Preparation
1. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
2. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
3. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.
4. Install acoustical roof deck rib insulation strips, specified in Division 05 Section "Steel Deck", according to acoustical roof deck manufacturer's written instructions, immediately before installation of overlying construction and to remain dry.

B. Substrate Board
1. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
a. Fasten substrate board to top flanges of steel deck according to recommendations in FM Approvals' "RoofNav" and FM Global Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.
OR
Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to membrane roofing system manufacturers' written instructions.

C. Vapor-Retarder Installation
1. Polyethylene Film: Loosely lay polyethylene-film vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.
a. Continuously seal side and end laps with tape **OR** adhesive, **as directed**.
2. Laminate Sheet: Install laminate-sheet vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively. Bond vapor retarder to substrate as follows:
a. Apply adhesive at rate recommended by vapor-retarder manufacturer. Seal laps with adhesive.
OR
Apply ribbons of hot roofing asphalt at spacing, temperature, and rate recommended by vapor-retarder manufacturer. Seal laps with hot roofing asphalt.
3. Built-Up Vapor Retarder: Install two glass-fiber felt plies lapping each felt 19 inches (483 mm) over preceding felt. Embed each felt in a solid mopping of hot roofing asphalt. Glaze-coat completed surface with hot roofing asphalt. Apply hot roofing asphalt within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
4. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into membrane roofing system.

D. Insulation Installation
1. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
2. Comply with membrane roofing system and insulation manufacturer's written instructions for installing roof insulation.
3. Install tapered insulation under area of roofing to conform to slopes indicated.

4. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches (68 mm) or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.
   a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
5. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
6. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
   a. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
7. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
   a. Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.
   b. Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
   c. Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
      OR
      Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
8. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
   a. Fasten insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
      OR
      Fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.
9. Mechanically Fastened and Adhered Insulation: Install first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
   a. Fasten first layer of insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
      OR
      Fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
   b. Set each subsequent layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
      OR
      Set each subsequent layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
      OR
      Set each subsequent layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
10. Loosely Laid Insulation: Loosely lay insulation units over substrate.
11. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction. Loosely butt cover boards together and fasten to roof deck, **as directed**.
    a. Fasten cover boards according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
       OR
       Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.

E. Adhered Membrane Roofing Installation
1. Adhere membrane **OR** fabric-backed membrane, **as directed**, roofing over area to receive roofing according to membrane roofing system manufacturer's written instructions. Unroll membrane roofing and allow to relax before installing.
2. Start installation of membrane roofing in presence of membrane roofing system manufacturer's technical personnel.
3. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
4. Bonding Adhesive: Apply to substrate and underside of membrane roofing at rate required by manufacturer and allow to partially dry before installing membrane roofing. Do not apply to splice area of membrane roofing.
5. Hot Roofing Asphalt: Apply a solid mopping of hot roofing asphalt to substrate at temperature and rate required by manufacturer and install fabric-backed membrane roofing. Do not apply to splice area of membrane roofing.
   OR
   Fabric-Backed Membrane Adhesive: Apply to substrate at rate required by manufacturer and install fabric-backed membrane roofing.
6. In addition to adhering, mechanically fasten membrane roofing securely at terminations, penetrations, and perimeters.
7. Apply membrane roofing with side laps shingled with slope of roof deck where possible.
8. Adhesive Seam Installation: Clean both faces of splice areas, apply splicing cement, and firmly roll side and end laps of overlapping membrane roofing according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of membrane roofing terminations.
   a. Apply a continuous bead of in-seam sealant before closing splice if required by membrane roofing system manufacturer.
9. Tape Seam Installation: Clean and prime both faces of splice areas, apply splice tape, and firmly roll side and end laps of overlapping membrane roofing according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of membrane roofing terminations.
10. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
11. Spread sealant or mastic bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.
12. Install membrane roofing and auxiliary materials to tie in to existing membrane roofing to maintain weather-tightness of transition and to not void warranty for existing membrane roofing system.
13. Adhere protection sheet over membrane roofing at locations indicated.

F. Mechanically Fastened Membrane Roofing Installation
1. Mechanically fasten membrane roofing over area to receive roofing according to roofing system manufacturer's written instructions. Unroll membrane roofing and allow to relax before installing.
   a. For in-splice attachment, install membrane roofing with long dimension perpendicular to steel roof deck flutes.
2. Start installation of membrane roofing in presence of roofing system manufacturer's technical personnel.
3. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
4. Mechanically fasten or adhere membrane roofing securely at terminations, penetrations, and perimeter of roofing.
5. Apply membrane roofing with side laps shingled with slope of roof deck where possible.
6. Adhesive Seam Installation: Clean both faces of splice areas, apply splicing cement, and firmly roll side and end laps of overlapping membrane roofing according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of membrane roofing terminations.
   a. Apply a continuous bead of in-seam sealant before closing splice if required by membrane roofing system manufacturer.

7. Tape Seam Installation: Clean and prime both faces of splice areas, apply splice tape, and firmly roll side and end laps of overlapping membrane roofing according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of membrane roofing terminations.
8. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
9. Spread sealant or mastic bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.
10. In-Splice Attachment: Secure one edge of membrane roofing using fastening plates or metal battens centered within membrane splice and mechanically fasten membrane roofing to roof deck. Field splice seam.
    OR
    Through-Membrane Attachment: Secure membrane roofing using fastening plates or metal battens and mechanically fasten membrane roofing to roof deck. Cover battens and fasteners with a continuous cover strip.
11. Install membrane roofing and auxiliary materials to tie in to existing roofing to maintain weather-tightness of transition and to not void warranty for existing membrane roofing system.
12. Adhere protection sheet over membrane roofing at locations indicated.

G. Loosely Laid And Ballasted Membrane Roofing Installation
1. Loosely lay membrane roofing over area to receive roofing according to roofing system manufacturer's written instructions. Unroll membrane roofing and allow to relax before installing.
    a. Comply with requirements in SPRI RP-4 for System 1 **OR** System 2 **OR** System 3, **as directed**.
2. Start installation of membrane roofing in presence of roofing system manufacturer's technical personnel.
3. Accurately align membrane roofing, without stretching, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
4. Mechanically fasten or adhere perimeter of membrane roofing according to requirements in SPRI RP-4.
    OR
    Mechanically fasten or adhere membrane roofing at corners, perimeters, and transitions according to requirements in SPRI RP-4.
    a. At corners and perimeters, omit aggregate ballast leaving membrane roofing exposed.
    b. At corners and perimeters, adhere a second layer of membrane roofing
5. Apply membrane roofing with side laps shingled with slope of deck where possible.
6. Adhesive Seam Installation: Clean both faces of splice areas, apply splicing cement, and firmly roll side and end laps of overlapping membrane roofing according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of membrane roofing terminations.
    a. Apply a continuous bead of in-seam sealant before closing splice if required by membrane roofing system manufacturer.
7. Tape Seam Installation: Clean and prime both faces of splice areas, apply splice tape, and firmly roll side and end laps of overlapping membrane roofing according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of membrane roofing terminations.
8. Leave seams uncovered until inspected by membrane roofing system manufacturer **OR** testing agency, **as directed**.
9. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
10. Spread sealant or mastic bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.
11. Install membrane roofing and auxiliary materials to tie in to existing roofing to maintain weather-tightness of transition and to not void warranty for existing membrane roofing system.
12. Adhere protection sheet over membrane roofing at locations indicated.

13. Install protection mat over membrane roofing, overlapping a minimum of 6 inches (150 mm). Install an additional protection mat layer at projections, pipes, vents, and drains, overlapping a minimum of 12 inches (300 mm).
14. Aggregate Ballast, **as directed**: Apply uniformly over membrane roofing at the rate required by membrane roofing system manufacturer, but not less than the following, spreading with care to minimize possibility of damage to membrane roofing system. Lay ballast as membrane roofing is installed, leaving membrane roofing ballasted at the end of the workday.
    a. Ballast Weight: Size 4 aggregate, 10 lb/sq. ft. (50 kg/sq. m).
    OR
    Ballast Weight: Size 2 aggregate, 13 lb/sq. ft. (65 kg/sq. m), at corners and perimeter; Size 4 aggregate, 10 lb/sq. ft. (50 kg/sq. m), elsewhere.
    OR
    Ballast Weight: Size 2 aggregate, 13 lb/sq. ft. (65 kg/sq. m).
15. Roof-Paver Ballast: Install lightweight **OR** heavyweight, **as directed**, roof-paver ballast according to manufacturer's written instructions.
    OR
    Roof-Paver Ballast: Install rubber roof-paver ballast according to manufacturer's written instructions, in locations indicated.
    a. Install perimeter paver edge securement.
    OR
    Roof-Paver and Aggregate Ballast: Install heavyweight roof pavers according to manufacturer's written instructions on roof corners and perimeter.
    b. Install Size 4 aggregate ballast elsewhere on roofing at a minimum rate of 10 lb/sq. ft. (50 kg/sq. m).
    OR
    Install Size 2 aggregate ballast elsewhere on roofing at a minimum rate of 13 lb/sq. ft. (65 kg/sq. m).

H. Base Flashing Installation
1. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.
2. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply to seam area of flashing.
3. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
4. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.
5. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars, **as directed**.

I. Coating Installation
1. Apply coatings to membrane roofing **OR** base flashings, **as directed**, according to manufacturer's written recommendations, by spray, roller, or other suitable application method.

J. Walkway Installation
1. Flexible Walkways: Install walkway products in locations indicated. Adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.
2. Roof-Paver Walkways: Install walkway roof pavers according to manufacturer's written instructions in locations indicated, to form walkways. Leave 3 inches (75 mm) of space between adjacent roof pavers.

K. Field Quality Control
1. Testing Agency: Engage a qualified independent testing agency to perform inspections.

2. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.
3. Repair or remove and replace components of membrane roofing system where inspections indicate that they do not comply with specified requirements.
4. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

L. Protecting And Cleaning
1. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Owner.
2. Correct deficiencies in or remove membrane roofing system that does not comply with requirements, repair substrates and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
3. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07212b

SECTION 07212c - CSPE MEMBRANE ROOFING

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for chlorosulfonate-polyethylene (CSPE) roofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Adhered CSPE membrane roofing system.
   b. Mechanically fastened CSPE membrane roofing system.
   c. Loosely laid and ballasted CSPE membrane roofing system.
   d. Vapor retarder.
   e. Roof insulation.
2. Section includes the installation of acoustical roof deck rib insulation strips furnished under Division 05 Section "Steel Deck".

C. Definitions
1. Roofing Terminology: See ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.

D. Performance Requirements
1. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.
2. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.
3. Roofing System Design: Provide membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.
4. FM Approvals Listing, **as directed**: Provide membrane roofing, base flashings, and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a membrane roofing system, and that are listed in FM Approvals' "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals markings.
   a. Fire/Windstorm Classification: Class 1A-60 **OR** Class 1A-75 **OR** Class 1A-90 **OR** Class 1A-105 **OR** Class 1A-120 **OR** Class 1A-135 **OR** Class 1A-150 **OR** Class 1A-165, **as directed**.
   b. Hail Resistance: MH **OR** SH, **as directed**.
5. Energy Performance: Provide roofing system with initial Solar Reflectance Index not less than 78 **OR** 29, **as directed**, when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency.
6. Energy Performance: Provide roofing system that is listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low **OR** steep, **as directed**,-slope roof products.
7. Energy Performance (for roofs that must comply with California Energy Commission's CEC-Title 24): Provide roofing system with initial solar reflectance not less than 0.70 and emissivity not less than 0.75 when tested according to CRRC-1.

E. Submittals
1. Product Data: For each type of product indicated.

2. LEED Submittals:
   a. Product Test Reports for Credit SS 7.2: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirement.
   b. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
3. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.
4. Samples: For each product included in the roofing system.
5. Research/evaluation reports.
6. Field quality-control reports.
7. Maintenance data.
8. Warranties: Sample of special warranties.

F. Quality Assurance
1. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
2. Source Limitations: Obtain components for membrane roofing system from same manufacturer as membrane roofing or approved by membrane roofing manufacturer.
3. Exterior Fire-Test Exposure: ASTM E 108, Class A **OR** Class B **OR** Class C, **as directed**; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.
4. Fire-Resistance Ratings: Where indicated, provide fire-resistance-rated roof assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
5. Preinstallation Roofing Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
2. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
   a. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
3. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
4. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

H. Project Conditions
1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

I. Warranty
1. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within 10 **OR** 15, **as directed**, years from date of Substantial Completion.

1.2 PRODUCTS

A. CSPE Membrane Roofing
1. CSPE: ASTM D 5019, Type 1, Grade 2, 45-mil- (1.1-mm-) thick, reinforced, flexible uncured sheet formed from CSPE, and as follows:
a. Exposed Face Color: White **OR** Blue **OR** Light gray **OR** Tan, **as directed**.

B. Auxiliary Membrane Roofing Materials
1. General: Auxiliary membrane roofing materials recommended by roofing system manufacturer for intended use, and compatible with membrane roofing.
a. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
b. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
1) Plastic Foam Adhesives: 50 g/L.
2) Gypsum Board and Panel Adhesives: 50 g/L.
3) Multipurpose Construction Adhesives: 70 g/L.
4) Fiberglass Adhesives: 80 g/L.
5) Contact Adhesive: 80 g/L.
6) Single-Ply Roof Membrane Sealants: 450 g/L.
7) Nonmembrane Roof Sealants: 300 g/L.
8) Sealant Primers for Nonporous Substrates: 250 g/L.
9) Sealant Primers for Porous Substrates: 775 g/L.
10) Other Adhesives and Sealants: 250 g/L.
2. Sheet Flashing: 45-mil- (1.1-mm-) thick, reinforced and 55-mil- (1.4-mm-) thick, non-reinforced CSPE as recommended by roofing system manufacturer for intended use.
3. Bonding Adhesive: Manufacturer's standard, water based, **as directed**.
4. Slip Sheet: Manufacturer's standard, of thickness required for application.
5. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.
6. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick (25 mm wide by 1.3 mm thick), prepunched.
7. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening membrane to substrate, and acceptable to membrane roofing system manufacturer.
8. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

C. Substrate Boards
1. Substrate Board: ASTM C 1396/C 1396M, Type X gypsum board, 5/8 inch (16 mm) thick.
OR
Substrate Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** Type X, 5/8 inch (16 mm), **as directed**, thick.
OR
Substrate Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.
OR
Substrate Board: ASTM C 728, perlite board, 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick, seal coated.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

D. Vapor Retarder

1. Polyethylene Film: ASTM D 4397, 6 mils (0.15 mm) thick, minimum, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).
   a. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
   b. Adhesive: Manufacturer's standard lap adhesive, FM Approvals approved for vapor-retarder application.
2. Laminated Sheet: Kraft paper, two layers, laminated with asphalt and edge reinforced with woven fiberglass yarn with maximum permeance rating of 0.50 perm (29 ng/Pa x s x sq. m) and with manufacturer's standard adhesive, **as directed**.
3. Glass-Fiber Felts: ASTM D 2178, Type IV, asphalt impregnated.

E. Roof Insulation
1. General: Preformed roof insulation boards manufactured or approved by CSPE membrane roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Approvals-approved roof insulation, **as directed**.
2. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.6-lb/cu. ft. (26-kg/cu. m) **OR** Type X, 1.3-lb/cu. ft. (21-kg/cu. m), **as directed**, minimum density, square edged.
3. Molded-Polystyrene Board Insulation: ASTM C 578, Type II, 1.35-lb/cu. ft. (22-kg/cu. m) **OR** Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) **OR** Type IX, 1.8-lb/cu. ft. (29-kg/cu. m), **as directed**, minimum density.
4. Composite Molded-Polystyrene Board Insulation: ASTM C 578, Type II, 1.35-lb/cu. ft. (22-kg/cu. m) **OR** Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) **OR** Type IX, 1.8-lb/cu. ft. (29-kg/cu. m), **as directed**, minimum density, with factory-applied facings, as follows:
   a. Facer: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, asphalt coated, 1/2 inch (13 mm) thick.
      OR
      Facer: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.
5. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2 **OR** Type II, Class I, Grade 3, **as directed**, felt or glass-fiber mat facer on both major surfaces.
6. Composite Polyisocyanurate Board Insulation: ASTM C 1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber mat facer on the other.
   a. Type IV, cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch (13 mm) thick.
   b. Type V, OSB facer, 7/16 inch (11 mm) thick.
   c. Type VII, glass mat faced gypsum board facer, 1/4 inch (6 mm) thick.
7. Perlite Board Insulation: ASTM C 728, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.
8. Cellulosic-Fiber Board Insulation: ASTM C 208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.
9. Cellular-Glass Board Insulation: ASTM C 552, Type IV, rigid, cellular-glass thermal board insulation faced with manufacturer's standard kraft-paper sheets.
10. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches (1:48) unless otherwise indicated.
11. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

F. Insulation Accessories
1. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards, **as directed**, to substrate, and acceptable to roofing system manufacturer.

3. Modified Asphaltic Insulation Adhesive: Insulation manufacturer's recommended modified asphalt, asbestos-free, cold-applied adhesive formulated to attach roof insulation to substrate or to another insulation layer.
4. Bead-Applied Insulation Adhesive: Insulation manufacturer's recommended bead-applied, low-rise, one- or multicomponent urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
5. Full-Spread Applied Insulation Adhesive: Insulation manufacturer's recommended spray-applied, low-rise, two-component urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
6. Cover Board: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, 1/2 inch (13 mm) thick.
   OR
   Cover Board: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.
   OR
   Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick, factory primed, **as directed**.
   OR
   Cover Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.
7. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric, water permeable and resistant to UV degradation, type and weight as recommended by roofing system manufacturer for application.

G. Asphalt Materials
1. Roofing Asphalt: ASTM D 312, Type III or Type IV **OR** ASTM D 6152, SEBS modified, **as directed**.
2. Asphalt Primer: ASTM D 41.

H. Aggregate Ballast (for loosely laid and aggregate-ballasted installations)
1. Aggregate Ballast: Provide aggregate ballast that will withstand weather exposure without significant deterioration and will not contribute to membrane degradation, of the following type and size:
   a. Aggregate Type: Smooth, washed, riverbed gravel or other acceptable smooth-faced stone **OR** Crushed gravel or crushed stone, **as directed**.
   b. Size: ASTM D 448, Size 4, ranging in size from 3/4 to 1-1/2 inches (19 to 38 mm).
      OR
      Size: ASTM D 448, Size 2, ranging in size from 1-1/2 to 2-1/2 inches (38 to 63 mm).
      OR
      Size: ASTM D 448, Size 3, ranging in size from 1 to 2 inches (25 to 50 mm).

I. Roof Pavers
1. Lightweight Roof Pavers: Interlocking, lightweight concrete units, specially factory cast for use as roof ballast; grooved back, with four-way drainage capability; beveled, doweled, or otherwise profiled; and as follows:
   a. Size: 8 by 16 inches (200 by 400 mm) **OR** 12 by 12 inches (300 by 300 mm) **OR** 12 by 16-1/2 inches (300 by 420 mm) **OR** 12 by 18 inches (300 by 450 mm), **as directed**.
   b. Weight: At least 10 lb/sq. ft. (50 kg/sq. m) but not exceeding 18 lb/sq. ft. (90 kg/sq. m).
   c. Compressive Strength: 2500 psi (17 MPa) **OR** 5000 psi (34 MPa), **as directed**, minimum.
   d. Colors and Textures: As selected from manufacturer's full range.
2. Heavyweight Roof Pavers: Heavyweight, hydraulically pressed, concrete units, square edged **OR** with top edges beveled 3/16 inch (5 mm), **as directed**, factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C 67; and as follows:

a. Size: 12 by 12 inches (300 by 300 mm) **OR** 18 by 18 inches (450 by 450 mm) **OR** 24 by 24 inches (600 by 600 mm), **as directed**. Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch (1.6 mm) in length, height, and thickness.
b. Weight: 18 lb/sq. ft. (90 kg/sq. m) **OR** 22 lb/sq. ft. (110 kg/sq. m), **as directed**.
c. Compressive Strength: 7500 psi (52 MPa) **OR** 6500 psi (45 MPa), **as directed**, minimum.
d. Colors and Textures: As selected from manufacturer's full range.

J. Walkways
1. Flexible Walkways: Factory-formed, nonporous, heavy-duty, solid-rubber, slip-resisting, surface-textured walkway pads **OR** rolls, **as directed**, approximately 3/16 inch (5 mm) thick, and acceptable to membrane roofing system manufacturer.
2. Walkway Roof Pavers: Heavyweight, hydraulically pressed, concrete units, square edged **OR** with top edges beveled 3/16 inch (5 mm), **as directed**, factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C 67; and as follows:
a. Size: 12 by 12 inches (300 by 300 mm) **OR** 18 by 18 inches (450 by 450 mm) **OR** 24 by 24 inches (600 by 600 mm), **as directed**. Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch (1.6 mm) in length, height, and thickness.
b. Weight: 18 lb/sq. ft. (90 kg/sq. m) **OR** 22 lb/sq. ft. (110 kg/sq. m), **as directed**.
c. Compressive Strength: 7500 psi (52 MPa) **OR** 6500 psi (45 MPa), **as directed**, minimum.
d. Colors and Textures: As selected from manufacturer's full range.

1.3 EXECUTION

A. Preparation
1. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
2. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
3. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.
4. Install acoustical roof deck rib insulation strips, specified in Division 05 Section "Steel Deck", according to acoustical roof deck manufacturer's written instructions, immediately before installation of overlying construction and to remain dry.

B. Substrate Board
1. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
a. Fasten substrate board to top flanges of steel deck according to recommendations in FM Approvals' "RoofNav" and FM Global Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.
OR
Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to membrane roofing system manufacturers' written instructions.

C. Vapor-Retarder Installation
1. Polyethylene Film: Loosely lay polyethylene-film vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.
a. Continuously seal side and end laps with tape **OR** adhesive, **as directed**.

2. Laminate Sheet: Install laminate-sheet vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively. Bond vapor retarder to substrate as follows:
   a. Apply adhesive at rate recommended by vapor-retarder manufacturer. Seal laps with adhesive.
      OR
      Apply ribbons of hot roofing asphalt at spacing, temperature, and rate recommended by vapor-retarder manufacturer. Seal laps with hot roofing asphalt.
3. Built-Up Vapor Retarder: Install two glass-fiber felt plies lapping each felt 19 inches (483 mm) over preceding felt. Embed each felt in a solid mopping of hot roofing asphalt. Glaze-coat completed surface with hot roofing asphalt. Apply hot roofing asphalt within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
4. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into membrane roofing system.

D. Insulation Installation
1. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
2. Comply with membrane roofing system and insulation manufacturer's written instructions for installing roof insulation.
3. Install tapered insulation under area of roofing to conform to slopes indicated.
4. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches (68 mm) or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.
   a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
5. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
6. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
   a. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
7. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
   a. Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.
   b. Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
   c. Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
      OR
      Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
8. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
   a. Fasten insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
      OR
      Fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.
9. Mechanically Fastened and Adhered Insulation: Install each layer of insulation and secure first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
   a. Fasten first layer of insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.

OR

Fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.

b. Set each subsequent layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.

OR

Set each subsequent layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.

OR

Set each subsequent layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

10. Loosely Laid Insulation: Loosely lay insulation units over substrate.
11. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction. Loosely butt cover boards together and fasten to roof deck, **as directed**.
    a. Fasten cover boards according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.

    OR

    Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.
12. Install slip sheet over insulation **OR** cover board, **as directed**, and immediately beneath membrane roofing.

E. Adhered Membrane Roofing Installation
1. Adhere membrane **OR** fabric-backed membrane, **as directed**, roofing over area to receive roofing according to membrane roofing system manufacturer's written instructions. Unroll membrane roofing and allow to relax before installing.
2. Start installation of membrane roofing in presence of membrane roofing system manufacturer's technical personnel.
3. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
4. Bonding Adhesive: Apply to substrate and underside of membrane roofing at rate required by manufacturer and allow to partially dry before installing membrane roofing. Do not apply to splice area of membrane roofing.
5. In addition to adhering, mechanically fasten membrane roofing securely at terminations, penetrations, and perimeter of roofing.
6. Apply membrane roofing with side laps shingled with slope of roof deck where possible.
7. Seams: Clean seam areas, overlap membrane roofing, and weld side and end laps of membrane roofing and sheet flashings according to manufacturer's written instructions to ensure a watertight seam installation. Complete welding of seams within 24 hours of exposing CSPE sheet or before curing of CSPE sheet has begun. Weld seams as follows:
    a. Weld Method: Hot air **OR** Solvent, **as directed**.
    b. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet membrane.
    c. Verify field strength of seams a minimum of twice daily and repair seam sample areas.
    d. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
8. Spread sealant bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.
9. Install membrane roofing and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition and to not void warranty for existing membrane roofing system.

F. Mechanically Fastened Membrane Roofing Installation
1. Mechanically fasten membrane roofing over area to receive roofing and install according to roofing system manufacturer's written instructions.
    a. For in-splice attachment, install membranes roofing with long dimension perpendicular to steel roof deck flutes.

2. Start installation of membrane roofing in presence of roofing system manufacturer's technical personnel.
3. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
4. Mechanically fasten or adhere membrane roofing securely at terminations, penetrations, and perimeter of roofing.
5. Apply membrane roofing with side laps shingled with slope of roof deck where possible.
6. In-Seam Attachment: Secure one edge of CSPE sheet using fastening plates or metal battens centered within membrane seam and mechanically fasten CSPE sheet to roof deck.
7. Seams: Clean seam areas, overlap membrane roofing, and weld side and end laps of membrane roofing and sheet flashings according to manufacturer's written instructions to ensure a watertight seam installation. Complete welding of seams within 24 hours of exposing CSPE sheet or before curing of CSPE sheet has begun. Weld seams as follows:
   a. Weld Method: Hot air **OR** Solvent, **as directed**.
   b. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet membrane.
   c. Verify field strength of seams a minimum of twice daily and repair seam sample areas.
   d. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
8. Spread sealant bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.
9. Install membrane roofing and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition and to not void warranty for existing membrane roofing system.

G. Loosely Laid And Ballasted Membrane Roofing Installation
1. Loosely lay membrane roofing over area to receive roofing and install according to roofing system manufacturer's written instructions.
   a. Comply with requirements in SPRI RP-4 for System 1 **OR** System 2 **OR** System 3, **as directed**.
2. Start installation of membrane roofing in presence of roofing system manufacturer's technical personnel.
3. Accurately align membrane roofing, without stretching, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
4. Mechanically fasten or adhere perimeter of membrane roofing according to requirements in SPRI RP-4.
   OR
   Mechanically fasten **OR** adhere, **as directed**, membrane roofing at corners, perimeters, and transitions according to requirements in SPRI RP-4.
   a. At corners and perimeters, omit aggregate ballast leaving membrane roofing exposed.
   b. At corners and perimeters, adhere a second layer of membrane roofing.
5. Apply membrane roofing with side laps shingled with slope of deck where possible.
6. Seams: Clean seam areas, overlap membrane roofing, and weld side and end laps of membrane roofing and sheet flashings according to manufacturer's written instructions to ensure a watertight seam installation. Complete welding of seams within 24 hours of exposing CSPE sheet or before curing of CSPE sheet has begun. Weld seams as follows:
   a. Weld Method: Hot air **OR** Solvent, **as directed**.
   b. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet membrane.
   c. Verify field strength of seams a minimum of twice daily and repair seam sample areas.
   d. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
7. Spread sealant bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.
8. Install membrane roofing and auxiliary materials to tie in to existing roofing.
9. Install protection mat over membrane roofing, overlapping a minimum of 6 inches (150 mm). Install an additional protection mat layer at projections, pipes, vents, and drains, overlapping a minimum of 12 inches (300 mm).

10. Aggregate Ballast: Apply uniformly over membrane roofing at the rate required by membrane roofing system manufacturer, but not less than the following, spreading with care to minimize possibility of damage to membrane roofing system. Lay ballast as membrane roofing is installed, leaving membrane roofing ballasted at the end of the workday.
    a. Ballast Weight: Size 4 aggregate, 10 lb/sq. ft. (50 kg/sq. m).
       OR
       Ballast Weight: Size 2 aggregate, 13 lb/sq. ft. (65 kg/sq. m), at corners and perimeter; Size 4 aggregate, 10 lb/sq. ft. (50 kg/sq. m), elsewhere.
       OR
       Ballast Weight: Size 2 aggregate, 13 lb/sq. ft. (65 kg/sq. m).
11. Roof-Paver Ballast: Install lightweight **OR** heavyweight, **as directed**, roof-paver ballast according to manufacturer's written instructions.
    OR
    Roof-Paver and Aggregate Ballast: Install heavyweight roof pavers according to manufacturer's written instructions on roof corners and perimeter.
    a. Install Size 4 aggregate ballast elsewhere on roofing at a minimum rate of 10 lb/sq. ft. (50 kg/sq. m).
       OR
       Install Size 2 aggregate ballast elsewhere on roofing at a minimum rate of 13 lb/sq. ft. (65 kg/sq. m).

H. Base Flashing Installation
1. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.
2. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply to seam area of flashing.
3. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
4. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Weld side and end laps to ensure a watertight seam installation. Complete welding of seams within 24 hours of exposing CSPE sheet or before curing of CSPE sheet has begun.
5. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars, **as directed**.

I. Walkway Installation
1. Flexible Walkways: Install walkway products in locations indicated. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.
2. Roof-Paver Walkways: Install walkway roof pavers according to manufacturer's written instructions in locations indicated, to form walkways. Leave 3 inches (75 mm) of space between adjacent roof pavers.

J. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform inspections.
2. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.
3. Repair or remove and replace components of membrane roofing system where inspections indicate that they do not comply with specified requirements.
4. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

K. Protecting And Cleaning
1. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for

deterioration and damage, describing its nature and extent in a written report, with copies to Owner.

2. Correct deficiencies in or remove membrane roofing system that does not comply with requirements, repair substrates and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
3. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07212c

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SECTION 07212d - APP-MODIFIED BITUMINOUS MEMBRANE ROOFING

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for atactic-polypropylene (APP) modified bituminous membrane roofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Atactic-polypropylene (APP) modified bituminous membrane roofing.
   b. Hybrid roofing system that combines built-up ply sheets with APP-modified bituminous membrane.
   c. Vapor retarder.
   d. Roof insulation.
2. Section includes the installation of insulation strips in ribs of acoustical roof deck. Insulation strips are furnished under Division 05 Section "Steel Deck".

C. Definitions
1. Roofing Terminology: See ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.
2. Hot Roofing Asphalt: Roofing asphalt heated to its equiviscous temperature, the temperature at which its viscosity is 125 centipoise for mop-applied roofing asphalt and 75 centipoise for mechanical spreader-applied roofing asphalt, within a range of plus or minus 25 deg F (14 deg C), measured at the mop cart or mechanical spreader immediately before application.

D. Performance Requirements
1. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.
2. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.
3. Roofing System Design: If membrane roofing system is to be designed to withstand uplift pressure established by ASCE/SEI 7, provide membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.
   a. Corner Uplift Pressure: as directed by the Owner.
   b. Perimeter Uplift Pressure: as directed by the Owner.
   c. Field-of-Roof Uplift Pressure: as directed by the Owner.
4. FM Approvals Listing: If Project is FM Global insured or if FM Approvals requirements will set a minimum quality standard, provide membrane roofing, base flashings, and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a membrane roofing system, and that are listed in FM Approvals' "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals markings.
   a. Fire/Windstorm Classification: Class 1A-60 **OR** Class 1A-75 **OR** Class 1A-90 **OR** Class 1A-105 **OR** Class 1A-120, **as directed**.
   b. Hail Resistance Rating: MH **OR** SH, **as directed**.
5. Energy Performance (if required for LEED-NC Credit SS 7.2): Provide roofing system with initial Solar Reflectance Index not less than 78 when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency.

OR

Energy Performance(for roofs that must comply with DOE's ENERGY STAR requirements): Provide roofing system that is listed on DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.

OR

Energy Performance(for roofs that must comply with California Energy Commission's CEC-Title 24): Provide roofing system with initial Solar Reflectance not less than 0.70 and Thermal Emittance not less than 0.75 when tested according to Cool Roof Rating Council's CRRC-1.

E. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
   a. Product Test Reports for Credit SS 7.2: For roof materials, indicating that roof materials comply with Solar Reflectance Index requirement.
   b. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
3. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.
   a. Base flashings and membrane terminations.
   b. Tapered insulation, including slopes.
   c. Crickets, saddles, and tapered edge strips, including slopes.
   d. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
4. Samples: For the following products:
   a. Sheet roofing materials, including base sheet, base-ply sheet, roofing membrane sheet, flashing backer sheet, membrane cap sheet and flashing sheet, of color specified.
   b. Roof insulation.
   c. Walkway pads or rolls.
   d. Six insulation fasteners of each type, length, and finish.
5. Qualification Data: For qualified Installer, manufacturer and testing agency.
6. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
   a. Submit evidence of complying with performance requirements.
7. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of membrane roofing system.
8. Research/Evaluation Reports: For components of membrane roofing system, from the ICC-ES **OR** applicable model code organization, **as directed**.
9. Maintenance Data: For roofing system to include in maintenance manuals.
10. Warranties: Sample of special warranties.

F. Quality Assurance
1. Manufacturer Qualifications: A qualified manufacturer that is UL listed **OR** FM Approvals approved, **as directed**, for membrane roofing system identical to that used for this Project.
2. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
3. Source Limitations: Obtain components including roof insulation and fasteners for membrane roofing system from same manufacturer as membrane roofing or approved by membrane roofing manufacturer.
4. Exterior Fire-Test Exposure: ASTM E 108, Class A **OR** Class B **OR** Class C, **as directed**; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.
5. Fire-Resistance Ratings: Where indicated, provide fire-resistance-rated roof assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

6. Preinstallation Roofing Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
2. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
   a. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
3. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
4. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

H. Project Conditions
1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

I. Warranty
1. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period.
   a. Special warranty includes membrane roofing, base flashings, roof insulation, fasteners, cover boards, substrate board, roofing accessories, and other components of membrane roofing system.
   b. Warranty Period: 10 **OR** 15, **as directed**, years from date of Substantial Completion.

1.2 PRODUCTS

A. APP-Modified Asphalt-Sheet Materials
1. Roofing Membrane Sheet: ASTM D 6222, Grade S, Type I or II, APP-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6223, Grade S, Type I or II, APP-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; smooth surfaced; suitable for application method specified.
2. Smooth-Surfaced Roofing Membrane Cap Sheet: ASTM D 6222, Grade S, Type I or II, APP-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6223, Grade S, Type I or II, APP-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; smooth surfaced; suitable for application method specified.
   OR
   Granule-Surfaced Roofing Membrane Cap Sheet: ASTM D 6222, Grade G, Type I or II, APP-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6223, Grade G, Type I or II, APP-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; granular surfaced; suitable for application method specified, and as follows:
   a. Granule Material: Mineral ceramic coated **OR** slate, **as directed**.
   b. Granule Color: White **OR** Gray **OR** Tan, **as directed**.

B. Base-Sheet Materials
1. Sheathing Paper: Red-rosin type, minimum 3 lb/100 sq. ft. (0.16 kg/sq. m).
2. Base Sheet: ASTM D 4601, Type II, SBS-modified, asphalt-impregnated and -coated sheet, with glass-fiber-reinforcing mat, dusted with fine mineral surfacing on both sides.

a. Weight: 25 lb/100 sq. ft. (1.2 kg/sq. m) **OR** 40 lb/100 sq. ft. (1.95 kg/sq. m) **OR** 50 lb/100 sq. ft. (2.4 kg/sq. m) **OR** 60 lb/100 sq. ft. (2.9 kg/sq. m) **OR** 75 lb/100 sq. ft. (3.7 kg/sq. m), **as directed**, minimum.

OR

Base Sheet: ASTM D 4601, Type I **OR** Type II, **as directed**, nonperforated, asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.

OR

Base Sheet: ASTM D 4897, Type II, venting, nonperforated, heavyweight, asphalt-impregnated and -coated, glass-fiber base sheet with coarse granular surfacing or embossed venting channels on bottom surface.

OR

Base Sheet: ASTM D 2626, asphalt-saturated and -coated organic felt, dusted with fine mineral surfacing on both sides.

C. Base-Ply Sheet Materials

1. Glass-Fiber Base-Ply Sheet: ASTM D 2178, Type IV **OR** Type VI, **as directed**, asphalt-impregnated, glass-fiber felt.

D. Base Flashing Sheet Materials

1. Backer Sheet: ASTM D 4601, Type I **OR** Type II, **a directed**, asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.

   OR

   Backer Sheet: ASTM D 2626, asphalt-saturated and -coated organic felt, dusted with fine mineral surfacing on both sides.

   OR

   Backer Sheet: ASTM D 6222, Grade S, Type I or II, APP-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6223, Grade S, Type I or II, APP-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; smooth surfaced; suitable for application method specified.
2. Smooth-Surfaced Flashing Sheet: ASTM D 6222, Grade S, Type I or II, APP-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6223, Grade S, Type I or II, APP-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; smooth surfaced; suitable for application method specified.

   OR

   Granule-Surfaced Flashing Sheet: ASTM D 6222, Grade G, Type I or II, APP-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6223, Grade G, Type I or II, APP-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; granular surfaced; suitable for application method specified, and as follows:
   a. Granule Color: White **OR** Gray **OR** Tan, **as directed**.
3. Glass-Fiber Fabric: Woven glass-fiber cloth, treated with asphalt, complying with ASTM D 1668, Type I.

E. Auxiliary Roofing Membrane Materials

1. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing membrane.
   a. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
   b. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
      1) Plastic Foam Adhesives: 50 g/L.
      2) Gypsum Board and Panel Adhesives: 50 g/L.
      3) Multipurpose Construction Adhesives: 70 g/L.
      4) Fiberglass Adhesives: 80 g/L.
      5) Contact Adhesive: 80 g/L.

6) Other Adhesives: 250 g/L.
7) Nonmembrane Roof Sealants: 300 g/L.
8) Sealant Primers for Nonporous Substrates: 250 g/L.
9) Sealant Primers for Porous Substrates: 775 g/L.

2. Asphalt Primer: ASTM D 41.
3. Roofing Asphalt: ASTM D 312, Type III **OR** Type IV **OR** Type III or IV as recommended by roofing system manufacturer for application, **as directed**.
   OR
   Roofing Asphalt: ASTM D 6152, SEBS modified.
4. Cold-Applied Adhesive: Roofing system manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive specially formulated for compatibility and use with roofing membrane and base flashings.
5. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required by roofing system manufacturer for application.
6. Mastic Sealant: Polyisobutylene, plain or modified bitumen; nonhardening, nonmigrating, nonskinning, and nondrying.
7. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing membrane components to substrate; tested by manufacturer for required pullout strength, and acceptable to roofing system manufacturer.
8. Metal Flashing Sheet: As specified in Division 07 Section "Sheet Metal Flashing And Trim".
9. Roofing Granules: Ceramic-coated **OR** Slate, **as directed**, roofing granules, No. 11 screen size with 100 percent passing No. 8 (2.36-mm) sieve and 98 percent of mass retained on No. 40 (0.425-mm) sieve, color to match roofing membrane.
10. Miscellaneous Accessories: Provide those recommended by roofing system manufacturer.

F. Substrate Boards
1. Substrate Board: ASTM C 1396/C 1396M, Type X gypsum board, 5/8 inch (16 mm) thick.
   OR
   Substrate Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** Type X, 5/8 inch (16 mm), **as directed**, thick, factory primed, **as directed**.
   OR
   Substrate Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.
   OR
   Substrate Board: ASTM C 728, perlite board, 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick, seal coated.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

G. Vapor Retarder
1. Polyethylene Film: ASTM D 4397, 6 mils (0.15 mm) thick, minimum, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).
   a. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
      OR
      Adhesive: Manufacturer's standard lap adhesive, FM Approvals approved for vapor-retarder application.
2. Laminated Sheet: Kraft paper, two layers, laminated with asphalt and edge reinforced with woven fiberglass yarn, with maximum permeance rating of 0.50 perm (29 ng/Pa x s x sq. m) and with manufacturer's standard adhesive, **as directed**.
3. Self-Adhering Sheet Vapor Retarder: ASTM D 1970, minimum of 40-mil- (1.0-mm-) thick, polyethylene film laminated to layer of rubberized asphalt adhesive; maximum permeance rating

of 0.1 perm (6 ng/Pa x s x sq. m); cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.

OR

Self-Adhering Sheet Vapor Retarder: 30- to 40-mil- (0.76- to 1.0-mm-) thick, polyethylene film laminated to layer of butyl rubber adhesive; maximum permeance rating of 0.1 perm (6 ng/Pa x s x sq. m); cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.

4. Glass-Fiber Felt: ASTM D 2178, Type IV, asphalt impregnated.

H. Roof Insulation

1. General: Preformed roof insulation boards manufactured or approved by roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Approvals-approved roof insulation, **as directed**.
2. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.6-lb/cu. ft. (26-kg/cu. m) **OR** Type X, 1.3-lb/cu. ft. (21-kg/cu. m), **as directed**, minimum density, square edged.
3. Molded-Polystyrene Board Insulation: ASTM C 578, Type II, 1.35-lb/cu. ft. (22-kg/cu. m) **OR** Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) **OR** Type IX, 1.8-lb/cu. ft. (29-kg/cu. m), **as directed**, minimum density.
4. Composite Molded-Polystyrene Board Insulation: ASTM C 578, Type II, 1.35-lb/cu. ft. (22-kg/cu. m) **OR** Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) **OR** Type IX, 1.8-lb/cu. ft. (29-kg/cu. m), **as directed**, minimum density, with factory-applied facings, as follows:
   a. Facer: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, asphalt coated, 1/2 inch (13 mm) thick.

      OR

      Facer: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.
5. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2 **OR** Type II, Class I, Grade 3, **as directed**, felt or glass-fiber mat facer on both major surfaces.
6. Composite Polyisocyanurate Board Insulation: ASTM C 1289, with factory-applied facing board, as indicated below by type, on one major surface and felt or glass-fiber mat facer on the other surface.
   a. Type IV, cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch (13 mm) thick.
   b. Type V, OSB facer, 7/16 inch (11 mm) thick.
   c. Type VII, glass-mat-faced gypsum board facer, 1/4 inch (6 mm) thick.
7. Perlite Board Insulation: ASTM C 728, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.
8. Cellulosic-Fiber Board Insulation: ASTM C 208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.
9. Cellular-Glass Board Insulation: ASTM C 552, Type IV, rigid, cellular-glass thermal board insulation faced with manufacturer's standard kraft-paper sheets.
10. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches (1:48) unless otherwise indicated.
11. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

I. Insulation Accessories

1. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards, **as directed**, to substrate, and acceptable to roofing system manufacturer.
3. Modified Asphaltic Insulation Adhesive: Insulation manufacturer's recommended modified asphaltic, asbestos-free, cold-applied adhesive formulated to attach roof insulation to substrate or to another insulation layer.

OR

Bead-Applied Insulation Adhesive: Insulation manufacturer's recommended bead-applied, low-rise, one-component or multicomponent urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.

OR

Full-Spread Applied Insulation Adhesive: Insulation manufacturer's recommended spray-applied, low-rise, two-component urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.

4. Insulation Cant Strips: ASTM C 728, perlite insulation board.

   OR

   Insulation Cant Strips: ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board.
5. Wood Nailer Strips: Comply with requirements in Division 06 Section(s) "Rough Carpentry" OR "Miscellaneous Carpentry", **as directed**.
6. Tapered Edge Strips: ASTM C 728, perlite insulation board.

   OR

   Tapered Edge Strips: ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board.
7. Cover Board: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, 1/2 inch (13 mm) thick.

   OR

   Cover Board: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.

   OR

   Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick, factory primed, **as directed**.

   OR

   Cover Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.
8. Substrate Joint Tape: 6- or 8-inch- (150- or 200-mm-) wide, coated, glass-fiber joint tape.

J. Coating Materials
1. Roof Coating: ASTM D 1227, Type II, Class 1, mineral-colloid-emulsified, fibered **OR** Class 2, chemically emulsified, filled or fibered, **as directed**, asphalt emulsion, asbestos free.
2. Roof Coating: ASTM D 1227, Type III, Class 1, mineral-colloid-emulsified **OR** Class 2, chemically emulsified, **as directed**, asphalt emulsion, nonfibered.
3. Roof Coating: ASTM D 2824, Type I, nonfibered **OR** Type III, fibered, asbestos-free, **as directed**, aluminum-pigmented asphaltic coating.
4. Roof Coating: Acrylic elastomer emulsion coating, formulated for use on bituminous roof surfaces and complying with ASTM D 6083.
   a. Color: White **OR** Gray **OR** Buff, **as directed**.

K. Walkways
1. Walkway Pads: Reinforced asphaltic composition pads with slip-resisting mineral-granule surface **OR** Polymer-modified, reconstituted rubber pads with slip-resisting textured surface, **as directed**, manufactured as a traffic pad for foot traffic and acceptable to roofing system manufacturer, 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 3/4 inch (19 mm), **as directed**, thick, minimum.
2. Walkway Backer Strips: ASTM D 6222, Grade S, Type I or II, APP-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6223, Grade S, Type I or II, APP-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; smooth surfaced; suitable for application method specified.
3. Walkway Cap Sheet Strips: ASTM D 6222, Grade G, Type I or II, APP-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6223, Grade G, Type I or II, APP-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; granular surfaced; suitable for application method specified, and as follows:
   a. Granule Material: Mineral ceramic coated **OR** slate, **as directed**.
   b. Granule Color: White **OR** Gray **OR** Tan, **as directed**.

1.3 EXECUTION

A. Examination
1. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:
   a. Verify that roof openings and penetrations are in place and curbs are set and braced and that roof drain bodies are securely clamped in place.
   b. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
   c. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Division 05 Section "Steel Deck".
   d. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
   e. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
      1) Test for moisture by pouring 1 pint (0.5 L) of hot roofing asphalt on deck at start of each day's work and at start of each roof area or plane. Do not proceed with roofing work if test sample foams or can be easily and cleanly stripped after cooling.
   f. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.
   g. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of 1/16 inch (1.6 mm) out of plane relative to adjoining deck.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
2. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
3. Prime surface of concrete deck with asphalt primer at a rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.
4. Install insulation strips in ribs of acoustical roof deck according to acoustical roof deck manufacturer's written instructions.

C. Substrate Board Installation
1. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
   a. Fasten substrate board to top flanges of steel deck according to recommendations in FM Approvals' "RoofNav" and FM Global Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.
      OR
      Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to membrane roofing system manufacturers' written instructions.

D. Vapor-Retarder Installation
1. Polyethylene Film: Loosely lay polyethylene-film vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.
   a. Continuously seal side and end laps with tape **OR** adhesive, **as directed**.
2. Laminate Sheet: Install laminate-sheet vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively. Bond vapor retarder to substrate as follows:

a. Apply adhesive at rate recommended by vapor-retarder manufacturer. Seal laps with adhesive.

OR

Apply ribbons of hot roofing asphalt at spacing, temperature, and rate recommended by vapor-retarder manufacturer. Seal laps with hot roofing asphalt.

3. Self-Adhering Sheet Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of 3-1/2 inches (90 mm) and 6 inches (150 mm), respectively. Seal laps by rolling.
4. Built-up Vapor Retarder: Install two glass-fiber felt plies lapping each felt 19 inches (483 mm) over preceding felt. Embed each felt in a solid mopping of hot roofing asphalt. Glaze-coat completed surface with hot roofing asphalt. Apply hot roofing asphalt within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
5. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into membrane roofing system.

E. Insulation Installation

1. Comply with roofing system manufacturer's written instructions for installing roof insulation.
2. If mechanically fastening base sheet to substrate before adhering first layer of insulation, install one lapped base-sheet course and mechanically fasten to substrate according to roofing system manufacturer's written instructions.
3. Nailer Strips: Mechanically fasten 4-inch nominal- (89-mm actual-) width wood nailer strips of same thickness as insulation perpendicular to sloped roof deck at the following spacing:
   a. 16 feet (4.88 m) apart for roof slopes steeper than 1 inch per 12 inches (1:12) but less than 3 inches per 12 inches (3:12).
   b. 48 inches (1220 mm) apart for roof slopes steeper than 3 inches per 12 inches (3:12).
4. Insulation Cant Strips: Install and secure preformed 45-degree insulation cant strips at junctures of roofing membrane system with vertical surfaces or angle changes more than 45 degrees.
5. Install tapered insulation under area of roofing to conform to slopes indicated.
6. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
   a. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
7. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches (68 mm) or more, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.
   a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
8. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
9. Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.
10. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
    a. Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.
    b. Set each layer of insulation in a solid mopping of hot roofing asphalt applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.

    OR

    Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.

    OR

    Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
11. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.

a. If Project is FM Global insured or if FM Approvals requirements are proposed as a performance standard, fasten insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
b. If number of fasteners will be based on ASCE/SEI 7's uplift pressure or SPRI's factored-design uplift pressure, fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.

12. Mechanically Fastened and Adhered Insulation: Install first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
    a. If Project is FM Global insured or if FM Approvals requirements are proposed as a performance standard, fasten first layer of insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
    b. If fastening is calculated from ASCE/SEI 7's uplift pressure or SPRI's factored-design uplift pressure, fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
        1) Set each subsequent layer of insulation in a solid mopping of hot roofing asphalt applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
           OR
           Set each subsequent layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
           OR
           Set each subsequent layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
    c. If cover boards will be field installed over roof insulation and immediately below roofing membrane, install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints a minimum of 6 inches (150 mm) in each direction from joints of insulation below. Loosely butt cover boards together and fasten to roof deck, **as directed**. Tape joints if required by roofing system manufacturer.
        1) Fasten cover boards according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
           OR
           Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.
        2) Apply hot roofing asphalt to underside, and immediately bond cover board to substrate.

F. Roofing Membrane Installation, General
    1. If referencing NRCA's roof assembly identification matrix system, install roofing membrane system according to roofing system manufacturer's written instructions and applicable recommendations in ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing."
        a. Install roofing system MBA **OR** MBAH, **as directed**,-3 **OR** 4, **as directed**,-N **OR** I **OR** C, **as directed**,-T **OR** L, **as directed**,-S **OR** M, **as directed**, according to roof assembly identification matrix and roof assembly layout illustrations in NRCA's "The NRCA Roofing and Waterproofing Manual" and to requirements in this Section.
    2. For roof system that exceeds requirements of NRCA's roof assemblies, install roofing membrane system according to roofing system manufacturer's written instructions and applicable recommendations in ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing" and as follows:
        a. Deck Type: N (nailable) **OR** I (insulated) **OR** C (concrete or nonnailable), **as directed**.
        b. Adhering Method: T (torched) **OR** L (cold-applied adhesive), **as directed**.
        c. Base Sheet: One **OR** One, installed over sheathing paper, **as directed**.
        d. Number of Glass-Fiber Base-Ply Sheets: One **OR** Two, **as directed**.
        e. Number of APP-Modified Asphalt Sheets: One **OR** Two, **as directed**.
        f. Surfacing Type: S (smooth) **OR** M (mineral-granule-surfaced cap sheet), **as directed**.

3. Start installation of roofing membrane in presence of roofing system manufacturer's technical personnel.
4. Where roof slope exceeds 1/2 inch per 12 inches (1:24) **OR** 3/4 inch per 12 inches (1:18), **as directed**, install roofing membrane sheets parallel with slope.
   a. Backnail roofing membrane sheets to nailer strips **OR** substrate, **as directed**, according to roofing system manufacturer's written instructions.
5. Cooperate with testing agencies engaged or required to perform services for installing roofing system.
6. Coordinate installation of roofing system so insulation and other components of the roofing membrane system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.
   a. At end of each day's work, provide tie-offs to cover exposed roofing membrane sheets and insulation with a course of coated felt set in roofing cement or hot roofing asphalt, with joints and edges sealed.
   b. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system.
   c. Remove and discard temporary seals before beginning work on adjoining roofing.
7. Asphalt Heating: Do not raise roofing asphalt temperature above equiviscous temperature range more than one hour before time of application. Do not exceed roofing asphalt manufacturer's recommended temperature limits during roofing asphalt heating. Do not heat roofing asphalt within 25 deg F (14 deg C) of flash point. Discard roofing asphalt maintained at a temperature exceeding finished blowing temperature for more than four hours.
   OR
   Asphalt Heating: Heat and apply SEBS-modified roofing asphalt according to roofing system manufacturer's written instructions.
8. Substrate-Joint Penetrations: Prevent roofing asphalt and adhesives from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.

G. Base-Sheet Installation
1. If sheathing paper is required over wood decks by roofing system manufacturer, loosely lay one course of sheathing paper, lapping edges and ends a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.
2. Install lapped base-sheet course, extending sheet over and terminating beyond cants. Attach base sheet as follows:
   a. Mechanically fasten to substrate, for nailable substrate.
      OR
      Spot- or strip-mop to substrate with hot roofing asphalt.
      OR
      Adhere to substrate in a solid mopping of hot roofing asphalt **OR** uniform coating of cold-applied adhesive, **as directed**, for nonnailable or insulated substrates.

H. Base-Ply Sheet Installation
1. Install glass-fiber base-ply sheets according to roofing system manufacturer's written instructions starting at low point of roofing system. Align glass-fiber base-ply sheets without stretching. Extend sheets over and terminate beyond cants.
   a. Shingle side laps of glass-fiber base-ply sheets uniformly to ensure that required number of glass-fiber base-ply sheets covers substrate at any point. Shingle in direction to shed water.
   b. Embed each glass-fiber base-ply sheet in a continuous void-free mopping of hot roofing asphalt to form a uniform membrane without glass-fiber base-ply sheets touching.

I. APP-Modified Bituminous Membrane Installation
1. Install modified bituminous roofing membrane cap sheet **OR** sheet and cap sheet, **as directed**, according to roofing manufacturer's written instructions, starting at low point of roofing system. Extend roofing membrane sheets over and terminate beyond cants, installing as follows:

a. Adhere to substrate in cold-applied adhesive.
OR
Torch apply to substrate.
b. Unroll roofing membrane sheets and allow them to relax for minimum time period required by manufacturer.

2. Laps: Accurately align roofing membrane sheets, without stretching, and maintain uniform side and end laps. Stagger end laps. Completely bond and seal laps, leaving no voids.
a. Repair tears and voids in laps and lapped seams not completely sealed.
b. Apply roofing granules to cover exuded bead at laps while bead is hot.
3. Install roofing membrane sheets so side and end laps shed water.

J. Flashing And Stripping Installation
1. Install base flashing over cant strips and other sloped and vertical surfaces, at roof edges, and at penetrations through roof; secure to substrates according to roofing system manufacturer's written instructions, and as follows:
a. Prime substrates with asphalt primer if required by roofing system manufacturer.
b. Backer Sheet Application: Mechanically fasten backer sheet to walls or parapets. Adhere backer sheet over roofing membrane at cants in cold-applied adhesive, **as directed**.
OR
Backer Sheet Application: Adhere backer sheet to substrate in a solid mopping of hot roofing asphalt **OR** cold-applied adhesive at rate required by roofing system manufacturer, **as directed**.
c. Flashing Sheet Application: Adhere flashing sheet to substrate in cold-applied adhesive at rate required by roofing system manufacturer.
OR
Flashing Sheet Application: Adhere flashing sheet to substrate in asphalt roofing cement at rate required by roofing system manufacturer.
OR
Flashing Sheet Application: Torch apply flashing sheet to substrate.
2. Extend base flashing up walls or parapets a minimum of 8 inches (200 mm) above roofing membrane and 4 inches (100 mm) onto field of roofing membrane.
3. Mechanically fasten top of base flashing securely at terminations and perimeter of roofing.
a. Seal top termination of base flashing with a strip of glass-fiber fabric set in asphalt roofing cement, **as directed**.
4. Install roofing membrane cap-sheet stripping where metal flanges and edgings are set on membrane roofing according to roofing system manufacturer's written instructions.
5. Roof Drains: Set 30-by-30-inch- (760-by-760-mm-) square metal flashing in bed of roofing-manufacturer-approved asphaltic adhesive on completed roofing membrane. Cover metal flashing with roofing membrane cap-sheet stripping and extend a minimum of 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, beyond edge of metal flashing onto field of roofing membrane. Clamp roofing membrane, metal flashing, and stripping into roof-drain clamping ring.
a. Install stripping according to roofing system manufacturer's written instructions.

K. Coating Installation
1. Apply coating to roofing membrane **OR** roofing membrane and base flashings, **as directed**, according to manufacturer's written instructions, by spray, roller, or other suitable application method to provide a dry film thickness of not less than 20 mils (0.5 mm), **as directed**.

L. Walkway Installation
1. Walkway Pads: Install walkway pads in cold-applied adhesive, using units of size indicated or, if not indicated, of manufacturer's standard size according to walkway pad manufacturer's written instructions.
2. Walkway Strips: Install walkway cap sheet **OR** backer and cap sheet, **as directed**, strips over roofing membrane using same application method as used for roofing membrane cap sheet.

M. Field Quality Control
   1. Testing Agency: Perform tests and inspections and to prepare test reports.
   2. Test Cuts: Test specimens will be removed to evaluate problems observed during quality-assurance inspections of roofing membrane as follows:
      a. Approximate quantities of components within roofing membrane will be determined according to ASTM D 3617.
      b. Test specimens will be examined for interply voids according to ASTM D 3617 and to comply with criteria established in Appendix 3 in ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing."
      c. Repair areas where test cuts were made according to roofing system manufacturer's written instructions.
   3. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.
      a. Notify the Owner and Owner 48 hours in advance of date and time of inspection.
   4. Roofing system will be considered defective if it does not pass tests and inspections.
      a. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

N. Protecting And Cleaning
   1. Protect roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to the Owner and Owner.
   2. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
   3. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07212d

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SECTION 07212e - SBS-MODIFIED BITUMINOUS MEMBRANE ROOFING

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for styrene-butadiene-styrene (SBS) modified bituminous membrane roofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Styrene-butadiene-styrene (SBS) modified bituminous membrane roofing.
   b. Hybrid roofing system that combines built-up ply sheets with SBS-modified bituminous membrane roofing.
   c. Vapor retarder.
   d. Roof insulation.
2. Section includes the installation of insulation strips in ribs of acoustical roof deck. Insulation strips are furnished under Division 05 Section "Steel Deck".

C. Definitions
1. Roofing Terminology: See ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.
2. Hot Roofing Asphalt: Roofing asphalt heated to its equiviscous temperature, the temperature at which its viscosity is 125 centipoise for mop-applied roofing asphalt and 75 centipoise for mechanical spreader-applied roofing asphalt, within a range of plus or minus 25 deg F (14 deg C), measured at the mop cart or mechanical spreader immediately before application.

D. Performance Requirements
1. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.
2. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.
3. Roofing System Design: If membrane roofing system is to be designed to withstand uplift pressure established by ASCE/SEI 7, provide membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.
   a. Corner Uplift Pressure: <Insert **lbf/sq. ft. (kPa/sq. m)**>.
   b. Perimeter Uplift Pressure: <Insert **lbf/sq. ft. (kPa/sq. m)**>.
   c. Field-of-Roof Uplift Pressure: <Insert **lbf/sq. ft. (kPa/sq. m)**>.
4. FM Approvals Listing: If Project is FM Global insured or if FM Approvals requirements will set a minimum quality standard, provide membrane roofing, base flashings, and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a membrane roofing system, and that are listed in FM Approvals' "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals markings.
   a. Fire/Windstorm Classification: Class 1A-60 **OR** Class 1A-75 **OR** Class 1A-90 **OR** Class 1A-105 **OR** Class 1A-120, **as directed**.
   b. Hail Resistance Rating: MH **OR** SH, **as directed**.
5. Energy Performance (if required for LEED-NC Credit SS 7.2): Provide roofing system with initial Solar Reflectance Index not less than 78 when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency.

6. Energy Performance (for roofs that must comply with DOE's ENERGY STAR requirements): Provide roofing system that is listed on DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.
7. Energy Performance (for roofs that must comply with California Energy Commission's CEC-Title 24): Provide roofing system with initial Solar Reflectance not less than 0.70 and Thermal Emittance not less than 0.75 when tested according to Cool Roof Rating Council's CRRC-1.

E. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
   a. Product Test Reports for Credit SS 7.2: For roof materials, indicating that roof materials comply with Solar Reflectance Index requirement.
   b. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
3. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.
   a. Base flashings and membrane terminations.
   b. Tapered insulation, including slopes.
   c. Crickets, saddles, and tapered edge strips, including slopes.
   d. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
4. Samples: For the following products:
   a. Sheet roofing materials, including base sheet, base-ply sheet, roofing membrane sheet, flashing backer sheet, membrane cap sheet and flashing sheet, of color specified.
   b. Roof insulation.
   c. 3 lb (1.5 kg) of aggregate surfacing material in gradation and color indicated.
   d. Walkway pads or rolls.
   e. Six insulation fasteners of each type, length, and finish.
5. Qualification Data: For qualified Installer, manufacturer and testing agency.
6. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
   a. Submit evidence of complying with performance requirements.
7. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of membrane roofing system.
8. Research/Evaluation Reports: For components of membrane roofing system, from the ICC-ES **OR** applicable model code organization, **as directed**.
9. Maintenance Data: For roofing system to include in maintenance manuals.
10. Warranties: Sample of special warranties.

F. Quality Assurance
1. Manufacturer Qualifications: A qualified manufacturer that is UL listed **OR** FM Approvals approved, **as directed**, for membrane roofing system identical to that used for this Project.
2. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
3. Source Limitations: Obtain components including roof insulation and fasteners for membrane roofing system from same manufacturer as membrane roofing or approved by membrane roofing manufacturer.
4. Exterior Fire-Test Exposure: ASTM E 108, Class A **OR** Class B **OR** Class C, **as directed**; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.
5. Fire-Resistance Ratings: Where indicated, provide fire-resistance-rated roof assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
6. Preinstallation Roofing Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
2. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
   a. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
3. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
4. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

H. Project Conditions
1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

I. Warranty
1. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period.
   a. Special warranty includes membrane roofing, base flashings, roof insulation, fasteners, cover boards, substrate board, roofing accessories, and other components of membrane roofing system.
   b. Warranty Period: 10 **OR** 15, **as directed**, years from date of Substantial Completion.

1.2 PRODUCTS

A. SBS-Modified Asphalt-Sheet Materials
1. Roofing Membrane Sheet: ASTM D 6164, Grade S, Type I or II, SBS-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6163, Grade S, Type I or II, SBS-modified asphalt sheet (reinforced with glass fibers) **OR** ASTM D 6162, Grade S, Type I or II, SBS-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; smooth surfaced; suitable for application method specified.
2. Smooth-Surfaced Roofing Membrane Cap Sheet: ASTM D 6164, Grade S, Type I or II, SBS-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6163, Grade S, Type I or II, SBS-modified asphalt sheet (reinforced with glass fibers) **OR** ASTM D 6162, Grade S, Type I or II, SBS-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; smooth surfaced; suitable for application method specified.
   OR
   Granule-Surface Roofing Membrane Cap Sheet: ASTM D 6164, Grade G, Type I or II, SBS-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6163, Grade G, Type I or II, SBS-modified asphalt sheet (reinforced with glass fibers) **OR** ASTM D 6162, Grade G, Type I or II, SBS-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; granular surfaced; suitable for application method specified, and as follows:
   a. Granule Color: White **OR** Gray **OR** Tan, **as directed**.
3. Metal-Foil-Surfaced Roofing Membrane Cap Sheet: ASTM D 6298, metal-foil surfaced SBS-modified asphalt sheet (reinforced with glass fibers); suitable for application method specified, and as follows:
   a. Foil Surfacing: Aluminum **OR** Copper **OR** Stainless steel **OR** Aluminum, fluoropolymer-coated finish, of color and gloss selected from manufacturer's full range, **as directed**.

B. Base-Sheet Materials
1. Sheathing Paper: Red-rosin type, minimum 3 lb/100 sq. ft. (0.16 kg/sq. m).
2. Base Sheet: ASTM D 4601, Type II, SBS-modified, asphalt-impregnated and -coated sheet, with glass-fiber-reinforcing mat, dusted with fine mineral surfacing on both sides.
   a. Weight: 25 lb/100 sq. ft. (1.2 kg/sq. m) **OR** 40 lb/100 sq. ft. (1.95 kg/sq. m) **OR** 50 lb/100 sq. ft. (2.4 kg/sq. m) **OR** 60 lb/100 sq. ft. (2.9 kg/sq. m) **OR** 75 lb/100 sq. ft. (3.7 kg/sq. m), **as directed**, minimum.

   OR

   Base Sheet: ASTM D 4601, Type I **OR** Type II, **as directed**, nonperforated, asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.

   OR

   Base Sheet: ASTM D 4897, Type II, venting, nonperforated, heavyweight, asphalt-impregnated and -coated, glass-fiber base sheet with coarse granular surfacing or embossed venting channels on bottom surface.

   OR

   Base Sheet: ASTM D 2626, asphalt-saturated and -coated organic felt, dusted with fine mineral surfacing on both sides.

C. Base-Ply Sheet Materials
1. Glass-Fiber Base-Ply Sheet: ASTM D 2178, Type IV **OR** Type VI, **as directed**, asphalt-impregnated, glass-fiber felt.

D. Base Flashing Sheet Materials
1. Backer Sheet: ASTM D 4601, Type I **OR** Type II, **as directed**, asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.

   OR

   Backer Sheet: ASTM D 2626, asphalt-saturated and -coated organic felt, dusted with fine mineral surfacing on both sides.

   OR

   Backer Sheet: ASTM D 6164, Grade S, Type I or II, SBS-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6163, Grade S, Type I or II, SBS-modified asphalt sheet (reinforced with glass fibers) **OR** ASTM D 6162, Grade S, Type I or II, SBS-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; smooth surfaced; suitable for application method specified.
2. Granule-Surfaced Flashing Sheet: ASTM D 6164, Grade G, Type I or II, SBS-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6163, Grade G, Type I or II, SBS-modified asphalt sheet (reinforced with glass fibers) **OR** ASTM D 6162, Grade G, Type I or II, SBS-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; granular surfaced; suitable for application method specified, and as follows:
   a. Granule Color: White **OR** Gray **OR** Tan, **as directed**.

   OR

   Metal-Foil-Surfaced Flashing Sheet: ASTM D 6298, metal-foil surfaced SBS-modified asphalt sheet (reinforced with glass fibers); suitable for application method specified, and as follows:
   a. Foil Surfacing: Aluminum **OR** Copper **OR** Stainless steel **OR** Aluminum, fluoropolymer-coated finish, of color and gloss selected from manufacturer's full range, **as directed**.
3. Glass-Fiber Fabric: Woven glass-fiber cloth, treated with asphalt, complying with ASTM D 1668, Type I.

E. Auxiliary Roofing Membrane Materials
1. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing membrane.
   a. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.

b. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
   1) Plastic Foam Adhesives: 50 g/L.
   2) Gypsum Board and Panel Adhesives: 50 g/L.
   3) Multipurpose Construction Adhesives: 70 g/L.
   4) Fiberglass Adhesives: 80 g/L.
   5) Contact Adhesive: 80 g/L.
   6) Other Adhesives: 250 g/L.
   7) Nonmembrane Roof Sealants: 300 g/L.
   8) Sealant Primers for Nonporous Substrates: 250 g/L.
   9) Sealant Primers for Porous Substrates: 775 g/L.

2. Asphalt Primer: ASTM D 41.
3. Roofing Asphalt: ASTM D 312, Type III **OR** Type IV **OR** Type III or IV as recommended by roofing system manufacturer for application, **as directed**.
   OR
   Roofing Asphalt: ASTM D 6152, SEBS modified.
4. Cold-Applied Adhesive: Roofing system manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive specially formulated for compatibility and use with roofing membrane and base flashings.
5. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required by roofing system manufacturer for application.
6. Mastic Sealant: Polyisobutylene, plain or modified bitumen; nonhardening, nonmigrating, nonskinning, and nondrying.
7. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing membrane components to substrate; tested by manufacturer for required pullout strength, and acceptable to roofing system manufacturer.
8. Metal Flashing Sheet: As specified in Division 07 Section "Sheet Metal Flashing And Trim".
9. Roofing Granules: Ceramic-coated roofing granules, No. 11 screen size with 100 percent passing No. 8 (2.36-mm) sieve and 98 percent of mass retained on No. 40 (0.425-mm) sieve, color to match roofing membrane.
10. Aggregate Surfacing: ASTM D 1863, No. 6 or No. 67, clean, dry, opaque, water-worn gravel or crushed stone, free of sharp edges **OR** crushed slag, free of sharp edges, **as directed**.
11. Miscellaneous Accessories: Provide those recommended by roofing system manufacturer.

F. Substrate Boards
1. Substrate Board: ASTM C 1396/C 1396M, Type X gypsum board, 5/8 inch (16 mm) thick.
   OR
   Substrate Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** Type X, 5/8 inch (16 mm), **as directed**, thick, factory primed, **as directed**.
   OR
   Substrate Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.
   OR
   Substrate Board: ASTM C 728, perlite board, 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick, seal coated.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

G. Vapor Retarder
1. Polyethylene Film: ASTM D 4397, 6 mils (0.15 mm) thick, minimum, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).

a. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
OR
Adhesive: Manufacturer's standard lap adhesive, FM Approvals approved for vapor-retarder application.

2. Laminated Sheet: Kraft paper, two layers, laminated with asphalt and edge reinforced with woven fiberglass yarn, with maximum permeance rating of 0.50 perm (29 ng/Pa x s x sq. m) and with manufacturer's standard adhesive, **as directed**.
3. Self-Adhering Sheet Vapor Retarder: ASTM D 1970, minimum of 40-mil- (1.0-mm-) thick, polyethylene film laminated to layer of rubberized asphalt adhesive; maximum permeance rating of 0.1 perm (6 ng/Pa x s x sq. m); cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.
OR
Self-Adhering Sheet Vapor Retarder: 30- to 40-mil- (0.76- to 1.0-mm-) thick, polyethylene film laminated to layer of butyl rubber adhesive; maximum permeance rating of 0.1 perm (6 ng/Pa x s x sq. m); cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.
4. Glass-Fiber Felt: ASTM D 2178, Type IV, asphalt impregnated.

H. Roof Insulation
1. General: Preformed roof insulation boards manufactured or approved by roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Approvals-approved roof insulation, **as directed**.
2. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.6-lb/cu. ft. (26-kg/cu. m) **OR** Type X, 1.3-lb/cu. ft. (21-kg/cu. m), **as directed**, minimum density, square edged.
3. Molded-Polystyrene Board Insulation: ASTM C 578, Type II, 1.35-lb/cu. ft. (22-kg/cu. m) **OR** Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) **OR** Type IX, 1.8-lb/cu. ft. (29-kg/cu. m), **as directed**, minimum density.
4. Composite Molded-Polystyrene Board Insulation: ASTM C 578, Type II, 1.35-lb/cu. ft. (22-kg/cu. m) **OR** Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) **OR** Type IX, 1.8-lb/cu. ft. (29-kg/cu. m), **as directed**, minimum density, with factory-applied facings, as follows:
a. Facer: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, asphalt coated, 1/2 inch (13 mm) thick.
OR
Facer: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.
5. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2 **OR** Type II, Class I, Grade 3, **as directed**, felt or glass-fiber mat facer on both major surfaces.
6. Composite Polyisocyanurate Board Insulation: ASTM C 1289, with factory-applied facing board, as indicated below by type, on one major surface and felt or glass-fiber mat facer on the other surface.
a. Type IV, cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch (13 mm) thick.
b. Type V, OSB facer, 7/16 inch (11 mm) thick.
c. Type VII, glass-mat-faced gypsum board facer, 1/4 inch (6 mm) thick.
7. Perlite Board Insulation: ASTM C 728, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.
8. Cellulosic-Fiber Board Insulation: ASTM C 208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.
9. Cellular-Glass Board Insulation: ASTM C 552, Type IV, rigid, cellular-glass thermal board insulation faced with manufacturer's standard kraft-paper sheets.
10. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches (1:48) unless otherwise indicated.
11. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

I. Insulation Accessories
1. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.
3. Modified Asphaltic Insulation Adhesive: Insulation manufacturer's recommended modified asphaltic, asbestos-free, cold-applied adhesive formulated to attach roof insulation to substrate or to another insulation layer.
OR
Bead-Applied Insulation Adhesive: Insulation manufacturer's recommended bead-applied, low-rise, one-component or multicomponent urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
OR
Full-Spread Applied Insulation Adhesive: Insulation manufacturer's recommended spray-applied, low-rise, two-component urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
4. Insulation Cant Strips: ASTM C 728, perlite insulation board.
OR
Insulation Cant Strips: ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board.
5. Wood Nailer Strips: Comply with requirements in Division 06 Section(s) "Rough Carpentry" OR "Miscellaneous Carpentry", **as directed**.
6. Tapered Edge Strips: ASTM C 728, perlite insulation board.
OR
Tapered Edge Strips: ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board.
7. Cover Board: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, 1/2 inch (13 mm) thick.
OR
Cover Board: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.
OR
Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick, factory primed, **as directed**.
OR
Cover Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.
8. Substrate Joint Tape: 6- or 8-inch- (150- or 200-mm-) wide, coated, glass-fiber joint tape.

J. Walkways
1. Walkway Pads: Reinforced asphaltic composition pads with slip-resisting mineral-granule surface **OR** Polymer-modified, reconstituted rubber pads with slip-resisting textured surface, **as directed**, manufactured as a traffic pad for foot traffic and acceptable to roofing system manufacturer, 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 3/4 inch (19 mm), **as directed**, thick, minimum.
2. Walkway Cap Sheet Strips: ASTM D 6164, Grade G, Type I or II, SBS-modified asphalt sheet (reinforced with polyester fabric) **OR** ASTM D 6163, Grade G, Type I or II, SBS-modified asphalt sheet (reinforced with glass fibers) **OR** ASTM D 6162, Grade G, Type I or II, SBS-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers), **as directed**; granular surfaced; suitable for application method specified, and as follows:
a. Granule Color: White **OR** Gray **OR** Tan, **as directed**.

1.3 EXECUTION

A. Examination
1. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:

a. Verify that roof openings and penetrations are in place and curbs are set and braced and that roof drain bodies are securely clamped in place.
b. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
c. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Division 5 Section "Steel Deck."
d. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
e. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
1) Test for moisture by pouring 1 pint (0.5 L) of hot roofing asphalt on deck at start of each day's work and at start of each roof area or plane. Do not proceed with roofing work if test sample foams or can be easily and cleanly stripped after cooling.
f. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.
g. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of 1/16 inch (1.6 mm) out of plane relative to adjoining deck.

2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
2. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
3. Prime surface of concrete deck with asphalt primer at a rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.
4. Install insulation strips in ribs of acoustical roof decks according to acoustical roof deck manufacturer's written instructions.

C. Substrate Board Installation
1. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
a. Fasten substrate board to top flanges of steel deck according to recommendations in FM Approvals' "RoofNav" and FM Global Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.
OR
Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to membrane roofing system manufacturers' written instructions.

D. Vapor-Retarder Installation
1. Polyethylene Film: Loosely lay polyethylene-film vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.
a. Continuously seal side and end laps with tape **OR** adhesive, **as directed**.
2. Laminate Sheet: Install laminate-sheet vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively. Bond vapor retarder to substrate as follows:
a. Apply adhesive at rate recommended by vapor-retarder manufacturer. Seal laps with adhesive.
OR
Apply ribbons of hot roofing asphalt at spacing, temperature, and rate recommended by vapor-retarder manufacturer. Seal laps with hot roofing asphalt.

3. Self-Adhering Sheet Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of 3-1/2 inches (90 mm) and 6 inches (150 mm), respectively. Seal laps by rolling.
4. Built-up Vapor Retarder: Install two glass-fiber felt plies lapping each felt 19 inches (483 mm) over preceding felt. Embed each felt in a solid mopping of hot roofing asphalt. Glaze-coat completed surface with hot roofing asphalt. Apply hot roofing asphalt within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
5. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into membrane roofing system.

E. Insulation Installation
1. Comply with roofing system manufacturer's written instructions for installing roof insulation.
2. Install one lapped base-sheet course and mechanically fasten to substrate according to roofing system manufacturer's written instructions.
3. Nailer Strips: Mechanically fasten 4-inch nominal- (89-mm actual-) width wood nailer strips of same thickness as insulation perpendicular to sloped roof deck at the following spacing:
   a. 16 feet (4.88 m) apart for roof slopes steeper than 1 inch per 12 inches (1:12) but less than 3 inches per 12 inches (3:12).
   b. 48 inches (1220 mm) apart for roof slopes steeper than 3 inches per 12 inches (3:12).
4. Insulation Cant Strips: Install and secure preformed 45-degree insulation cant strips at junctures of roofing membrane system with vertical surfaces or angle changes more than 45 degrees.
5. Install tapered insulation under area of roofing to conform to slopes indicated.
6. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
   a. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
7. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches (68 mm) or more, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.
   a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
8. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
9. Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.
10. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
    a. Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.
    b. Set each layer of insulation in a solid mopping of hot roofing asphalt applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.

       OR

       Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.

       OR

       Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
11. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
    a. If Project is FM Global insured or if FM Approvals requirements are proposed as a performance standard, fasten insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
    b. If number of fasteners will be based on ASCE/SEI 7's uplift pressure or SPRI's factored design uplift pressure, fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.

12. Mechanically Fastened and Adhered Insulation: Install first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.

13. If Project is FM Global insured or if FM Approvals requirements are proposed as a performance standard, fasten first layer of insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
14. If fastening is calculated from ASCE/SEI 7's uplift pressure or SPRI's factored design uplift pressure, fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
    a. Set each subsequent layer of insulation in a solid mopping of hot roofing asphalt applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
       OR
       Set each subsequent layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
       OR
       Set each subsequent layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

F. If cover boards will be field installed over roof insulation and immediately below roofing membrane, install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints a minimum of 6 inches (150 mm) in each direction from joints of insulation below. Loosely butt cover boards together and fasten to roof deck, **as directed**. Tape joints if required by roofing system manufacturer.
    a. Fasten cover boards according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
       OR
       Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.
    b. Apply hot roofing asphalt to underside, and immediately bond cover board to substrate.

G. Roofing Membrane Installation, General
1. If referencing NRCA's roof assembly identification matrix system, install roofing membrane system according to roofing system manufacturer's written instructions and applicable recommendations in ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing."
    a. Install roofing system MBS **OR** MBSH, **as directed**,-2 **OR** 3 **OR** 4, **as directed**,-N **OR** I **OR** C, **as directed**,-T **OR** M **OR** L, **as directed**,-A **OR** M **OR** F, **as directed**, according to roof assembly identification matrix and roof assembly layout illustrations in NRCA's "The NRCA Roofing and Waterproofing Manual" and to requirements in this Section.
2. For roof system that exceeds requirements of NRCA's roof assemblies, install roofing membrane system according to roofing system manufacturer's written instructions and applicable recommendations in ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing" and as follows:
    a. Deck Type: N (nailable) **OR** I (insulated) **OR** C (concrete or nonnailable), **as directed**.
    b. Adhering Method: T (torched) **OR** M (mopped) **OR** L (cold-applied adhesive), **as directed**.
    c. Base Sheet: One **OR** One, installed over sheathing paper, **as directed**.
    d. Number of Glass-Fiber Base-Ply Sheets: One **OR** Two, **as directed**.
    e. Number of SBS-Modified Asphalt Sheets: One **OR** Two, **as directed**.
    f. Surfacing Type: A (aggregate) **OR** M (mineral-granule-surfaced cap sheet) **OR** F (foil-surfaced cap sheet), **as directed**.
3. Start installation of roofing membrane in presence of roofing system manufacturer's technical personnel.
4. Where roof slope exceeds 1/2 inch per 12 inches (1:24) **OR** 3/4 inch per 12 inches (1:18), **as directed**, install roofing membrane sheets parallel with slope.

a. Backnail roofing membrane sheets to nailer strips **OR** substrate, **as directed**, according to roofing system manufacturer's written instructions.

5. Cooperate with testing agencies engaged or required to perform services for installing roofing system.
6. Coordinate installation of roofing system so insulation and other components of the roofing membrane system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.
   a. At end of each day's work, provide tie-offs to cover exposed roofing membrane sheets and insulation with a course of coated felt set in roofing cement or hot roofing asphalt, with joints and edges sealed.
   b. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system.
   c. Remove and discard temporary seals before beginning work on adjoining roofing.
7. Asphalt Heating: Do not raise roofing asphalt temperature above equiviscous temperature range more than one hour before time of application. Do not exceed roofing asphalt manufacturer's recommended temperature limits during roofing asphalt heating. Do not heat roofing asphalt within 25 deg F (14 deg C) of flash point. Discard roofing asphalt maintained at a temperature exceeding finished blowing temperature for more than four hours.
   OR
   Asphalt Heating: Heat and apply SEBS-modified roofing asphalt according to roofing system manufacturer's written instructions.
8. Substrate-Joint Penetrations: Prevent roofing asphalt and adhesives from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.

H. Base-Sheet Installation
1. Loosely lay one course of sheathing paper, lapping edges and ends a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.
2. Install lapped base-sheet course, extending sheet over and terminating beyond cants. Attach base sheet as follows:
   a. Mechanically fasten to substrate, for nailable substrate.
      OR
      Spot- or strip-mop to substrate with hot roofing asphalt.
      OR
      Adhere to substrate in a solid mopping of hot roofing asphalt **OR** uniform coating of cold-applied adhesive, **as directed**, for nonnailable or insulated substrates.

I. Base-Ply Sheet Installation
1. Install glass-fiber base-ply sheets according to roofing system manufacturer's written instructions starting at low point of roofing system. Align glass-fiber base-ply sheets without stretching. Extend sheets over and terminate beyond cants.
   a. Shingle side laps of glass-fiber base-ply sheets uniformly to ensure that required number of glass-fiber base-ply sheets covers substrate at any point. Shingle in direction to shed water.
   b. Embed each glass-fiber base-ply sheet in a continuous void-free mopping of hot roofing asphalt to form a uniform membrane without glass-fiber base-ply sheets touching.

J. SBS-Modified Bituminous Membrane Installation
1. Install modified bituminous roofing membrane cap sheet **OR** sheet and cap sheet, **as directed**, according to roofing manufacturer's written instructions, starting at low point of roofing system. Extend roofing membrane sheets over and terminate beyond cants, installing as follows:
   a. Adhere to substrate in a solid mopping of hot roofing asphalt applied at not less than 425 deg F (218 deg C).
      OR
      Adhere to substrate in cold-applied adhesive.
      OR

Torch apply to substrate.

b. Unroll roofing membrane sheets and allow them to relax for minimum time period required by manufacturer.

2. Laps: Accurately align roofing membrane sheets, without stretching, and maintain uniform side and end laps. Stagger end laps. Completely bond and seal laps, leaving no voids.
   a. Repair tears and voids in laps and lapped seams not completely sealed.
   b. Apply roofing granules to cover exuded bead at laps while bead is hot.
3. Install roofing membrane sheets so side and end laps shed water.
4. Aggregate Surfacing: Promptly after installing and testing roofing membrane, base flashing, and stripping, flood-coat roof surface with 60 lb/100 sq. ft. (3 kg/sq. m) of hot roofing asphalt. While flood coat is hot and fluid, cast the following average weight of aggregate in a uniform course:
   a. Aggregate Weight: 400 lb/100 sq. ft. (20 kg/sq. m) for gravel or crushed stone or 300 lb/100 sq. ft. (15 kg/sq. m) for slag.

K. Flashing And Stripping Installation
1. Install base flashing over cant strips and other sloped and vertical surfaces, at roof edges, and at penetrations through roof; secure to substrates according to roofing system manufacturer's written instructions, and as follows:
   a. Prime substrates with asphalt primer if required by roofing system manufacturer.
   b. Backer Sheet Application: Mechanically fasten backer sheet to walls or parapets. Adhere backer sheet over roofing membrane at cants in a solid mopping of hot roofing asphalt **OR** cold-applied adhesive, **as directed**.
      OR
      Backer Sheet Application: Adhere backer sheet to substrate in a solid mopping of hot roofing asphalt **OR** cold-applied adhesive at rate required by roofing system manufacturer, **as directed**.
   c. Flashing Sheet Application: Adhere flashing sheet to substrate in a solid mopping of hot roofing asphalt applied at not less than 425 deg F (218 deg C). Apply hot roofing asphalt to back of flashing sheet if recommended by roofing system manufacturer.
      OR
      Flashing Sheet Application: Adhere flashing sheet to substrate in cold-applied adhesive at rate required by roofing system manufacturer.
      OR
      Flashing Sheet Application: Adhere flashing sheet to substrate in asphalt roofing cement at rate required by roofing system manufacturer.
      OR
      Flashing Sheet Application: Torch apply flashing sheet to substrate.
2. Extend base flashing up walls or parapets a minimum of 8 inches (200 mm) above roofing membrane and 4 inches (100 mm) onto field of roofing membrane.
3. Mechanically fasten top of base flashing securely at terminations and perimeter of roofing.
   a. Seal top termination of base flashing with a strip of glass-fiber fabric set in asphalt roofing cement, **as directed**.
4. Install roofing membrane cap-sheet stripping where metal flanges and edgings are set on membrane roofing according to roofing system manufacturer's written instructions.
5. Roof Drains: Set 30-by-30-inch- (760-by-760-mm-) square metal flashing in bed of asphalt roofing cement on completed roofing membrane. Cover metal flashing with roofing membrane cap-sheet stripping and extend a minimum of 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, beyond edge of metal flashing onto field of roofing membrane. Clamp roofing membrane, metal flashing, and stripping into roof-drain clamping ring.
   a. Install stripping according to roofing system manufacturer's written instructions.

L. Walkway Installation
1. Walkway Pads: Install walkway pads using units of size indicated or, if not indicated, of manufacturer's standard size according to walkway pad manufacturer's written instructions.
   a. Set walkway pads in cold-applied adhesive.

OR

Set walkway pads in additional pour coat of hot roofing asphalt after aggregate surfacing of modified bituminous roofing membrane.

2. Walkway Cap Sheet Strips: Install walkway cap sheet strips over roofing membrane using same application method as used for roofing membrane cap sheet. Install walkway cap sheet strips before flood coat and aggregate surface is applied, **as directed**.

M. Field Quality Control
   1. Testing Agency: Perform tests and inspections and to prepare test reports.
   2. Test Cuts: Test specimens will be removed to evaluate problems observed during quality-assurance inspections of roofing membrane as follows:
      a. Approximate quantities of components within roofing membrane will be determined according to ASTM D 3617.
      b. Test specimens will be examined for interply voids according to ASTM D 3617 and to comply with criteria established in Appendix 3 in ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing."
      c. Repair areas where test cuts were made according to roofing system manufacturer's written instructions.
   3. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.
      a. Notify the Owner and Owner 48 hours in advance of date and time of inspection.
   4. Roofing system will be considered defective if it does not pass tests and inspections.
      a. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

N. Protecting And Cleaning
   1. Protect roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to the Owner and Owner.
   2. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
   3. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07212e

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Task	Specification	Specification Description
07212	07210	Building Insulation

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SECTION 07213 - FLUID-APPLIED PROTECTED MEMBRANE ROOFING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for fluid-applied protected membrane roofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Show locations and extent of roofing.
   a. Show locations, extent, and details of roof pavers.
3. Maintenance data.
4. Sample warranties.

C. Quality Assurance
1. Fire-Test-Response Characteristics: Provide hot fluid-applied roofing identical to assemblies tested for fire-test-response characteristics indicated by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   a. Exterior Fire-Test Exposure: Class A; complying with ASTM E 108, for application and slopes indicated.
2. Preinstallation Conference: Conduct conference at Project site.

D. Delivery, Storage, And Handling
1. Deliver materials to Project site in original containers with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing and mixing with other components.
   a. Handle and store roofing materials and place equipment in a manner to avoid significant or permanent damage to deck or structural supporting members.
2. Protect roofing insulation materials from damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location.

E. Project Conditions
1. Environmental Limitations: Apply roofing within the range of ambient and substrate temperatures recommended by roofing system manufacturer. Do not apply roofing to a damp or wet substrate or when temperature is below 0 deg F (minus 18 deg C).
   a. Do not apply roofing in snow, rain, fog, or mist.

F. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace roofing that does not remain watertight and base flashing that does not within 10 **OR** 15 **OR** 20, **as directed**, years from date of Substantial Completion.
   a. Warranty also includes insulation and roof pavers.

1.2 PRODUCTS

A. Roofing Membrane
1. Hot Fluid-Applied, Rubberized-Asphalt Roofing Membrane: Single component; 100 percent solids; hot fluid-applied, rubberized asphalt.

B. Base Flashing Sheet Materials

1. Elastomeric Flashing Sheet: 50-mil- (1.3-mm-) thick, minimum, uncured sheet neoprene with manufacturer's recommended contact adhesives as follows:
   a. Tensile Strength: 1400 psi (9.6 MPa) minimum; ASTM D 412, Die C.
   b. Elongation: 300 percent minimum; ASTM D 412.
   c. Tear Resistance: 125 psi (860 kPa) minimum; ASTM D 624, Die C.
   d. Brittleness: Does not break at minus 30 deg F (16 deg C); ASTM D 2137.
2. SBS-Modified Bituminous Flashing Sheet: ASTM D 6164, Grade G, Type I or Type II, polyester-reinforced, SBS-modified asphalt sheet; granular surfaced; suitable for application method specified, white **OR** gray **OR** tan, **as directed**.
   a. Backer Sheet: ASTM D 6164, Grade S, Type I or Type II, polyester-reinforced, SBS-modified asphalt sheet; smooth surfaced; suitable for application method specified.
3. APP-Modified Bituminous Flashing Sheet: ASTM D 6222, Grade S, smooth **OR** Grade G, granular, **as directed**, surfaced, Type I or Type II, polyester-reinforced, APP-modified asphalt sheet; suitable for application method specified.
   a. Granule Color: White **OR** Gray **OR** Tan, **as directed**.

C. Auxiliary Materials
1. General: Furnish auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing.
   a. Furnish liquid-type auxiliary materials that meet VOC limits of authorities having jurisdiction.
2. Primer: ASTM D 41, asphaltic primer.
3. Elastomeric Sheet: 50-mil- (1.3-mm-) thick, minimum, uncured sheet neoprene with manufacturer's recommended contact adhesives as follows:
   a. Tensile Strength: 1400 psi (9.6 MPa) minimum; ASTM D 412, Die C.
   b. Elongation: 300 percent minimum; ASTM D 412.
   c. Tear Resistance: 125 psi (860 kPa) minimum; ASTM D 624, Die C.
   d. Brittleness: Does not break at minus 30 deg F (16 deg C); ASTM D 2137.
4. Metal Termination Bars: Manufacturer's standard, predrilled, stainless-steel or aluminum termination bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.
5. Reinforcing Fabric: Manufacturer's recommended, spun-bonded polyester fabric.
6. Protection Course: Manufacturer's standard, 80-to-90-mil- (2.0-to-2.3-mm-) thick, fiberglass-reinforced rubberized asphalt or modified bituminous sheet.
7. Geotextile Fabric: Woven or nonwoven polypropylene, polyolefin, or polyester geotextile fabric; water permeable and resistant to UV-light degradation; of type and weight recommended by insulation manufacturer for application.
8. Roof-Paver Metal Straps: Securement strapping fabricated from stainless steel, a minimum of 3 inches (75 mm) wide by 0.031 inch (0.8 mm) thick with stainless-steel anchors or other corrosion-resistant, postinstalled expansion anchors approved by insulation manufacturer.

D. Board Insulation
1. Extruded-Polystyrene Board Insulation: ASTM C 578, Type VI, 1.8 lb/cu. ft. (29 kg/cu. m) **OR** Type VII, 2.2 lb/cu. ft. (35 kg/cu. m), **as directed**, with two or four edges rabbeted.
2. Extruded-Polystyrene Board Insulation: ASTM C 578, Type VI, 1.8 lb/cu. ft. (29 kg/cu. m) **OR** Type VII, 2.2 lb/cu. ft. (35 kg/cu. m), **as directed**, with rabbeted edges and with one side having ribbed drainage channels.

E. Mortar-Faced Board Insulation
1. Mortar-Faced, Extruded-Polystyrene Board Insulation: ASTM C 578, Type VI, 1.8-lb/cu. ft. (29-kg/cu. m) minimum density, with tongue-and-groove edges on long dimension, and latex-modified cement mortar topping, 3/8 inch (9 mm) thick, 4 lb/sq. ft. (19.5 kg/sq. m) **OR** 15/16 inch (23 mm) thick, 11 lb/sq. ft. (53.7 kg/sq. m), **as directed**.
   a. Metal Securement System: Perimeter securement flashing and strapping fabricated from stainless steel, a minimum of 0.031 inch (0.8 mm) thick, with stainless-steel anchors or

other corrosion-resistant, postinstalled expansion anchors approved by insulation manufacturer.

F. Aggregate Ballast
1. Aggregate Ballast: Washed, crushed stone or smooth stone that will withstand weather exposure without significant deterioration and will not contribute to membrane degradation; of the following size:
a. Size:
1) ASTM D 448, Size 5, ranging in size from 1/2 to 1 inch (13 to 25 mm).
2) ASTM D 448, Size 4, ranging in size from 3/4 to 1-1/2 inches (19 to 38 mm).
3) ASTM D 448, Size 2, ranging in size from 1-1/2 to 2-1/2 inches (38 to 63 mm).

G. Roof Pavers
1. Interlocking Roof Pavers: Interlocking, lightweight concrete units, specially factory cast for use as roof ballast; grooved back, with four-way drainage capability; beveled, doweled, or otherwise profiled; and as follows:
a. Size: 8 by 16 inches (200 by 400 mm) 12 by 12 inches (300 by 300 mm) 12 by 16-1/2 inches (300 by 420 mm) 12 by 18 inches (300 by 450 mm)
b. Weight: At least 10 lb/sq. ft. (50 kg/sq. m) but not exceeding 18 lb/sq. ft. (90 kg/sq. m).
c. Compressive Strength: 2500 psi (17 MPa) **OR** 5000 psi (34 MPa), **as directed**, minimum.
d. Colors and Textures: As selected from manufacturer's full range.
2. Roof Pavers: Heavyweight, hydraulically pressed, concrete units, square edged **OR** with top edges beveled 3/16 inch (5 mm), **as directed**, factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C 67; and as follows:
a. Size: 24 by 24 inches (600 by 600 mm). Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch (1.6 mm) in length, height, and thickness.
b. Weight: 18 lb/sq. ft. (90 kg/sq. m) **OR** 20 lb/sq. ft. (100 kg/sq. m) **OR** 22 lb/sq. ft. (110 kg/sq. m) **OR** 24 lb/sq. ft. (120 kg/sq. m), **as directed**, minimum.
c. Compressive Strength: 7500 psi (52 MPa) **OR** 6500 psi (45 MPa), **as directed**, minimum; ASTM C 140.
d. Colors and Textures: As selected from manufacturer's full range.
e. Paver Supports:
1) Integral corner pedestals.
OR
Paver manufacturer's standard SBR rubber, high-density polyethylene, or polyurethane paver support assembly, including fixed-height **OR** adjustable or stackable, **as directed**, pedestals, shims, and spacer tabs for joint spacing of 1/8 inch (3 mm) **OR** 3/16 inch (5 mm), **as directed**.

1.3 EXECUTION

A. Preparation
1. Clean and prepare substrate according to manufacturer's written recommendations. Provide clean, dust-free, and dry substrate for roofing application.
2. Mask off adjoining surfaces not receiving roofing to prevent spillage from affecting other construction.
3. Protect roof drains and other deck penetrations to prevent spillage and migration of roofing fluids.
4. Remove grease, oil, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
5. Remove fins, ridges, and other projections and fill honeycomb, aggregate pockets, and other voids.

B. Joints, Cracks, And Terminations

1. Prepare and treat substrates to receive roofing membrane, including joints and cracks, roof drains, and penetrations, according roofing system manufacturer's written instructions.
   a. Rout and fill joints and cracks in substrate. Before filling, remove dust and dirt according to ASTM D 4258.
   b. Adhere strip of elastomeric sheet to substrate in a layer of hot fluid-applied, rubberized asphalt. Extend elastomeric sheet a minimum of 6 inches (150 mm) on each side of moving joints and cracks or joints and cracks exceeding 1/8 inch (3 mm) thick, and beyond roof drains and penetrations. Apply second layer of hot fluid-applied, rubberized asphalt over elastomeric sheet.
   c. Embed strip of reinforcing fabric into a layer of hot fluid-applied, rubberized asphalt. Extend reinforcing fabric a minimum of 6 inches (150 mm) on each side of nonmoving joints and cracks not exceeding 1/8 inch (3 mm) thick, and beyond roof drains and penetrations.
      1) Apply second layer of hot fluid-applied, rubberized asphalt over reinforcing fabric.
2. At expansion joints and discontinuous deck-to-wall or deck-to-deck joints, bridge joints with elastomeric sheet extended a minimum of 6 inches (150 mm) on each side of joints and adhere to substrates in a layer of hot fluid-applied, rubberized asphalt. Apply second layer of hot fluid-applied, rubberized asphalt over elastomeric sheet.

C. Base Flashing Installation
1. Install base flashing at terminations of roofing membrane according to manufacturer's written instructions.
2. Prime substrate with asphalt primer if required by manufacturer.
3. Bond elastomeric flashing sheet in contact adhesive against wall substrate to within 3 inches (75 mm) of deck. Adhere remaining vertical leg and horizontal leg of flashing sheet in a layer of hot fluid-applied, rubberized asphalt.
4. Bond modified bituminous flashing sheet to substrate as follows:
   a. Adhere SBS-modified bituminous backer sheet and flashing sheet to substrate in a layer of hot fluid-applied, rubberized asphalt.
   b. Torch apply APP-modified bituminous flashing sheet to substrate.
   c. Adhere SBS-modified bituminous backer sheet and flashing sheet to substrate in a layer of hot fluid-applied, rubberized asphalt or torch apply APP-modified bituminous flashing sheet to substrate as standard with manufacturer.
5. Extend flashing sheet up walls or parapets a minimum of 8 inches (200 mm) above insulation and 6 inches (150 mm) onto roof deck.
6. Install termination bars and mechanically fasten to top of flashing sheet at terminations and perimeter of roofing.

D. Roofing Membrane Application
1. Apply primer, at manufacturer's recommended rate, over prepared substrate and allow to dry.
2. Heat and apply rubberized asphalt according to manufacturer's written instructions.
   a. Heat rubberized asphalt in an oil- or air-jacketed melter with mechanical agitator specifically designed for heating rubberized asphalt.
3. Start application with manufacturer's authorized representative present.
4. Unreinforced Membrane: Apply hot rubberized asphalt to area to receive roofing. Spread hot rubberized asphalt to form a uniform, unreinforced, seamless membrane, 180-mil (4.5-mm) minimum thickness **OR** 180-mil (4.5-mm) average thickness, but not less than 125 mil (3.2 mm) thick, **as directed**.
5. Reinforced Membrane: Apply hot fluid-applied, rubberized asphalt to area to receive roofing. Spread a 90-mil- (2.3-mm-) thick layer of hot fluid-applied, rubberized asphalt; embed reinforcing fabric, overlapping sheets 2 inches (50 mm); spread another 125-mil- (3.2-mm-) thick layer of hot fluid-applied, rubberized asphalt to form a uniform, reinforced, seamless membrane, 215 mils (5.5 mm) thick.
6. Apply hot fluid-applied, rubberized asphalt over prepared joints and up wall terminations and vertical surfaces to heights indicated or required by manufacturer.

7. Cover waterproofing with protection course with overlapped joints before membrane is subject construction traffic.

E. Insulation Installation
1. Loosely lay board insulation units over roofing membrane, with long joints of insulation in continuous straight lines and with end joints staggered between rows. Abut edges and ends between units.
2. Install one or more layers of insulation to achieve required thickness over roofing membrane. Cut and fit to within 3/4 inch (19 mm) of projections and penetrations.
   a. Where overall insulation thickness is 2 inches (50 mm) or more, install required thickness in two or more layers with joints of each succeeding layer staggered over joints of previous layer a minimum of 6 inches (150 mm) in each direction.
3. Install geotextile fabric over insulation, overlapping edges and ends at least 12 inches (300 mm). Do not lap ends of fabric sheets within 72 inches (1800 mm) of roof perimeter. Extend fabric 2 to 3 inches (50 to 75 mm) above ballast at perimeter and penetrations. Apply additional layer of fabric around penetrations to prevent aggregate from getting between penetration and insulation. Do not cover drains or restrict water flow to drains.

F. Ballast Installation
1. To roofed area, apply aggregate ballast uniformly over geotextile fabric at rate required by insulation manufacturer, but not less than the following, carefully spreading aggregate to not damage roofing membrane and base flashings. Install roof-paver ballast according to insulation manufacturer's written instructions. Apply ballast as insulation is installed, leaving roofing membrane insulated and ballasted at end of workday.
   a. Ballast for Dow's Standard Design: 15 lb/sq. ft. (75 kg/sq. m), Size 5 aggregate within 102 inches (2600 mm) of roof perimeter and corners and 24 inches (600 mm) of roof penetrations; 10 lb/sq. ft. (50 kg/sq. m), Size 5 aggregate elsewhere. Revise ballast loads for roof perimeter, corners, and penetration loads below to 20 lb/sq. ft. (100 kg/sq. m) for insulation 3 inches (75 mm) or thicker.
      1) Install one row of roof pavers in lieu of aggregate ballast at roof perimeter, corners, and penetrations if combining aggregate ballast with roof pavers.
   b. Ballast for Dow's Design #1:
      1) 15 lb/sq. ft. (75 kg/sq. m), Size 4 aggregate within 102 inches (2600 mm) of roof perimeter and corners and 24 inches (600 mm) of roof penetrations; 12 lb/sq. ft. (60 kg/sq. m), Size 4 aggregate elsewhere. Revise ballast loads for roof perimeter, corners, and penetration loads below to 20 lb/sq. ft. (100 kg/sq. m) for insulation 3 inches (75 mm) or thicker.
         OR
         12 lb/sq. ft. (60 kg/sq. m), Size 4 aggregate to field of roof; install two rows of roof pavers at roof perimeter, corners, and penetrations according to insulation manufacturer's written instructions if combining aggregate ballast with roof pavers.
   c. Ballast for Dow's Design #2:
      1) 15 lb/sq. ft. (75 kg/sq. m), Size 2 aggregate within 102 inches (2600 mm) of roof perimeter and 24 inches (600 mm) of roof penetrations; 13 lb/sq. ft. (65 kg/sq. m), Size 2 aggregate to field of roof; and install three rows of roof pavers at corners of roof according to insulation manufacturer's written instructions. Mechanically fasten securement strapping to center of first perimeter corner row of roof pavers. Revise ballast loads for roof perimeter, corners, and penetration loads below to 20 lb/sq. ft. (100 kg/sq. m) for insulation 3 inches (75 mm) or thicker.
         OR
         13 lb/sq. ft. (65 kg/sq. m), Size 2 aggregate to field of roof and install three rows of concrete pavers at roof perimeter, corners, and penetrations according to insulation manufacturer's written instructions if combining aggregate ballast with roof pavers at roof perimeters, corners, and penetrations. Mechanically fasten securement strapping to center of first perimeter and perimeter corner row of roof pavers.
   d. Ballast for Dow's Design #3:

1) 15 lb/sq. ft. (75 kg/sq. m), Size 2 aggregate within 24 inches (600 mm) of roof penetrations; 13 lb/sq. ft. (65 kg/sq. m), Size 2 aggregate to field of roof; and install four rows of roof pavers at roof perimeter and corners according to insulation manufacturer's written instructions. Mechanically fasten securement strapping to center of first two perimeter and perimeter corner rows of roof pavers. Revise ballast loads for roof perimeter, corners, and penetration loads below to 20 lb/sq. ft. (100 kg/sq. m) for insulation 3 inches (75 mm) or thicker.
2) Walkway Pavers: Install walkways formed from one row **OR** two rows, **as directed**, of roof pavers, loosely laid and butted.

G. Roof-Paver Installation
1. Interlocking Roof Pavers: Install interlocking roof pavers over roofed area according to manufacturer's written instructions.
2. Install roof pavers over roofed area according to insulation manufacturer's written instructions.
3. Install roof pavers over roofed area according to insulation manufacturer's written instructions. Mechanically fasten roof-paver metal straps to center of first perimeter and first perimeter corner row of roof pavers.
4. Install roof pavers over roofed area according to insulation manufacturer's written instructions. Mechanically fasten roof-paver metal straps to center of first two perimeters and first two perimeter corner rows of roof pavers.
5. Install roof pavers on pedestals set according to pedestal manufacturer's written instructions.

H. Mortar-Faced Board Insulation Installation
1. Install mortar-faced board insulation loosely laid, according to manufacturer's written instructions, with tongue-and-groove joints nested. Stagger end joints of adjoining rows and abut insulation.
   a. Mechanically fasten metal securement strapping at penetrations and at perimeter edges of mortar-faced board insulation.
   b. Over mortar-faced board insulation, install roof pavers on roof perimeter and corners according to manufacturer's written instructions.
2. Install one row **OR** two rows, **as directed**, of 24-inch- (600-mm-) wide roof pavers to roof perimeter, corners, and penetrations according to mortar-faced board insulation manufacturer's written instructions.

I. Cleaning And Protection
1. Protect roofing from damage and wear during remainder of construction period.
2. Protect installed insulation from damage due to UV light, physical abuse, and other causes. Provide temporary coverings where insulation will be subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.
3. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

1.4 ROOFING INSTALLER'S WARRANTY

Warranty shall be submitted in the following format:

A. WHEREAS <**Insert name**> of <**Insert address**>, herein called the "Roofing Installer," has performed roofing and associated work ("work") on the following project:
1. Owner:
2. Address:
3. Building Name/Type:
4. Address:
5. Area of Work:
6. Acceptance Date:
7. Warranty Period:

8. Expiration Date:

B. AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period he will, at his own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:

    a. lightning;
    b. peak gust wind speeds, as directed by the Owner;
    c. fire;
    d. failure of roofing system substrate, including settlement, excessive deflection, deterioration, decomposition, and cracking wider than 1/8 inch (3 mm);
    e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
    f. vapor condensation on bottom of roofing; and
    g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.

2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
3. Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.
4. During Warranty Period, if Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void, unless Roofing Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.
6. Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this <**Insert day**> day of <**Insert month**>, <**Insert year**>.

1. Authorized Signature:
2. Name:
3. Title:

END OF SECTION 07213

Task	Specification	Specification Description
07213	07212	Built-Up Asphalt Roofing
07213	07212a	Built-Up Coal-Tar Roofing
07213	07212b	EPDM Membrane Roofing
07213	07212c	CSPE Membrane Roofing
07213	07212d	APP-Modified Bituminous Membrane Roofing
07213	07212e	SBS-Modified Bituminous Membrane Roofing
07215	07210	Building Insulation

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SECTION 07240 - POLYMER-BASED EXTERIOR INSULATION AND FINISH SYSTEM (EIFS)

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for polymer-based exterior insulation and finish systems (EIFS). Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Exterior insulation and finish system (EIFS) applied over concrete, masonry, exterior cement board, gypsum sheathing, and plywood sheathing.
   b. Prefabricated panels consisting of EIFS applied over exterior cement board and gypsum sheathing on metal framing.
2. Products furnished, but not installed under this Section, include anchors and other attachment devices to be cast in concrete and embedded in masonry assemblies.

C. System Description
1. Class PB EIFS: A non-load-bearing, exterior wall cladding system that consists of an insulation board attached adhesively, mechanically, or both to the substrate; an integrally reinforced base coat; and a textured protective finish coat.

D. Performance Requirements
1. EIFS Performance: Comply with the following:
   a. Bond Integrity: Free from bond failure within EIFS components or between system and supporting wall construction, resulting from exposure to fire, wind loads, weather, or other in-service conditions.
   b. Weathertightness: Resistant to water penetration from exterior into EIFS and assemblies behind it or through them into interior of building that results in deterioration of thermal-insulating effectiveness or other degradation of EIFS and assemblies behind it, including substrates, supporting wall construction, and interior finish.
2. Class PB EIFS: Provide EIFS having physical properties and structural performance that comply with the following:
   a. Abrasion Resistance: Sample consisting of 1-inch- (25.4-mm-) thick EIFS mounted on 1/2-inch- (12.7-mm-) thick gypsum board; cured for a minimum of 28 days; and showing no cracking, checking, or loss of film integrity after exposure to 528 quarts (500 L) of sand when tested per ASTM D 968, Method A.
   b. Absorption-Freeze Resistance: No visible deleterious effects and negligible weight loss after 60 cycles per EIMA 101.01.
   c. Accelerated Weathering: Five samples per ICC-ES AC219 showing no cracking, checking, crazing, erosion, rusting, blistering, peeling, delamination, or other characteristics that might affect performance as a wall cladding after testing for 2000 hours when viewed under 5 times magnification per ASTM G 153 or ASTM G 154 **OR** ASTM G 153 or ASTM G 155, **as directed**.
   d. Freeze-Thaw: No surface changes, cracking, checking, crazing, erosion, rusting, blistering, peeling, or delamination, or indications of delamination between components when viewed under 5 times magnification after 60 cycles per EIMA 101.01 **OR** 10 cycles per ICC-ES AC219, **as directed**.
   e. Mildew Resistance of Finish Coat: Sample applied to 2-by-2-inch (50.8-by-50.8-mm) clean glass substrate, cured for 28 days, and showing no growth when tested per ASTM D 3273 and evaluated according to ASTM D 3274.

f. Salt-Spray Resistance: No deleterious affects when tested according to ICC-ES AC219.
g. Tensile Adhesion: No failure in the EIFS, adhesive, base coat, or finish coat when tested per EIMA 101.03 **OR** ICC-ES AC219, **as directed**.
h. Water Penetration: Sample consisting of 1-inch- (25.4-mm-) thick EIFS mounted on 1/2-inch- (12.7-mm-)thick gypsum board, cured for 28 days, and showing no water penetration into the plane of the base coat to expanded-polystyrene board interface of the test specimen after 15 minutes at 6.24 lbf/sq. ft. (299 Pa) of air pressure difference or 20 percent of positive design wind pressure, whichever is greater, across the specimen during a test period when tested per EIMA 101.02.
i. Water Resistance: Three samples, each consisting of 1-inch- (25.4-mm-) thick EIFS mounted on 1/2-inch- (12.7-mm-) thick gypsum board; cured for 28 days; and showing no cracking, checking, crazing, erosion, rusting, blistering, peeling, or delamination after testing for 14 days per ASTM D 2247.
j. Wind-Driven-Rain Resistance: Resist wind-driven rain according to ICC-ES AC219.
k. Impact Resistance: Sample consisting of 1-inch- (25.4-mm-) thick EIFS when constructed, conditioned, and tested per EIMA 101.86; and meeting or exceeding the following:
    1) Standard Impact Resistance: 25 to 49 inch-lb (2.8 to 5.6 J).
    2) Medium Impact Resistance: 50 to 89 inch-lb (5.7 to 10.1 J).
    3) High Impact Resistance: 90 to 150 inch-lb (10.2 to 17 J).
    4) Ultra-High Impact Resistance: More than 150 inch-lb (17 J).
l. Structural Performance Testing: EIFS assembly and components shall comply with ICC-ES AC219 when tested per ASTM E 330.

3. Performance of Prefabricated Panels: Prefabricated panels shall be designed as follows and withstand the structural performance indicated for Class PB EIFS and thermal movement limits indicated below without failure due to defective manufacture, fabrication, installation, or other defects in construction.
    a. Delegated Design: Design prefabricated panels, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
    b. Structural Performance: EIFS shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to SEI/ASCE 7.
        1) Wind Loads: Uniform pressure as indicated on Drawings.
    c. Deflection Limits: Design prefabricated panels to withstand design loads without deflections greater than 1/240.
    d. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
        1) Temperature Change (Range): 100 deg F (55 deg C).

E. Submittals
1. Product Data: For each type and component of EIFS indicated.
2. LEED Submittal:
    a. Product Data for Credit EQ 4.1: For adhesives and sealants used inside the weatherproofing system, including printed statement of VOC content.
3. Shop Drawings: For EIFS. Include plans, elevations, sections, details of components, details of penetration and termination, flashing details, joint locations and configurations, lifting points for prefabricated panels, fastening and anchorage details including mechanical fasteners, and connections and attachments to other work.
4. Panel Schedule: For prefabricated panel fabrication.
5. Samples: For each exposed product and for each color and texture specified.
6. Delegated-Design Submittal: For prefabricated panels indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
7. Material or product certificates.

8. Product test reports.
9. Compatibility and Adhesion Test Reports: For joint sealants from sealant manufacturer indicating the following:
    a. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
    b. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
10. Field quality-control reports and special inspection reports.
11. Evaluation reports
12. Maintenance data.

F. Quality Assurance
1. Installer Qualifications: An installer who is certified in writing by EIFS manufacturer as qualified to install manufacturer's system using trained workers.
2. Source Limitations: Obtain EIFS from single source from single EIFS manufacturer and from sources approved by EIFS manufacturer as compatible with system components.
3. Fire-Test-Response Characteristics: Provide EIFS and system components with the following fire-test-response characteristics as determined by testing identical EIFS and system components per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.
    a. Fire-Resistance Characteristics: Per ASTM E 119.
    b. Full-Scale Multistory Fire Test: Per UBC Standard 26-4.
    c. Full-Scale Diversified Fire Test: Per ASTM E 108 modified for testing vertical walls.
    d. Intermediate-Scale Multistory Fire Test: Per NFPA 285 **OR** UBC Standard 26-9, **as directed**.
    e. Radiant Heat Exposure: No ignition of EIFS when tested according to NFPA 268.
    f. Potential Heat: Acceptable level when tested according to NFPA 259.
    g. Surface-Burning Characteristics: Provide insulation board, adhesives, base coats, and finish coats with flame-spread index of 25 or less and smoke-developed index of 450 or less, per ASTM E 84 **OR** UBC Standard 8-1, **as directed**.
4. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver materials in original, unopened packages with manufacturers' labels intact and clearly identifying products.
2. Store materials inside and under cover; keep them dry and protected from weather, direct sunlight, surface contamination, aging, corrosion, damaging temperatures, construction traffic, and other causes.
    a. Stack insulation board flat and off the ground.
    b. Protect plastic insulation against ignition at all times. Do not deliver plastic insulating materials to Project site before installation time.
    c. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

H. Project Conditions
1. Weather Limitations: Maintain ambient temperatures above 40 deg F (4.4 deg C) for a minimum of 24 hours before, during, and after adhesives or coatings are applied. Do not apply EIFS adhesives or coatings during rainfall. Proceed with installation only when existing and forecasted weather conditions and ambient outdoor air, humidity, and substrate temperatures permit EIFS to be applied, dried, and cured according to manufacturers' written instructions and warranty requirements.

1.2 PRODUCTS

A. Materials
1. Compatibility: Provide adhesive, fasteners, board insulation, reinforcing meshes, base- and finish-coat systems, sealants, and accessories that are compatible with one another and with substrates and approved for use by EIFS manufacturer for Project.
2. Prefabricated Panels: Comply with requirements in Division 05 Section "Cold-formed Metal Framing" for metal framing and with requirements in Division 06 Section "Sheathing" for gypsum sheathing and weather-resistant sheathing paper.
3. Exterior Cement Board: Not less than 5/16-inch- (8-mm-) **OR** 7/16-inch- (11-mm-), **as directed**, thick, fiber cement board complying with ASTM C 1186, Type A, for exterior applications.
   a. Fasteners: Wafer-head or flat-head steel drill screws complying with ASTM C 954, with an organic-polymer coating or other corrosion-protective coating having a salt-spray resistance of more than 500 hours per ASTM B 117.
      1) Size and Length: As recommended by sheathing manufacturer for type and thickness of sheathing board to be attached.
4. Primer/Sealer: EIFS manufacturer's standard substrate conditioner with VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), designed to seal substrates from moisture penetration and to improve the bond between substrate of type indicated and adhesive used for application of insulation.
5. Flexible-Membrane Flashing: Cold-applied, fully self-adhering, self-healing, rubberized-asphalt and polyethylene-film composite sheet or tape and primer; EIFS manufacturer's standard or product recommended in writing by EIFS manufacturer.
6. Insulation Adhesive: EIFS manufacturer's standard formulation designed for indicated use; compatible with substrate; with VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24); and complying with one of the following:
   a. Job-mixed formulation of portland cement complying with ASTM C 150, Type I, and polymer-based adhesive specified for base coat.
   b. Factory-blended dry formulation of portland cement, dry polymer admixture, and fillers specified for base coat.
   c. Factory-mixed noncementitious formulation designed for adhesive attachment of insulation to substrates of type indicated, as recommended by EIFS manufacturer.
7. Molded, Rigid Cellular Polystyrene Board Insulation: Comply with ASTM C 578, Type I; EIFS manufacturer's requirements; and EIMA's "EIMA Guideline Specification for Expanded Polystyrene (EPS) Insulation Board" for most stringent requirements for material performance and qualities of insulation, including dimensions and permissible variations, and the following:
   a. Aging: Before cutting and shipping, age insulation in block form by air drying for not less than six weeks or by another method approved by EIMA that produces equivalent results.
   b. Flame-Spread and Smoke-Developed Indexes: 25 and 450 or less, respectively, per ASTM E 84.
   c. Dimensions: Provide insulation boards not more than 24 by 48 inches (610 by 1219 mm) and in thickness indicated, but not more than 4 inches (102 mm) thick or less than thickness allowed by ASTM C 1397.
   d. Foam Shapes: Provide with profiles and dimensions indicated on Drawings.
8. Reinforcing Mesh: Balanced, alkali-resistant, open-weave, glass-fiber mesh treated for compatibility with other EIFS materials, complying with ASTM D 578 and the following:
   a. Standard-Impact Reinforcing Mesh: Not less than 4.0 oz./sq. yd. (136 g/sq. m).
   b. Intermediate-Impact Reinforcing Mesh: Not less than 10 oz./sq. yd. (339 g/sq. m) **OR** 12.0 oz./sq. yd. (407 g/sq. m), **as directed**.
   c. High-Impact Reinforcing Mesh: Not less than 15 oz./sq. yd. (509 g/sq. m).
   d. Heavy-Duty Reinforcing Mesh: Not less than 20 oz./sq. yd. (678 g/sq. m).
   e. Strip Reinforcing Mesh: Not less than 3.75 oz./sq. yd. (127 g/sq. m).
   f. Detail Reinforcing Mesh: Not less than 4.0 oz./sq. yd. (136 g/sq. m).
   g. Corner Reinforcing Mesh: Not less than 7.2 oz./sq. yd. (244 g/sq. m).

9. Base-Coat Materials: EIFS manufacturer's standard mixture complying with one of the following:
   a. Job-mixed formulation of portland cement complying with ASTM C 150, Type I, white or natural color; and manufacturer's standard polymer-emulsion adhesive designed for use with portland cement.
   b. Job-combined formulation of manufacturer's standard polymer-emulsion adhesive and manufacturer's standard dry mix containing portland cement.
   c. Factory-blended dry formulation of portland cement, dry polymer admixture, and inert fillers to which only water is added at Project site.
   d. Factory-mixed noncementitious formulation of polymer-emulsion adhesive and inert fillers that is ready to use without adding other materials.
10. Waterproof Adhesive/Base-Coat Materials: EIFS manufacturer's standard waterproof formulation with VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24) complying with one of the following:
   a. Job-mixed formulation of portland cement complying with ASTM C 150, Type I, white or natural color; and manufacturer's standard polymer-emulsion adhesive designed for use with portland cement.
   b. Job-combined formulation of manufacturer's standard polymer-emulsion adhesive and manufacturer's standard dry mix containing portland cement.
11. Primer: EIFS manufacturer's standard factory-mixed, elastomeric-polymer primer for preparing base-coat surface for application of finish coat.
12. Finish-Coat Materials: EIFS manufacturer's standard acrylic-based coating **OR** standard acrylic-based coating with enhanced mildew resistance **OR** siliconized acrylic-based coating, **as directed**, complying with the following:
   a. Factory-mixed formulation of polymer-emulsion binder, colorfast mineral pigments, sound stone particles, and fillers.
   b. Factory-mixed formulation of polymer-emulsion binder, colorfast mineral pigments, and fillers used with stone particles for embedding in finish coat to produce an applied-aggregate finish.
      1) Aggregate: Marble chips of size and color as selected by the Owner from manufacturer's full range.
   c. Sealer: Manufacturer's waterproof, clear acrylic-based sealer for protecting finish coat.
   d. Colors: As selected by the Owner from manufacturer's full range.
13. Water: Potable.
14. Mechanical Fasteners: EIFS manufacturer's standard corrosion-resistant fasteners consisting of thermal cap, standard washer and shaft attachments, and fastener indicated below; selected for properties of pullout, tensile, and shear strength required to resist design loads of application indicated; capable of pulling fastener head below surface of insulation board; and of the following description:
   a. For attachment to steel studs from 0.033 to 0.112 inch (0.84 to 2.84 mm) in thickness, provide steel drill screws complying with ASTM C 954.
   b. For attachment to light-gage steel framing members not less than 0.0179 inch (0.45 mm) in thickness, provide steel drill screws complying with ASTM C 1002.
   c. For attachment to wood framing members and plywood sheathing, provide steel drill screws complying with ASTM C 1002, Type W.
   d. For attachment to masonry and concrete substrates, provide sheathing dowel in form of a plastic wing-tipped fastener with thermal cap, sized to fit insulation thickness indicated and to penetrate substrate to depth required to secure anchorage.
   e. For attachment, provide manufacturer's standard fasteners suitable for substrate.
15. Trim Accessories: Type as designated or required to suit conditions indicated and to comply with EIFS manufacturer's written instructions; manufactured from UV-stabilized PVC; and complying with ASTM D 1784, manufacturer's standard Cell Class for use intended, and ASTM C 1063.
   a. Casing Bead: Prefabricated, one-piece type for attachment behind insulation, of depth required to suit thickness of coating and insulation, with face leg perforated for bonding to coating and back leg.

b. Drip Screed/Track: Prefabricated, one-piece type for attachment behind insulation with face leg extended to form a drip, of depth required to suit thickness of coating and insulation, with face leg perforated for bonding to coating and back leg.
c. Expansion Joint: Prefabricated, one-piece V profile; designed to relieve stress of movement.
d. Window Sill Flashing: Prefabricated type for both flashing and sloping sill over framing beneath windows; with end and back dams; designed to direct water to exterior.
e. Parapet Cap Flashing: Type for both flashing and covering parapet top with design complying with ASTM C 1397.

B. Elastomeric Sealants
1. Elastomeric Sealant Products: Provide EIFS manufacturer's listed and recommended chemically curing, elastomeric sealant that is compatible with joint fillers, joint substrates, and other related materials, and complies with requirements for products and testing indicated in ASTM C 1481 and with requirements in Division 07 Section "Joint Sealants" for products corresponding to description indicated below:
a. Multicomponent, nonsag urethane sealant.
b. Single-component, nonsag, neutral-curing silicone sealant.
c. Provide sealants, used inside the weatherproofing system, with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Preformed Foam Sealant Products: Provide sealant compatible with adjacent materials and complying with requirements in Division 07 Section "Joint Sealants".
3. Sealant Color: As selected by the Owner from manufacturer's full range.

C. Mixing
1. General: Comply with EIFS manufacturer's requirements for combining and mixing materials. Do not introduce admixtures, water, or other materials except as recommended by EIFS manufacturer. Mix materials in clean containers. Use materials within time period specified by EIFS manufacturer or discard.

D. Panel Fabrication
1. Panel Framing: Fabricate panel framing to comply with requirements in Division 05 Section "Cold-formed Metal Framing".
a. Connect panel framing by welding unless otherwise indicated.
b. Connections: Provide connections capable of adjustment, complying with erection tolerance requirements, to anchor panels to structure.
2. Exterior Cement Board: Install on metal framing to comply with requirements in "Exterior Cement-Board Installation" Article.
3. EIFS Application: Apply EIFS to sheathed metal-framed panels to comply with requirements in "Trim Installation," "Insulation Installation," "Base-Coat Installation," and "Finish-Coat Installation" articles and as follows:
a. Wrap base coat and reinforcing mesh at edges of panels and extend coverage not less than 4 inches (100 mm) over backs of panels unless otherwise indicated.
b. Wrap base coat and reinforcing mesh at edges of panels and extend coverage not less than full thickness to cover edges of metal framing unless otherwise indicated.
c. Continue finish coat around corners at edges of panels, unless otherwise indicated, and extend to location indicated for sealant application. Do not extend finish coat over surfaces where sealant will be applied.
d. Continue finish coat around corners at edges of panels and extend over edges to cover base coat unless otherwise indicated.
4. Panel Fabrication Tolerances: Comply with the following:
a. Overall Height and Width: Plus or minus 1/8 inch (3.2 mm).
b. Cumulative Height and Width over Length of Building: Not more than 3/8 inch (9.6 mm).
c. Openings within One Unit: Plus or minus 1/8 inch (3.2 mm) for window and door frames.

d. Out of Square: Plus or minus 1/8 inch (3.2 mm).
e. Locations of Reveals and Architectural Features: Plus or minus 1/8 inch (3.2 mm).
f. Thickness: Plus or minus 1/16 inch (1.6 mm).
g. Flatness: Not more than 1/8 inch in 8 feet (3.2 mm in 2.4 m) across face of panel.

1.3 EXECUTION

A. Preparation
1. Protect contiguous work from moisture deterioration and soiling caused by application of EIFS. Provide temporary covering and other protection needed to prevent spattering of exterior finish coats on other work.
2. Protect EIFS, substrates, and wall construction behind them from inclement weather during installation. Prevent penetration of moisture behind EIFS and deterioration of substrates.
3. Prepare and clean substrates to comply with EIFS manufacturer's written instructions to obtain optimum bond between substrate and adhesive for insulation.
a. Concrete Substrates: Provide clean, dry, neutral-pH substrate for insulation installation. Verify suitability of substrate by performing bond and moisture tests recommended by EIFS manufacturer.

B. Exterior Cement-Board Installation
1. Exterior Cement Board: Install on metal framing to comply with cement-board manufacturer's written instructions and evaluation report acceptable to authorities having jurisdiction. Install board with steel drill screws spaced no more than 8 inches (203 mm) o.c. along framing with perimeter fasteners at least 3/8 inch (9.6 mm) but less than 5/8 inch (15.9 mm) from edges of boards.

C. EIFS Installation, General
1. Comply with ASTM C 1397 and EIFS manufacturer's written instructions for installation of EIFS as applicable to each type of substrate indicated.

D. Substrate Protection Application
1. Primer/Sealer: Apply over gypsum sheathing substrates to protect substrates from degradation and where required by EIFS manufacturer for improving adhesion of insulation to substrate.
2. Waterproof Adhesive/Base Coat: Apply over sloped surfaces **OR** window sills **OR** parapets **OR** where indicated on Drawings, **as directed**, to protect substrates from degradation.
3. Flexible-Membrane Flashing: Install over weather-resistive barrier, applied and lapped to shed water; seal at openings, penetrations, terminations, and where indicated by EIFS manufacturer's written instructions to protect wall assembly from degradation. Prime substrates, if required, and install flashing to comply with EIFS manufacturer's written instructions and details.

E. Trim Installation
1. Trim: Apply trim accessories at perimeter of EIFS, at expansion joints, at window sills, and elsewhere as indicated, according to EIFS manufacturer's written instructions. Coordinate with installation of insulation.
a. Drip Screed/Track: Use at bottom edges of EIFS unless otherwise indicated.
b. Window Sill Flashing: Use at windows unless otherwise indicated.
c. Expansion Joint: Use where indicated on Drawings.
d. Casing Bead: Use at other locations.
e. Parapet Cap Flashing: Use where indicated on Drawings.

F. Insulation Installation
1. Board Insulation: Adhesively **OR** Mechanically **OR** Adhesively and mechanically, **as directed**, attach insulation to substrate in compliance with ASTM C 1397, EIFS manufacturer's written instructions, and the following:

a. Apply adhesive to insulation by notched-trowel method in a manner that results in coating the entire surface of sheathing with adhesive once insulation is adhered to sheathing unless EIFS manufacturer's written instructions specify using primer/sealer with ribbon-and-dab method. Apply adhesive to a thickness of not less than 1/4 inch (6.4 mm) for factory mixed and not less than 3/8 inch (9.6 mm) for field mixed, measured from surface of insulation before placement.
b. Press and slide insulation into place. Apply pressure over the entire surface of insulation to accomplish uniform contact, high initial grab, and overall level surface.
c. Allow adhered insulation to remain undisturbed for period recommended by EIFS manufacturer, but not less than 24 hours, before installing mechanical fasteners, beginning rasping and sanding insulation, or applying base coat and reinforcing mesh.
d. Mechanically attach insulation to substrate by method complying with EIFS manufacturer's written instructions. Install top surface of fastener heads flush with plane of insulation. Install fasteners into or through substrates with the following minimum penetration:
    1) Steel Framing: 5/16 inch (8 mm).
    2) Wood Framing: 1 inch (25 mm).
    3) Concrete and Masonry: 1 inch (25 mm).
e. Apply insulation over dry substrates in courses with long edges of boards oriented horizontally.
f. Begin first course of insulation from a level base line and work upward.
g. Begin first course of insulation from screed/track and work upward. Work from perimeter casing beads toward interior of panels if possible.
h. Stagger vertical joints of insulation boards in successive courses to produce running bond pattern. Locate joints so no piece of insulation is less than 12 inches (300 mm) wide or 6 inches (150 mm) high. Offset joints not less than 6 inches (150 mm) from corners of window and door openings and not less than 4 inches (100 mm) from aesthetic reveals.
    1) Adhesive Attachment: Offset joints of insulation not less than 6 inches (150 mm) from horizontal and 4 inches (100 mm) from vertical joints in sheathing.
    2) Mechanical Attachment: Offset joints of insulation from horizontal joints in sheathing.
i. Interlock ends at internal and external corners.
j. Abut insulation tightly at joints within and between each course to produce flush, continuously even surfaces without gaps or raised edges between boards. If gaps greater than 1/16 inch (1.6 mm) occur, fill with insulation cut to fit gaps exactly; insert insulation without using adhesive or other material.
k. Cut insulation to fit openings, corners, and projections precisely and to produce edges and shapes complying with details indicated.
l. Rasp or sand flush entire surface of insulation to remove irregularities projecting more than 1/32 inch (0.8 mm) **OR** 1/16 inch (1.6 mm), **as directed**, from surface of insulation and to remove yellowed areas due to sun exposure; do not create depressions deeper than 1/16 inch (1.6 mm).
m. Cut aesthetic reveals in outside face of insulation with high-speed router and bit configured to produce grooves, rabbets, and other features that comply with profiles and locations indicated. Do not reduce insulation thickness at aesthetic reveals to less than 3/4 inch (19 mm).
n. Install foam shapes and attach to sheathing **OR** structure, **as directed**.
o. Interrupt insulation for expansion joints where indicated.
p. Form joints for sealant application by leaving gaps between adjoining insulation edges and between insulation edges and dissimilar adjoining surfaces. Make gaps wide enough to produce joint widths indicated after encapsulating joint substrates with base coat and reinforcing mesh.
q. Form joints for sealant application with back-to-back casing beads for joints within EIFS and with perimeter casing beads at dissimilar adjoining surfaces. Make gaps between

casing beads and between perimeter casing beads and adjoining surfaces of width indicated.

r. After installing insulation and before applying reinforcing mesh, fully wrap board edges with strip reinforcing mesh. Cover edges of board and extend encapsulating mesh not less than 2-1/2 inches (64 mm) over front and back face unless otherwise indicated on Drawings.

s. Treat exposed edges of insulation as follows:

1) Except for edges forming substrates of sealant joints, encapsulate with base coat, reinforcing mesh, and finish coat.

2) Encapsulate edges forming substrates of sealant joints within EIFS or between EIFS and other work with base coat and reinforcing mesh.

3) At edges trimmed by accessories, extend base coat, reinforcing mesh, and finish coat over face leg of accessories.

t. Coordinate installation of flashing and insulation to produce wall assembly that does not allow water to penetrate behind flashing and EIFS protective-coating lamina.

2. Expansion Joints: Install at locations indicated, where required by EIFS manufacturer, and as follows:

a. At expansion joints in substrates behind EIFS.

b. Where EIFS adjoin dissimilar substrates, materials, and construction, including other EIFS.

c. At floor lines in multilevel wood-framed construction.

d. Where wall height or building shape changes.

e. Where EIFS manufacturer requires joints in long continuous elevations.

f. Where panels abut one another.

G. Base-Coat Installation

1. Base Coat: Apply to exposed surfaces of insulation and foam shapes in minimum thickness recommended in writing by EIFS manufacturer, but not less than 1/16-inch (1.6-mm) dry-coat thickness.

2. Reinforcing Mesh: Embed type indicated below in wet base coat to produce wrinkle-free installation with mesh continuous at corners and overlapped not less than 2-1/2 inches (64 mm) or otherwise treated at joints to comply with ASTM C 1397 and EIFS manufacturer's written instructions. Do not lap reinforcing mesh within 8 inches (204 mm) of corners. Completely embed mesh, applying additional base-coat material if necessary, so reinforcing-mesh color and pattern are not visible.

a. Standard-impact reinforcing mesh unless otherwise indicated.

b. Intermediate-impact reinforcing mesh where indicated.

c. High-impact reinforcing mesh where indicated.

d. Heavy-duty reinforcing mesh where indicated.

3. Double-Layer Reinforcing Mesh Application: Where indicated, apply second base coat and second layer of standard-impact **OR** intermediate-impact, **as directed**, reinforcing mesh, overlapped not less than 2-1/2 inches (64 mm) or otherwise treated at joints to comply with ASTM C 1397 and EIFS manufacturer's written instructions in same manner as first application. Do not apply until first base coat has cured.

4. Additional Reinforcing Mesh: Apply strip reinforcing mesh around openings extending 4 inches (100 mm) beyond perimeter. Apply additional 9-by-12-inch (230-by-300-mm) strip reinforcing mesh diagonally at corners of openings (re-entrant corners). Apply 8-inch- (200-mm-) wide strip reinforcing mesh at both inside and outside corners unless base layer of mesh is lapped not less than 4 inches (100 mm) on each side of corners.

a. At aesthetic reveals, apply strip reinforcing mesh not less than 8 inches (200 mm) wide.

b. Embed strip reinforcing mesh in base coat before applying first layer of reinforcing mesh.

5. Foam Shapes: Fully embed reinforcing mesh in base coat.

6. Double Base-Coat Application: Where indicated, apply second base coat in same manner and thickness as first application except without reinforcing mesh. Do not apply until first base coat has cured.

H. Finish-Coat Installation
1. Primer: Apply over dry base coat according to EIFS manufacturer's written instructions.
2. Finish Coat: Apply over dry primed base coat, maintaining a wet edge at all times for uniform appearance, in thickness required by EIFS manufacturer to produce a uniform finish of color and texture matching approved sample and free of cold joints, shadow lines, and texture variations.
   a. Texture: As selected by the Owner from manufacturer's full range.
   b. Embed aggregate in finish coat according to EIFS manufacturer's written instructions to produce a uniform applied-aggregate finish of color and texture matching approved sample.
3. Sealer Coat: Apply over dry finish coat, in number of coats and thickness required by EIFS manufacturer.

I. Installation Of Prefabricated Panels
1. General: Install panels according to Shop Drawings. Install by welding metal framing to structural-steel frame **OR** by welding to steel-weld plates anchored in concrete, **as directed**, to comply with requirements in Division 05 Section "Cold-formed Metal Framing" unless otherwise indicated.
   a. Lift panels only as indicated on Shop Drawings.
   b. Do not warp or stress panels by forcing alignment.
   c. Adjust connections to align panels and maintain correct and uniform joint widths.
   d. Install bracing as panels are erected. Weld securely to panel framing and to structure.
2. Erection Tolerances: Install panels level, plumb, and true to line with no variation in plane or alignment exceeding 1/16 inch (1.6 mm) and no variation in position exceeding 1/8 inch (3.2 mm).
   a. Maintain clearance between panels required for installing joint sealants.

J. Installation Of Joint Sealants
1. Prepare joints and apply sealants, of type and at locations indicated, to comply with applicable requirements in Division 07 Section "Joint Sealants" and in ASTM C 1481.
   a. Apply joint sealants after base coat has cured but before applying finish coat.
   b. Clean surfaces to receive sealants to comply with indicated requirements and EIFS manufacturer's written instructions.
   c. Apply primer recommended in writing by sealant manufacturer for surfaces to be sealed.
   d. Install sealant backing to control depth and configuration of sealant joint and to prevent sealant from adhering to back of joint.
   e. Apply masking tape to protect areas adjacent to sealant joints. Remove tape immediately after tooling joints, without disturbing joint seal.
   f. Recess sealant sufficiently from surface of EIFS so an additional sealant application, including cylindrical sealant backing, can be installed without protruding beyond EIFS surface.

K. Field Quality Control
1. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
   a. According to ICC-ES AC24 **OR** ICC-ES AC219, **as directed**.
2. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
3. EIFS Tests and Inspections: For the following:
   a. According to ICC-ES AC24 **OR** ICC-ES AC219, **as directed**.
4. Prefabricated Panels: Test and inspect field welds.
5. Remove and replace EIFS where test results indicate that EIFS do not comply with specified requirements.
6. Prepare test and inspection reports.

L. Cleaning And Protection

1. Remove temporary covering and protection of other work. Promptly remove coating materials from window and door frames and other surfaces outside areas indicated to receive EIFS coatings.

END OF SECTION 07240

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SECTION 07240a - WATER-DRAINAGE EXTERIOR INSULATION AND FINISH SYSTEM (EIFS)

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for water drainage exterior insulation and finish system (EIFS). Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes water-drainage exterior insulation and finish system (EIFS) applied over water-resistive coating over sheathing, weather-resistant sheathing paper over sheathing, weather-resistant sheathing paper over exterior cement board, and exterior cement board over weather-resistant sheathing paper.

C. System Description
1. Class PB EIFS: A non-load-bearing, exterior wall cladding system that consists of an insulation board attached adhesively, mechanically, or both to the substrate; an integrally reinforced base coat; and a textured protective finish coat.
2. Water-Drainage EIFS: EIFS with a means that allows water entering into an EIFS assembly to drain to the exterior.

D. Performance Requirements
1. EIFS Performance: Comply with the following:
   a. Bond Integrity: Free from bond failure within EIFS components or between system and supporting wall construction, resulting from exposure to fire, wind loads, weather, or other in-service conditions.
   b. Weathertightness: Resistant to water penetration from exterior into water-drainage EIFS and assemblies behind it or through them into interior of building that results in deterioration of thermal-insulating effectiveness or other degradation of EIFS and assemblies behind it, including substrates, supporting wall construction, and interior finish, and including a means that allows water entering into an EIFS assembly to drain to the exterior.
2. Class PB EIFS: Provide EIFS having physical properties and structural performance that comply with the following:
   a. Abrasion Resistance: Sample consisting of 1-inch- (25.4-mm-) thick EIFS mounted on 1/2-inch- (12.7-mm-) thick gypsum board; cured for a minimum of 28 days; and showing no cracking, checking, or loss of film integrity after exposure to 528 quarts (500 L) of sand when tested per ASTM D 968, Method A.
   b. Absorption-Freeze Resistance: No visible deleterious effects and negligible weight loss after 60 cycles per EIMA 101.01.
   c. Accelerated Weathering: Five samples per ICC-ES AC235 showing no cracking, checking, crazing, erosion, rusting, blistering, peeling, delamination, or other characteristics that might affect performance as a wall cladding after testing for 2000 hours when viewed under 5 times magnification per ASTM G 153 or ASTM G 154 **OR** ASTM G 153 or ASTM G 155, **as directed**.
   d. Freeze-Thaw: No surface changes, cracking, checking, crazing, erosion, rusting, blistering, peeling, or delamination, or indications of delamination between components when viewed under 5 times magnification after 60 cycles per EIMA 101.01 **OR** 10 cycles per ICC-ES AC235, **as directed**.

e. Mildew Resistance of Finish Coat: Sample applied to 2-by-2-inch (50.8-by-50.8-mm) clean glass substrate, cured for 28 days, and showing no growth when tested per ASTM D 3273 and evaluated according to ASTM D 3274.
f. Salt-Spray Resistance: No deleterious affects when tested according to ICC-ES AC235.
g. Tensile Adhesion: No failure in the EIFS, adhesive, base coat, or finish coat when tested per EIMA 101.03 **OR** ICC-ES AC235, **as directed**.
h. Water Penetration: Sample consisting of 1-inch- (25.4-mm-) thick EIFS mounted on 1/2-inch- (12.7-mm-) thick gypsum board, cured for 28 days, and showing no water penetration into the plane of the base coat to expanded polystyrene board interface of the test specimen after 15 minutes at 6.24 lbf/sq. ft. (299 Pa) of air pressure difference or 20 percent of positive design wind pressure, whichever is greater, across the specimen during a test period when tested per EIMA 101.02.
i. Water Resistance: Three samples, each consisting of 1-inch- (25.4-mm-) thick EIFS mounted on 1/2-inch- (12.7-mm-) thick gypsum board; cured for 28 days; and showing no cracking, checking, crazing, erosion, rusting, blistering, peeling, or delamination after testing for 14 days per ASTM D 2247.
j. Impact Resistance: Sample consisting of 1-inch- (25.4-mm-) thick EIFS when constructed, conditioned, and tested per EIMA 101.86; and meeting or exceeding the following:
    1) Standard Impact Resistance: 25 to 49 inch-lb (2.8 to 5.6 J).
    2) Medium Impact Resistance: 50 to 89 inch-lb (5.7 to 10.1 J).
    3) High Impact Resistance: 90 to 150 inch-lb (10.2 to 17 J).
    4) Ultra-High Impact Resistance: More than 150 inch-lb (17 J).
k. Drainage: According to ICC-ES AC24 **OR** ICC-ES AC235, **as directed**.
l. Structural Performance Testing: EIFS assembly and components shall comply with ICC-ES AC235 when tested per ASTM E 330.

E. Submittals
1. Product Data: For each type and component of EIFS indicated.
2. LEED Submittal:
    a. Product Data for Credit EQ 4.1: For adhesives and sealants used inside the weatherproofing system, including printed statement of VOC content.
3. Shop Drawings: For EIFS. Include plans, elevations, sections, details of components, details of penetration and termination, flashing details, joint locations and configurations, fastening and anchorage details including mechanical fasteners, and connections and attachments to other work.
4. Samples: For each exposed product and for each color and texture specified.
5. Material or product certificates.
6. Product test reports.
7. Compatibility and Adhesion Test Reports: For joint sealants from sealant manufacturer indicating the following:
    a. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
    b. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
8. Field quality-control reports and special inspection reports.
9. Evaluation reports
10. Maintenance data.

F. Quality Assurance
1. Installer Qualifications: An installer who is certified in writing by EIFS manufacturer as qualified to install manufacturer's system using trained workers.
2. Source Limitations: Obtain EIFS from single source from single EIFS manufacturer and from sources approved by EIFS manufacturer as compatible with system components.

3. Fire-Test-Response Characteristics: Provide EIFS and system components with the following fire-test-response characteristics as determined by testing identical EIFS and system components per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.
   a. Fire-Resistance Characteristics: Per ASTM E 119.
   b. Full-Scale Multistory Fire Test: Per UBC Standard 26-4.
   c. Full-Scale Diversified Fire Test: Per ASTM E 108 modified for testing vertical walls.
   d. Intermediate-Scale Multistory Fire Test: Per FPA 285 **OR** UBC Standard 26-9, **as directed**.
   e. Radiant Heat Exposure: No ignition of EIFS when tested according to NFPA 268.
   f. Potential Heat: Acceptable level when tested according to NFPA 259.
   g. Surface-Burning Characteristics: Provide insulation board, adhesives, base coats, and finish coats with flame-spread index of 25 or less and smoke-developed index of 450 or less, per ASTM E 84 **OR** UBC Standard 8-1, **as directed**.
4. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver materials in original, unopened packages with manufacturers' labels intact and clearly identifying products.
2. Store materials inside and under cover; keep them dry and protected from weather, direct sunlight, surface contamination, aging, corrosion, damaging temperatures, construction traffic, and other causes.
   a. Stack insulation board flat and off the ground.
   b. Protect plastic insulation against ignition at all times. Do not deliver plastic insulating materials to Project site before installation time.
   c. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

H. Project Conditions
1. Weather Limitations: Maintain ambient temperatures above 40 deg F (4.4 deg C) for a minimum of 24 hours before, during, and after adhesives or coatings are applied. Do not apply EIFS adhesives or coatings during rainfall. Proceed with installation only when existing and forecasted weather conditions and ambient outdoor air, humidity, and substrate temperatures permit EIFS to be applied, dried, and cured according to manufacturers' written instructions and warranty requirements.

1.2 PRODUCTS

A. Materials
1. Compatibility: Provide water-resistive coating, adhesive, fasteners, board insulation, reinforcing meshes, base- and finish-coat systems, sealants, and accessories that are compatible with one another and with substrates and approved for use by EIFS manufacturer for Project.
2. Exterior Cement Board: Not less than 5/16-inch- (8-mm-) **OR** 7/16-inch- (11-mm-), **as directed** thick, fiber cement board complying with ASTM C 1186, Type A, for exterior applications.
   a. Fasteners: Wafer-head or flat-head steel drill screws complying with ASTM C 954, with an organic-polymer coating or other corrosion-protective coating having a salt-spray resistance of more than 500 hours per ASTM B 117.
      1) Size and Length: As recommended by sheathing manufacturer for type and thickness of sheathing board to be attached.
3. Water-Resistive Coatings: EIFS manufacturer's standard formulation and accessories for use as water/weather-resistive barriers, compatible with substrate, and complying with physical and performance criteria of ICC-ES AC209 **OR** ICC-ES AC212, **as directed**.

a. Sheathing Joint Tape **OR** Compound and Tape, **as directed**: Type recommended by EIFS manufacturer for sealing joints between and penetrations through sheathing.
b. VOC Content of Coatings Used as Insulation Adhesive: 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

4. Primer/Sealer: EIFS manufacturer's standard substrate conditioner with VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), designed to seal substrates from moisture penetration and to improve the bond between substrate of type indicated and adhesive used for application of insulation.
5. Flexible-Membrane Flashing: Cold-applied, fully self-adhering, self-healing, rubberized-asphalt and polyethylene-film composite sheet or tape and primer; EIFS manufacturer's standard or product recommended in writing by EIFS manufacturer.
6. Drainage Mat: Three-dimensional, nonwoven, entangled filament, nylon or plastic **OR** Woven or fused, self-furring, PVC mesh lath, **as directed**, mat designed to drain incidental moisture by gravity; EIFS manufacturer's standard or product recommended in writing by EIFS manufacturer with manufacturer's standard corrosion-resistant mechanical fasteners suitable for intended substrate.
7. Spacers: Closed-cell polyethylene **OR** Woven or fused, self-furring, PVC mesh lath, **as directed** furring strips; EIFS manufacturer's standard or product recommended in writing by EIFS manufacturer with manufacturer's standard corrosion-resistant mechanical fasteners suitable for intended substrate.
8. Insulation Adhesive: EIFS manufacturer's standard formulation designed for indicated use; compatible with substrate; with VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24); and complying with one of the following:
   a. Job-mixed formulation of portland cement complying with ASTM C 150, Type I, and polymer-based adhesive specified for base coat.
   b. Factory-blended dry formulation of portland cement, dry polymer admixture, and fillers specified for base coat.
   c. Factory-mixed noncementitious formulation designed for adhesive attachment of insulation to substrates of type indicated, as recommended by EIFS manufacturer.
9. Molded, Rigid Cellular Polystyrene Board Insulation: Comply with ASTM C 578, Type I; EIFS manufacturer's requirements; and EIMA's "EIMA Guideline Specification for Expanded Polystyrene (EPS) Insulation Board" for most stringent requirements for material performance and qualities of insulation, including dimensions and permissible variations, and the following:
   a. Aging: Before cutting and shipping, age insulation in block form by air drying for not less than six weeks or by another method approved by EIMA that produces equivalent results.
   b. Flame-Spread and Smoke-Developed Indexes: 25 and 450 or less, respectively, per ASTM E 84.
   c. Dimensions: Provide insulation boards not more than 24 by 48 inches (610 by 1219 mm) and in thickness indicated but not more than 4 inches (102 mm) thick or less than thickness allowed by ASTM C 1397.
   d. Channeled Board Insulation: EIFS manufacturer's standard factory-fabricated profile with linear, vertical drainage channels, slots, or waves on the back side of board.
   e. Board Insulation Closure Blocks: EIFS manufacturer's standard density, size, and configuration.
   f. Foam Shapes: Provide with profiles and dimensions indicated on Drawings.
10. Reinforcing Mesh: Balanced, alkali-resistant, open-weave, glass-fiber mesh treated for compatibility with other EIFS materials, made from continuous multiend strands with retained mesh tensile strength of not less than 120 lbf/in. (21 dN/cm) per ASTM E 2098 **OR** EIMA 105.01, **as directed**; complying with ASTM D 578 and the following:
    a. Standard-Impact Reinforcing Mesh: Not less than 4.0 oz./sq. yd. (136 g/sq. m).
    b. Intermediate-Impact Reinforcing Mesh: Not less than 10 oz./sq. yd. (339 g/sq. m) **OR** 12.0 oz./sq. yd. (407 g/sq. m), **as directed**.
    c. High-Impact Reinforcing Mesh: Not less than 15 oz./sq. yd. (509 g/sq. m).
    d. Heavy-Duty Reinforcing Mesh: Not less than 20 oz./sq. yd. (678 g/sq. m).

e. Strip Reinforcing Mesh: Not less than 3.75 oz./sq. yd. (127 g/sq. m).
f. Detail Reinforcing Mesh: Not less than 4.0 oz./sq. yd. (136 g/sq. m).
g. Corner Reinforcing Mesh: Not less than 7.2 oz./sq. yd. (244 g/sq. m).

11. Base-Coat Materials: EIFS manufacturer's standard mixture complying with one of the following requirements:
    a. Job-mixed formulation of portland cement complying with ASTM C 150, Type I, white or natural color; and manufacturer's standard polymer-emulsion adhesive designed for use with portland cement.
    b. Job-combined formulation of manufacturer's standard polymer-emulsion adhesive and manufacturer's standard dry mix containing portland cement.
    c. Factory-blended dry formulation of portland cement, dry polymer admixture, and inert fillers to which only water is added at Project site.
    d. Factory-mixed noncementitious formulation of polymer-emulsion adhesive and inert fillers that is ready to use without adding other materials.
12. Waterproof Adhesive/Base-Coat Materials: EIFS manufacturer's standard waterproof formulation with VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), complying with one of the following:
    a. Job-mixed formulation of portland cement complying with ASTM C 150, Type I, white or natural color; and manufacturer's standard polymer-emulsion adhesive designed for use with portland cement.
    b. Job-combined formulation of manufacturer's standard polymer-emulsion adhesive and manufacturer's standard dry mix containing portland cement.
13. Primer: EIFS manufacturer's standard factory-mixed, elastomeric-polymer primer for preparing base-coat surface for application of finish coat.
14. Finish-Coat Materials: EIFS manufacturer's standard acrylic-based coating **OR** standard acrylic-based coating with enhanced mildew resistance **OR** siliconized acrylic-based coating, **as directed**, complying with the following:
    a. Factory-mixed formulation of polymer-emulsion binder, colorfast mineral pigments, sound stone particles, and fillers.
    b. Factory-mixed formulation of polymer-emulsion binder, colorfast mineral pigments, and fillers used with stone particles for embedding in finish coat to produce an applied-aggregate finish.
        1) Aggregate: Marble chips of size and as selected by the Owner from manufacturer's full range.
    c. Sealer: Manufacturer's waterproof, clear acrylic-based sealer for protecting finish coat.
    d. Colors: As selected by the Owner from manufacturer's full range.
15. Water: Potable.
16. Mechanical Fasteners: EIFS manufacturer's standard corrosion-resistant fasteners consisting of thermal cap, standard washer and shaft attachments, and fastener indicated below; selected for properties of pullout, tensile, and shear strength required to resist design loads of application indicated; capable of pulling fastener head below surface of insulation board; and of the following description:
    a. For attachment to steel studs from 0.033 to 0.112 inch (0.84 to 2.84 mm) in thickness, provide steel drill screws complying with ASTM C 954.
    b. For attachment to light-gage steel framing members not less than 0.0179 inch (0.45 mm) in thickness, provide steel drill screws complying with ASTM C 1002.
    c. For attachment to wood framing members and plywood sheathing, provide steel drill screws complying with ASTM C 1002, Type W.
    d. For attachment to masonry and concrete substrates, provide sheathing dowel in form of a plastic wing-tipped fastener with thermal cap, sized to fit insulation thickness indicated and to penetrate substrate to depth required to secure anchorage.
    e. For attachment, provide manufacturer's standard fasteners suitable for substrate.
17. Trim Accessories: Type as designated or required to suit conditions indicated and to comply with EIFS manufacturer's written instructions; manufactured from UV-stabilized PVC; and complying with ASTM D 1784, manufacturer's standard Cell Class for use intended, and ASTM C 1063.

a. Casing Bead: Prefabricated, one-piece type for attachment behind insulation, of depth required to suit thickness of coating and insulation, with face leg perforated for bonding to coating and back leg.
b. Drip Screed/Track: Prefabricated, one-piece type for attachment behind insulation with face leg extended to form a drip, of depth required to suit thickness of coating and insulation, with face leg perforated for bonding to coating and back leg.
c. Weep Screed/Track: Prefabricated, one-piece type for attachment behind insulation with perforated face leg extended to form a drip and weep holes in track bottom, of depth required to suit thickness of coating and insulation, with face leg perforated for bonding to coating and back leg; designed to drain incidental moisture that gets into wall construction to the exterior at terminations of EIFS with drainage.
d. Expansion Joint: Prefabricated, one-piece V profile; designed to relieve stress of movement.
e. Window Sill Flashing: Prefabricated type for both flashing and sloping sill over framing beneath windows; with end and back dams; designed to direct water to exterior.
f. Parapet Cap Flashing: Type for both flashing and covering parapet top with design complying with ASTM C 1397.

B. Elastomeric Sealants
1. Elastomeric Sealant Products: Provide EIFS manufacturer's listed and recommended chemically curing, elastomeric sealant that is compatible with joint fillers, joint substrates, and other related materials, and complies with requirements for products and testing indicated in ASTM C 1481 and with requirements in Division 07 Section "Joint Sealants" for products corresponding to description indicated below:
a. Multicomponent, nonsag urethane sealant.
b. Single-component, nonsag, neutral-curing silicone sealant.
c. Provide sealants, for use inside the weatherproofing system, with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Preformed Foam Sealant Products: Provide sealant compatible with adjacent materials and complying with requirements in Division 07 Section "Joint Sealants".
3. Sealant Color: As selected by the Owner from manufacturer's full range.

C. Mixing
1. General: Comply with EIFS manufacturer's requirements for combining and mixing materials. Do not introduce admixtures, water, or other materials except as recommended by EIFS manufacturer. Mix materials in clean containers. Use materials within time period specified by EIFS manufacturer or discard.

1.3 EXECUTION

A. Preparation
1. Protect contiguous work from moisture deterioration and soiling caused by application of EIFS. Provide temporary covering and other protection needed to prevent spattering of exterior finish coats on other work.
2. Protect EIFS, substrates, and wall construction behind them from inclement weather during installation. Prevent penetration of moisture behind drainage plane of EIFS and deterioration of substrates.
3. Prepare and clean substrates to comply with EIFS manufacturer's written instructions to obtain optimum bond between substrate and adhesive for insulation.

B. Exterior Cement-Board Installation
1. Exterior Cement Board: Install on metal framing to comply with cement-board manufacturer's written instructions and evaluation report acceptable to authorities having jurisdiction. Install

board with steel drill screws spaced no more than 8 inches (203 mm) o.c. along framing with perimeter fasteners at least 3/8 inch (9.6 mm) but less than 5/8 inch (15.9 mm) from edges of boards.

C. EIFS Installation, General
   1. Comply with EIFS manufacturer's written instructions for installation of EIFS as applicable to each type of substrate indicated.

D. Substrate Protection Application
   1. Primer/Sealer: Apply over gypsum sheathing substrates to protect substrates from degradation and where required by EIFS manufacturer for improving adhesion of insulation to substrate.
   2. Water-Resistive Coatings: Apply over substrates to protect substrates from degradation and to provide water-/weather-resistive barrier.
      a. Tape and seal joints, exposed edges, terminations, and inside and outside corners of sheathing unless otherwise indicated by EIFS manufacturer's written instructions.
   3. Waterproof Adhesive/Base Coat: Apply over sloped surfaces **OR** window sills **OR** parapets **OR** where indicated on Drawings, **as directed**, to protect substrates from degradation.
   4. Flexible-Membrane Flashing: Install over weather-resistive barrier, applied and lapped to shed water; seal at openings, penetrations, terminations, and where indicated by EIFS manufacturer's written instructions to protect wall assembly from degradation. Prime substrates, if required, and install flashing to comply with EIFS manufacturer's written instructions and details.

E. Trim Installation
   1. Trim: Apply trim accessories at perimeter of EIFS, at expansion joints, at window sills, and elsewhere as indicated, according to EIFS manufacturer's written instructions. Coordinate with installation of insulation.
      a. Weep Screed/Track: Use at bottom termination edges, at window and door heads, and at floor line expansion joints of water-drainage EIFS unless otherwise indicated.
      b. Window Sill Flashing: Use at windows unless otherwise indicated.
      c. Expansion Joint: Use where indicated on Drawings.
      d. Casing Bead: Use at other locations.
      e. Parapet Cap Flashing: Use where indicated on Drawings.

F. Drainage Mat Installation
   1. Drainage Mat: Apply wrinkle free, continuously, with edges butted **OR** overlapped, **as directed**, and adhesively secured **OR** mechanically secured with fasteners, **as directed**, over water-/weather-resistive barrier according to manufacturer's written instructions.

G. Insulation Installation
   1. Board Insulation: Adhesively **OR** Mechanically **OR** Adhesively and mechanically, **as directed**, attach insulation to substrate in compliance with ASTM C 1397, EIFS manufacturer's written instructions, and the following:
      a. Apply adhesive to insulation by notched-trowel method in a manner that results in coating the entire surface of sheathing with adhesive once insulation is adhered to sheathing unless EIFS manufacturer's written instructions specify using primer/sealer with ribbon-and-dab method. Apply adhesive to a thickness of not less than 1/4 inch (6.4 mm) for factory mixed and not less than 3/8 inch (9.6 mm) for field mixed, measured from surface of insulation before placement.
      b. Apply adhesive to insulation by notched-trowel method in a manner that results in coating the entire surface of drainage mat with adhesive once insulation is adhered to drainage mat.
      c. Apply adhesive to ridges on back of insulation by notched-trowel method in a manner that results in full adhesive contact over the entire surface of ridges, leaving channels free of adhesive once insulation is adhered to substrate.

d. Press and slide insulation into place. Apply pressure over the entire surface of insulation to accomplish uniform contact, high initial grab, and overall level surface.
e. Allow adhered insulation to remain undisturbed for period recommended by EIFS manufacturer, but not less than 24 hours, before installing mechanical fasteners, beginning rasping and sanding insulation, or applying base coat and reinforcing mesh.
f. Mechanically attach insulation to substrate by method complying with EIFS manufacturer's written instructions. Install top surface of fastener heads flush with plane of insulation. Install fasteners into or through substrates with the following minimum penetration:
    1) Steel Framing: 5/16 inch (8 mm).
    2) Wood Framing: 1 inch (25 mm).
    3) Concrete and Masonry: 1 inch (25 mm).
g. Apply insulation over drainage mat and dry substrates in courses with long edges of boards oriented horizontally.
h. Begin first course of insulation from a level base line and work upward.
i. Begin first course of insulation from screed/track and work upward. Work from perimeter casing beads toward interior of panels if possible.
j. Stagger vertical joints of insulation boards in successive courses to produce running bond pattern. Locate joints so no piece of insulation is less than 12 inches (300 mm) wide or 6 inches (150 mm) high. Offset joints not less than 6 inches (150 mm) from corners of window and door openings and not less than 4 inches (100 mm) from aesthetic reveals.
    1) Adhesive Attachment: Offset joints of insulation not less than 6 inches (150 mm) from horizontal and 4 inches (100 mm) from vertical joints in sheathing.
    2) Mechanical Attachment: Offset joints of insulation from horizontal joints in sheathing.
k. Place insulation with adhesive strips and channels, slots, or waves aligned in the vertical position for drainage. Align drainage channels, slots, or waves with channels, slots, or waves in insulation boards above and below.
l. Interlock ends at internal and external corners.
m. Abut insulation tightly at joints within and between each course to produce flush, continuously even surfaces without gaps or raised edges between boards. If gaps greater than 1/16 inch (1.6 mm) occur, fill with insulation cut to fit gaps exactly; insert insulation without using adhesive or other material.
n. Cut insulation to fit openings, corners, and projections precisely and to produce edges and shapes complying with details indicated.
o. Rasp or sand flush entire surface of insulation to remove irregularities projecting more than 1/32 inch (0.8 mm) **OR** 1/16 inch (1.6 mm), **as directed**, from surface of insulation and to remove yellowed areas due to sun exposure; do not create depressions deeper than 1/16 inch (1.6 mm).
p. Cut aesthetic reveals in outside face of insulation with high-speed router and bit configured to produce grooves, rabbets, and other features that comply with profiles and locations indicated. Do not reduce insulation thickness at aesthetic reveals to less than 3/4 inch (19 mm).
q. Install foam shapes and attach to sheathing **OR** structure, **as directed**.
r. Interrupt insulation for expansion joints where indicated.
s. Install insulation closure blocks using ribbon-and-dab method to create air zones where indicated.
t. Form joints for sealant application by leaving gaps between adjoining insulation edges and between insulation edges and dissimilar adjoining surfaces. Make gaps wide enough to produce joint widths indicated after encapsulating joint substrates with base coat and reinforcing mesh.
u. Form joints for sealant application with back-to-back casing beads for joints within EIFS and with perimeter casing beads at dissimilar adjoining surfaces. Make gaps between casing beads and between perimeter casing beads and adjoining surfaces of width indicated.

v. After installing insulation and before applying field-applied reinforcing mesh, fully wrap board edges. Cover edges of board and extend encapsulating mesh not less than 2-1/2 inches (64 mm) over front and back face unless otherwise indicated on Drawings.

w. Treat exposed edges of insulation as follows:

1) Except for edges forming substrates of sealant joints, encapsulate with base coat, reinforcing mesh, and finish coat.

2) Encapsulate edges forming substrates of sealant joints within EIFS or between EIFS and other work with base coat and reinforcing mesh.

3) At edges trimmed by accessories, extend base coat, reinforcing mesh, and finish coat over face leg of accessories.

x. Coordinate installation of flashing and insulation to produce wall assembly that does not allow water to penetrate behind flashing and water-/weather-resistive barrier.

2. Expansion Joints: Install at locations indicated, where required by EIFS manufacturer, and as follows:

a. At expansion joints in substrates behind EIFS.

b. Where EIFS adjoin dissimilar substrates, materials, and construction, including other EIFS.

c. At floor lines in multilevel wood-framed construction.

d. Where wall height or building shape changes.

e. Where EIFS manufacturer requires joints in long continuous elevations.

H. Base-Coat Installation

1. Base Coat: Apply to exposed surfaces of insulation and foam shapes in minimum thickness recommended in writing by EIFS manufacturer, but not less than 1/16-inch (1.6-mm) dry-coat thickness.

2. Reinforcing Mesh: Embed type indicated below in wet base coat to produce wrinkle-free installation with mesh continuous at corners and overlapped not less than 2-1/2 inches (64 mm) or otherwise treated at joints to comply with ASTM C 1397 and EIFS manufacturer's written instructions. Do not lap reinforcing mesh within 8 inches (204 mm) of corners. Completely embed mesh, applying additional base-coat material if necessary, so reinforcing-mesh color and pattern are not visible.

a. Standard-impact reinforcing mesh unless otherwise indicated.

b. Intermediate-impact reinforcing mesh where indicated.

c. High-impact reinforcing mesh where indicated.

d. Heavy-duty reinforcing mesh where indicated.

3. Double-Layer Reinforcing Mesh Application: Where indicated, apply second base coat and second layer of standard-impact **OR** intermediate-impact, **as directed**, reinforcing mesh, overlapped not less than 2-1/2 inches (64 mm) or otherwise treated at joints to comply with ASTM C 1397 and EIFS manufacturer's written instructions in same manner as first application. Do not apply until first base coat has cured.

4. Additional Reinforcing Mesh: Apply strip reinforcing mesh around openings extending 4 inches (100 mm) beyond perimeter. Apply additional 9-by-12-inch (230-by-300-mm) strip reinforcing mesh diagonally at corners of openings (re-entrant corners). Apply 8-inch- (200-mm-) wide strip reinforcing mesh at both inside and outside corners unless base layer of mesh is lapped not less than 4 inches (100 mm) on each side of corners.

a. At aesthetic reveals, apply strip reinforcing mesh not less than 8 inches (200 mm) wide.

b. Embed strip reinforcing mesh in base coat before applying first layer of reinforcing mesh.

5. Foam Shapes: Fully embed reinforcing mesh in base coat.

6. Double Base-Coat Application: Where indicated, apply second base coat in same manner and thickness as first application except without reinforcing mesh. Do not apply until first base coat has cured.

I. Finish-Coat Installation

1. Primer: Apply over dry base coat according to EIFS manufacturer's written instructions.

2. Finish Coat: Apply over dry primed base coat, maintaining a wet edge at all times for uniform appearance, in thickness required by EIFS manufacturer to produce a uniform finish of color and texture matching approved sample and free of cold joints, shadow lines, and texture variations.
   a. Texture: As selected by the Owner from manufacturer's full range.
   b. Embed aggregate in finish coat according to EIFS manufacturer's written instructions to produce a uniform applied-aggregate finish of color and texture matching approved sample.
3. Sealer Coat: Apply over dry finish coat, in number of coats and thickness required by EIFS manufacturer.

J. Installation Of Joint Sealants
1. Prepare joints and apply sealants, of type and at locations indicated, to comply with applicable requirements in Division 07 Section "Joint Sealants" and in ASTM C 1481.
   a. Apply joint sealants after base coat has cured but before applying finish coat.
   b. Clean surfaces to receive sealants to comply with indicated requirements and EIFS manufacturer's written instructions.
   c. Apply primer recommended in writing by sealant manufacturer for surfaces to be sealed.
   d. Install sealant backing to control depth and configuration of sealant joint and to prevent sealant from adhering to back of joint.
   e. Apply masking tape to protect areas adjacent to sealant joints. Remove tape immediately after tooling joints, without disturbing joint seal.
   f. Recess sealant sufficiently from surface of EIFS so an additional sealant application, including cylindrical sealant backing, can be installed without protruding beyond EIFS surface.

K. Field Quality Control
1. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
   a. According to ICC-ES AC24 **OR** ICC-ES AC235, **as directed**.
2. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
3. EIFS Tests and Inspections: For the following:
   a. According to ICC-ES AC24 **OR** ICC-ES AC235, **as directed**.
4. Remove and replace EIFS where test results indicate that EIFS do not comply with specified requirements.
5. Prepare test and inspection reports.

L. Cleaning And Protection
1. Remove temporary covering and protection of other work. Promptly remove coating materials from window and door frames and other surfaces outside areas indicated to receive EIFS coatings.

END OF SECTION 07240a

SECTION 07310 - ASPHALT SHINGLES

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for asphalt shingles. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Asphalt shingles.
b. Underlayment.

C. Definition
1. Roofing Terminology: See ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definitions of terms related to roofing work in this Section.

D. Submittals
1. Product Data: For each type of product indicated.
2. Samples: For each exposed product and for each color and blend specified.
3. Product test reports.
4. Research/evaluation reports.
5. Maintenance data.
6. Warranties: Sample of special warranties.

E. Quality Assurance
1. Fire-Resistance Characteristics: Where indicated, provide asphalt shingles and related roofing materials identical to those of assemblies tested for fire resistance per test method below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.
a. Exterior Fire-Test Exposure: Class A **OR** Class C, **as directed**; ASTM E 108 or UL 790, for application and roof slopes indicated.
2. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Store roofing materials in a dry, well-ventilated, weathertight location according to asphalt shingle manufacturer's written instructions. Store underlayment rolls on end on pallets or other raised surfaces. Do not double stack rolls.
a. Handle, store, and place roofing materials in a manner to avoid significant or permanent damage to roof deck or structural supporting members.
2. Protect unused underlayment from weather, sunlight, and moisture when left overnight or when roofing work is not in progress.

G. Warranty
1. Special Warranty: Standard form in which manufacturer agrees to repair or replace asphalt shingles that fail in materials or workmanship within specified warranty period.
a. Material Warranty Period: 25 **OR** 30 **OR** 35 **OR** 40, **as directed**, years from date of Substantial Completion, prorated, with first three **OR** five **OR** 12, **as directed**, years nonprorated.
b. Wind-Speed Warranty Period: Asphalt shingles will resist blow-off or damage caused by wind speeds up to 60 mph (27 m/s) **OR** 75 mph (33 m/s) **OR** 80 mph (36 m/s) **OR** 100 mph

(45 m/s), **as directed**, for five **OR** 10, **as directed**, years from date of Substantial Completion.

c. Algae-Discoloration Warranty Period: Asphalt shingles will not discolor five **OR** 10, **as directed**, years from date of Substantial Completion.

d. Workmanship Warranty Period: 10 **OR** 12, **as directed**, years from date of Substantial Completion.

1.2 PRODUCTS

A. Glass-Fiber-Reinforced Asphalt Shingles

1. Laminated-Strip Asphalt Shingles: ASTM D 3462, laminated, multi-ply overlay construction, glass-fiber reinforced, mineral-granule surfaced, and self-sealing.
   a. Butt Edge: Straight **OR** Notched **OR** Crenelated, **as directed**, cut.
   b. Strip Size: Manufacturer's standard.
   c. Algae Resistance: Granules treated to resist algae discoloration.
   d. Color and Blends: As selected by the Owner from manufacturer's full range.
2. Laminated-Strip, SBS-Modified Asphalt Shingles: ASTM D 3462, laminated, multi-ply overlay construction, glass-fiber reinforced, mineral-granule surfaced, and self-sealing; complying with UL 2218, Class IV.
   a. Butt Edge: Straight **OR** Notched **OR** Crenelated, **as directed**, cut.
   b. Strip Size: Manufacturer's standard.
   c. Algae Resistance: Granules treated to resist algae discoloration.
   d. Color and Blends: As selected by the Owner from manufacturer's full range.
3. Multitab-Strip Asphalt Shingles: ASTM D 3462, glass-fiber reinforced, mineral-granule surfaced, and self-sealing.
   a. Tab Arrangement: Three tabs, regularly spaced **OR** Four tabs, regularly spaced **OR** Five tabs, randomly spaced, **as directed**.
   b. Cutout Shape: Square **OR** Tapered, **as directed**.
   c. Butt Edge: Straight **OR** Stagger, **as directed**, cut.
   d. Strip Size: Manufacturer's standard.
   e. Algae Resistance: Granules treated to resist algae discoloration.
   f. Color and Blends: As selected by the Owner from manufacturer's full range.
4. Three-Tab-Strip, SBS-Modified Asphalt Shingles: ASTM D 3462, glass-fiber reinforced, mineral-granule surfaced, and self-sealing; complying with UL 2218, Class IV.
   a. Strip Size: Manufacturer's standard.
   b. Algae Resistance: Granules treated to resist algae discoloration.
   c. Color and Blends: As selected by the Owner from manufacturer's full range.
5. No-Cutout-Strip Asphalt Shingles: ASTM D 3462, glass-fiber reinforced, mineral-granule surfaced, self-sealing, square, and single tab.
   a. Butt Edge: Stagger **OR** Straight, **as directed**, cut.
   b. Strip Size: Manufacturer's standard.
   c. Algae Resistance: Granules treated to resist algae discoloration.
   d. Color and Blends: As selected by the Owner from manufacturer's full range.
6. Hip and Ridge Shingles: Manufacturer's standard units to match asphalt shingles **OR** Site-fabricated units cut from asphalt shingle strips. Trim each side of lapped portion of unit to taper approximately 1 inch (25 mm), **as directed**.

B. Organic-Felt-Reinforced Asphalt Shingles

1. Laminated-Strip Asphalt Shingles: ASTM D 225, laminated, multi-ply overlay construction, organic-felt reinforced, mineral-granule surfaced, and self-sealing; complying with requirements in ASTM D 3161 for wind resistance.
   a. Butt Edge: Straight **OR** Notched **OR** Crenelated, **as directed**, cut.
   b. Strip Size: Manufacturer's standard.
   c. Algae Resistance: Granules treated to resist algae discoloration.

d. Color and Blends: As selected by the Owner from manufacturer's full range.

2. Multitab-Strip Asphalt Shingles: ASTM D 225, organic-felt reinforced, mineral-granule surfaced, and self-sealing; complying with requirements in ASTM D 3161 for wind resistance.
   a. Tab Arrangement: Three tabs, regularly spaced **OR** Four tabs, regularly spaced **OR** Six tabs, regularly spaced, scalloped edge, **as directed**.
   b. Strip Size: Manufacturer's standard.
   c. Algae Resistance: Granules treated to resist algae discoloration.
   d. Color and Blends: As selected by the Owner from manufacturer's full range.
3. No-Cutout-Strip Asphalt Shingles: ASTM D 225, organic-felt reinforced, mineral-granule surfaced, self-sealing, square, and single tab; complying with requirements in ASTM D 3161 for wind resistance.
   a. Butt Edge: Stagger **OR** Straight, **as directed**, cut.
   b. Strip Size: Manufacturer's standard.
   c. Color and Blends: As selected by the Owner from manufacturer's full range.
4. Hip and Ridge Shingles: Manufacturer's standard units to match asphalt shingles **OR** Site-fabricated units cut from asphalt shingle strips. Trim each side of lapped portion of unit to taper approximately 1 inch (25 mm), **as directed**.

C. Underlayment Materials
1. Felt: ASTM D 226 **OR** ASTM D 4869, **as directed**, Type I **OR** Type II, **as directed**, asphalt-saturated organic felts, nonperforated.
2. Self-Adhering Sheet Underlayment, Granular Surfaced: ASTM D 1970, minimum of 55-mil- (1.4-mm-) thick sheet; glass-fiber-mat-reinforced, SBS-modified asphalt; mineral-granule surfaced; with release paper backing; cold applied. Provide primer for adjoining concrete or masonry surfaces to receive underlayment.
3. Self-Adhering Sheet Underlayment, Polyethylene Faced: ASTM D 1970, minimum of 40-mil- (1.0-mm-) thick, slip-resisting, polyethylene-film-reinforced top surface laminated to SBS-modified asphalt adhesive, with release paper backing; cold applied. Provide primer for adjoining concrete or masonry surfaces to receive underlayment.
4. Self-Adhering Sheet Underlayment, High Temperature: Minimum of 30- to 40-mil- (0.76- to 1.0-mm-) thick, slip-resisting, polyethylene-film-reinforced top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release paper backing; cold applied. Provide primer for adjoining concrete or masonry surfaces to receive underlayment.
   a. Thermal Stability: Stable after testing at 240 deg F (116 deg C); ASTM D 1970.
   b. Low-Temperature Flexibility: Passes after testing at minus 20 deg F (29 deg C); ASTM D 1970.
5. Granular-Surfaced Valley Lining: ASTM D 6380, Class M, organic-felt-based **OR** ASTM D 3909, mineral-granular-surfaced, glass-felt-based, **as directed**, asphalt roll roofing; 36 inches (914 mm) wide.

D. Ridge Vents
1. Rigid Ridge Vent: Manufacturer's standard, rigid section high-density polypropylene or other UV-stabilized plastic ridge vent with nonwoven geotextile filter strips and external deflector baffles; for use under ridge shingles.
2. Flexible Ridge Vent: Manufacturer's standard, compression-resisting, three-dimensional, open-nylon or polyester-mat filter bonded to a nonwoven, nonwicking, geotextile fabric cover.

E. Accessories
1. Asphalt Roofing Cement: ASTM D 4586, Type II, asbestos free.
2. Roofing Nails: ASTM F 1667; aluminum, stainless-steel, copper, or hot-dip galvanized-steel wire shingle nails, minimum 0.120-inch- (3-mm-) diameter, barbed **OR** smooth, **as directed**, shank, sharp-pointed, with a minimum 3/8-inch- (9.5-mm-) diameter flat head and of sufficient length to penetrate 3/4 inch (19 mm) into solid wood decking or extend at least 1/8 inch (3 mm) through OSB or plywood sheathing.
   a. Where nails are in contact with metal flashing, use nails made from same metal as flashing.

3. Felt Underlayment Nails: Aluminum, stainless-steel, or hot-dip galvanized-steel wire with low-profile capped heads or disc caps, 1-inch (25-mm) minimum diameter.

F. Metal Flashing And Trim
1. General: Comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim".
   a. Sheet Metal: Copper **OR** Stainless steel **OR** Zinc-tin alloy-coated stainless steel **OR** Zinc-tin alloy-coated steel **OR** Zinc-tin alloy-coated copper **OR** Anodized aluminum **OR** Aluminum, mill finished, **as directed**.
2. Fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of the item.
   a. Apron Flashings: Fabricate with lower flange a minimum of 4 inches (100 mm) **OR** 5 inches (125 mm), **as directed**, over and 4 inches (100 mm) beyond each side of downslope asphalt shingles and 6 inches (150 mm) up the vertical surface.
   b. Step Flashings: Fabricate with a headlap of 2 inches (50 mm) and a minimum extension of 4 inches (100 mm) **OR** 5 inches (125 mm), **as directed**, over the underlying asphalt shingle and up the vertical surface.
   c. Cricket **OR** Backer, **as directed**, Flashings: Fabricate with concealed flange extending a minimum of 18 inches (450 mm) **OR** 24 inches (600 mm), **as directed**, beneath upslope asphalt shingles and 6 inches (150 mm) beyond each side of chimney **OR** skylight, **as directed**, and 6 inches (150 mm) above the roof plane.
   d. Open-Valley Flashings: Fabricate in lengths not exceeding 10 feet (3 m) with 1-inch- (25-mm-) high, inverted-V profile at center of valley and equal flange widths of 10 inches (250 mm) **OR** 12 inches (300 mm), **as directed**.
   e. Drip Edges: Fabricate in lengths not exceeding 10 feet (3 m) with 2-inch (50-mm) roof-deck flange and 1-1/2-inch (38-mm) fascia flange with 3/8-inch (9.6-mm) drip at lower edge.
3. Vent Pipe Flashings: ASTM B 749, Type L51121, at least 1/16 inch (1.6 mm) thick. Provide lead sleeve sized to slip over and turn down into pipe, soldered to skirt at slope of roof, and extending at least 4 inches (100 mm) from pipe onto roof.

1.3 EXECUTION

A. Underlayment Installation
1. General: Comply with underlayment manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.
2. Single-Layer Felt Underlayment: Install on roof deck parallel with and starting at the eaves. Lap sides a minimum of 2 inches (50 mm) over underlying course. Lap ends a minimum of 4 inches (100 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm). Fasten with felt underlayment **OR** roofing, **as directed**, nails.
   a. Install felt underlayment on roof deck not covered by self-adhering sheet underlayment. Lap sides of felt over self-adhering sheet underlayment not less than 3 inches (75 mm) in direction to shed water. Lap ends of felt not less than 6 inches (150 mm) over self-adhering sheet underlayment.
   b. Install fasteners at no more than 36 inch (900 mm) o.c. where the basic wind speed is equal to or greater than 110 mph (176 km/h).
3. Double-Layer Felt Underlayment: Install on roof deck parallel with and starting at the eaves. Install a 19-inch- (485-mm-) wide starter course at eaves and completely cover with full-width second course. Install succeeding courses lapping previous courses 19 inches (485 mm) in shingle fashion. Lap ends a minimum of 6 inches (150 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm). Fasten with felt underlayment **OR** roofing, **as directed**, nails.

a. Apply a continuous layer of asphalt roofing cement over starter course and on felt underlayment surface to be concealed by succeeding courses as each felt course is installed. Apply over entire roof **OR** at locations indicated on Drawings, **as directed**.
b. Install felt underlayment on roof sheathing not covered by self-adhering sheet underlayment. Lap edges over self-adhering sheet underlayment not less than 3 inches (75 mm) in direction to shed water.
c. Terminate felt underlayment flush **OR** extended up not less than 4 inches (100 mm), **as directed**, against sidewalls, curbs, chimneys, and other roof projections.
d. Install fasteners at no more than 36 inch (900 mm) o.c. where the basic wind speed is equal to or greater than 110 mph (176 km/h).

4. Self-Adhering Sheet Underlayment: Install, wrinkle free, on roof deck. Comply with low-temperature installation restrictions of underlayment manufacturer if applicable. Install at locations indicated below **OR** on Drawings, **as directed**, lapped in direction to shed water. Lap sides not less than 3-1/2 inches (89 mm). Lap ends not less than 6 inches (150 mm) staggered 24 inches (600 mm) between courses. Roll laps with roller. Cover underlayment within seven days.
   a. Prime concrete and masonry surfaces to receive self-adhering sheet underlayment.
   b. Eaves: Extend from edges of eaves 24 inches (600 mm) **OR** 36 inches (914 mm), **as directed**, beyond interior face of exterior wall.
   c. Rakes: Extend from edges of rake 24 inches (600 mm) **OR** 36 inches (914 mm), **as directed**, beyond interior face of exterior wall.
   d. Valleys: Extend from lowest to highest point 18 inches (450 mm) on each side.
   e. Hips: Extend 18 inches (450 mm) on each side.
   f. Ridges: Extend 36 inches (914 mm) on each side without obstructing continuous ridge vent slot.
   g. Sidewalls: Extend beyond sidewall 18 inches (450 mm), and return vertically against sidewall not less than 4 inches (100 mm).
   h. Dormers, Chimneys, Skylights, and Other Roof-Penetrating Elements: Extend beyond penetrating element 18 inches (450 mm), and return vertically against penetrating element not less than 4 inches (100 mm).
   i. Roof Slope Transitions: Extend 18 inches (450 mm) on each roof slope.
5. Concealed, Woven **OR** Closed-Cut, **as directed**, Valley Lining: Comply with NRCA's recommendations. Install a 36-inch- (914-mm-) wide felt underlayment centered in valley. Fasten to roof deck with felt underlayment **OR** roofing, **as directed**, nails.
   a. Lap roof-deck felt underlayment over valley felt underlayment at least 6 inches (150 mm).
   b. Install a 36-inch- (914-mm-) wide strip of granular-surfaced valley lining centered in valley, with granular-surface face up. Lap ends of strips at least 12 inches (300 mm) in direction to shed water, and seal with asphalt roofing cement. Fasten to roof deck with roofing nails.
6. Metal-Flashed, Open-Valley Underlayment: Install two layers of 36-inch- (914-mm-) wide felt underlayment centered in valley. Stagger end laps between layers at least 72 inches (1830 mm). Lap ends of each layer at least 12 inches (300 mm) in direction to shed water, and seal with asphalt roofing cement. Fasten each layer to roof deck with felt underlayment **OR** roofing, **as directed**, nails.
   a. Lap roof-deck felt underlayment over first layer of valley felt underlayment at least 6 inches (150 mm).
7. Granular-Surfaced, Open-Valley Lining: Comply with NRCA's recommendations. Install a 36-inch- (914-mm-) wide felt underlayment centered in valley. Fasten to roof deck with felt underlayment **OR** roofing, **as directed**, nails.
   a. Lap roof-deck felt underlayment over valley felt underlayment at least 6 inches (150 mm).
   b. Install an 18-inch- (450-mm-) wide strip of valley lining centered in valley, with granular-surface face down. Install a second 36-inch- (914-mm-) wide strip of valley lining centered in valley, with granular-surface face up. Lap ends of each strip at least 12 inches (300 mm) in direction to shed water, and seal with asphalt roofing cement. Stagger end laps between succeeding strips at least 72 inches (1830 mm). Fasten each strip to roof deck with roofing nails.

B. Metal Flashing Installation
1. General: Install metal flashings and other sheet metal to comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim".
   a. Install metal flashings according to recommendations in ARMA's "Residential Asphalt Roofing Manual" and asphalt shingle recommendations in NRCA's "The NRCA Roofing and Waterproofing Manual."
2. Apron Flashings: Extend lower flange over and beyond each side of downslope asphalt shingles and up the vertical surface.
3. Step Flashings: Install with a headlap of 2 inches (50 mm) and extend over the underlying asphalt shingle and up the vertical surface. Fasten to roof deck only.
4. Cricket **OR** Backer, **as directed**, Flashings: Install against the roof-penetrating element extending concealed flange beneath upslope asphalt shingles and beyond each side.
5. Open-Valley Flashings: Install centered in valleys, lapping ends at least 8 inches (200 mm) in direction to shed water. Fasten upper end of each length to roof deck beneath overlap.
   a. Secure hemmed flange edges into metal cleats spaced 12 inches (300 mm) apart and fastened to roof deck.
   b. Adhere 9-inch- (225-mm-) wide strip of self-adhering sheet to metal flanges and to self-adhering sheet underlayment.
6. Rake Drip Edges: Install rake drip edge flashings over underlayment and fasten to roof deck.
7. Eave Drip Edges: Install eave drip edge flashings below underlayment and fasten to roof sheathing.
8. Pipe Flashings: Form flashing around pipe penetrations and asphalt shingles. Fasten and seal to asphalt shingles as recommended by manufacturer.

C. Asphalt Shingle Installation
1. General: Install asphalt shingles according to manufacturer's written instructions, recommendations in ARMA's "Residential Asphalt Roofing Manual," and asphalt shingle recommendations in NRCA's "The NRCA Roofing and Waterproofing Manual."
2. Install starter strip along lowest roof edge, consisting of an asphalt shingle strip with tabs removed **OR** at least 7 inches (175 mm) wide, **as directed**, with self-sealing strip face up at roof edge.
   a. Extend asphalt shingles 1/2 inch (13 mm) **OR** 3/4 inch (19 mm), **as directed**, over fasciae at eaves and rakes.
   b. Install starter strip along rake edge.
3. For Three-Tab- And Other Multitab-Strip Asphalt Shingles: Install first and remaining courses of asphalt shingles stair-stepping diagonally across roof deck with 4-inch (100-mm) **OR** 5-inch (125-mm) **OR** 6-inch (150-mm) **OR** 1/2-tab **OR** 1/3-tab **OR** manufacturer's recommended, **as directed**, offset pattern at succeeding courses, maintaining uniform exposure.
4. For Laminated-Strip And No-Cutout-Strip Asphalt Shingles: Install first and remaining courses of asphalt shingles stair-stepping diagonally across roof deck with manufacturer's recommended offset pattern at succeeding courses, maintaining uniform exposure.
5. Install asphalt shingles by single-strip column or racking method, maintaining uniform exposure. Install full-length first course followed by cut second course, repeating alternating pattern in succeeding courses.
6. Fasten asphalt shingle strips with a minimum of four **OR** five **OR** six, **as directed**, roofing nails located according to manufacturer's written instructions.
   a. Where roof slope exceeds 20:12, seal asphalt shingles with asphalt roofing cement spots after fastening with additional roofing nails.
   b. Where roof slope is less than 4:12, seal asphalt shingles with asphalt roofing cement spots.
   c. When ambient temperature during installation is below 50 deg F (10 deg C), seal asphalt shingles with asphalt roofing cement spots.
7. Woven Valleys: Extend succeeding asphalt shingle courses from both sides of valley 12 inches (300 mm) beyond center of valley, weaving intersecting shingle-strip courses over each other. Use one-piece shingle strips without joints in valley.

a. Do not nail asphalt shingles within 6 inches (150 mm) of valley center.

8. Closed-Cut Valleys: Extend asphalt shingle strips from one side of valley 12 inches (300 mm) beyond center of valley. Use one-piece shingle strips without joints in valley. Fasten with extra nail in upper end of shingle. Install asphalt shingle courses from other side of valley and cut back to a straight line 2 inches (50 mm) short of valley centerline. Trim upper concealed corners of cut-back shingle strips.
   a. Do not nail asphalt shingles within 6 inches (150 mm) of valley center.
   b. Set trimmed, concealed-corner asphalt shingles in a 3-inch- (75-mm-) wide bed of asphalt roofing cement.
9. Open Valleys: Cut and fit asphalt shingles at open valleys, trimming upper concealed corners of shingle strips. Maintain uniform width of exposed open valley **OR** Widen exposed portion of open valley 1/8 inch in 12 inches (1:96), **as directed**, from highest to lowest point.
   a. Set valley edge of asphalt shingles in a 3-inch- (75-mm-) wide bed of asphalt roofing cement.
   b. Do not nail asphalt shingles to metal open-valley flashings.
10. Ridge Vents: Install continuous ridge vents over asphalt shingles according to manufacturer's written instructions. Fasten with roofing nails of sufficient length to penetrate sheathing.
11. Ridge and Hip Cap Shingles: Maintain same exposure of cap shingles as roofing shingle exposure. Lap cap shingles at ridges to shed water away from direction of prevailing winds. Fasten with roofing nails of sufficient length to penetrate sheathing.
    a. Fasten ridge cap asphalt shingles to cover ridge vent without obstructing airflow.

END OF SECTION 07310

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SECTION 07310a - METAL SHINGLES

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for metal shingles. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Metal-shingle panels.
   b. Individual metal shingles.
   c. Underlayment.
   d. Ridge vents.
   e. Snow guards.

C. Definitions
1. Roofing Terminology: See ASTM D 1079 and glossary in NRCA's "The NRCA Roofing and Waterproofing Manual" for definitions of terms related to roofing work in this Section.

D. Performance Requirements
1. General Performance: Metal shingles shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
2. Wind-Uplift Resistance: Provide metal-shingle assemblies that comply with the following wind-uplift requirements.
   a. Class: 15 **OR** 30 **OR** 60 **OR** 90, **as directed**, when tested according to UL 580.
   b. Uplift Resistance: 75 lbf/sq. ft. (3.6 kPa) **OR** 120 lbf/sq. ft. (5.75 kPa) **OR** 165 lbf/sq. ft. (7.9 kPa), **as directed**, when tested according to UL 1897.
3. Impact Resistance: Class 3 **OR** Class 4, **as directed**, when tested according to UL 2218.
4. Energy Performance, Solar Reflectance (for LEED-NC Credit SS 7.2): Provide shingles with Solar Reflectance Index not less than 29 when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.
5. Energy Performance, ENERGY STAR: Provide roofing system that is listed on the DOE's "Roof Products Qualified Product List" for steep-slope roof products.
6. Recycled Content: Provide metal shingles with recycled content so that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 50 percent by weight.

E. Submittals
1. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.
2. LEED Submittals:
   a. Product Test Reports for Credit SS 7.2: For metal shingles, documentation indicating compliance with Solar Reflectance Index requirement.
   b. Product Data for Credit(s) MR 4.1 and MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.

3. Shop Drawings: For metal shingles. Show roof plans and wall elevations, **as directed**; sections at hips, gables, ridges, valleys, and eaves; details of metal shingles, flashing, trim, and accessories; and attachments to other work.
4. Samples: Full-size components of each type of metal shingle indicated, including visible accessories.
5. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency or performed by a qualified testing agency, for metal shingles, demonstrating compliance with requirements specified in "Performance Requirements" Article.
6. Warranty: Sample of special warranties.

F. Quality Assurance
1. Source Limitations: Obtain metal shingles from single source from single manufacturer.
2. Fire-Test Exposure Rating: Class A **OR** Class B **OR** Class C, **as directed**; for application and roof slopes indicated, as determined by testing identical products per test method UL 790 or ASTM E 108 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
3. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Do not store metal-shingle materials in contact with other materials that might cause staining, denting, or other surface damage. Store metal-shingle materials away from uncured concrete and masonry.
2. Protect strippable protective covering on metal shingles from exposure to sunlight and high humidity, except to the extent necessary for the period of metal-shingle installation.

H. Project Conditions
1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing to be performed according to manufacturer's written instructions and warranty requirements.
    a. Install self-adhering sheet underlayment within the range of ambient and substrate temperatures recommended by manufacturer.

I. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace metal shingles and accessories that fail in materials within specified warranty period.
    a. Failures include, but are not limited to, the following:
        1) Structural failures including wind uplift.
        2) Water penetration and hail perforation.
        3) Deterioration of metals, metal finishes, and other materials beyond normal weathering.
    b. Materials-Only Warranty Period: 15 **OR** 25 **OR** 50, **as directed**, years from date of Substantial Completion.
2. Special Project Warranty: Roofing Installer's Warranty, signed by roofing Installer, covering Work of this Section, in which Installer agrees to repair or replace components of roofing that fail in materials or workmanship within the following warranty period:
    a. Warranty Period: Two **OR** Five, **as directed**, years from date of Substantial Completion.
3. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal shingles that show evidence of deterioration of factory-applied finishes within specified warranty period.
    a. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
        1) Color fading more than 5 Hunter units when tested according to ASTM D 2244.
        2) Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
        3) Cracking, checking, peeling, or failure of paint to adhere to bare metal.
    b. Warranty Period: 10 **OR** 20, **as directed**, years from date of Substantial Completion.

1.2 PRODUCTS

A. Sheet Metal Materials
1. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer for finish required, with temper to suit forming operations and performance required.
a. Mill Finish: Uncoated aluminum sheet.
b. High-Performance Organic Coating (Coil-Coated Finishes): Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
1) Two-Coat Fluoropolymer: AAMA 620. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
2) Three-Coat Fluoropolymer: AAMA 620. System consisting of primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent PVDF resin by weight.
3) Concealed Surface: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat and with a minimum total dry film thickness of 0.5 mil (0.013 mm).
2. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 37 (Class AZM150 coating designation, Grade 255); structural quality.
a. Mill Finish: Satin-finish, aluminum-zinc alloy-coated steel sheet without additional coating.
b. Granular-Coating Finish: Entire upper surface of shingle, including flange edges, coated with ceramic-colored quartz granules or crushed stone chips bonded to shingle with a resin adhesive and sealed with a clear overglaze.
3. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality.
a. Mill Finish: Zinc-coated (galvanized) steel sheet without additional coating **OR** with manufacturer's standard mill-phosphatized finish, **as directed**.
b. High-Performance Organic Coating, (Coil-Coated Finishes): Prepainted by the coil-coating process to comply with ASTM A 755/A 755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
1) Two-Coat Fluoropolymer: AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
2) Three-Coat Fluoropolymer: AAMA 621. System consisting of primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent PVDF resin by weight.
4. Copper Sheet: ASTM B 370; Temper H00, cold rolled, unless Temper 060 is required for forming.
a. Mill Finish: Nonpatinated and exposed.
b. Pre-Patinated Finish: Dark brown **OR** Verdigris, **as directed**, pre-patinated according to ASTM B 882.
5. Zinc-Alloy Sheet: Alloy of 99.995 percent pure electrolytic high-grade zinc with alloy additives of copper (0.08 to 0.20 percent), titanium (0.07 to 0.12 percent), and aluminum (0.015 percent) **OR** Zinc alloy consisting of 99 percent pure zinc with 0.08 to 1.00 percent copper, 0.06 to 0.20 percent titanium, and up to 0.015 percent aluminum, **as directed**; with manufacturer's standard factory-applied, flexible, protective back coating.
a. Bright-Rolled Finish: Uncoated, bright-rolled zinc-alloy sheet.
b. Preweathered Finish: Factory-applied preweathering to uniform color.

B. Metal Shingles
1. Aluminum Shingles: Factory-formed, interlocking shingle panels **OR** individual shingles, **as directed**.
a. Shingle Panels: Stamped panels resembling multiple shakes **OR** shingles **OR** Spanish tiles **OR** flat tiles **OR** scalloped tiles, **as directed**.

1) Material: Formed aluminum, 0.020 inch (0.51 mm) thick **OR** 0.032 inch (0.81 mm) thick **OR** thickness as needed to meet performance requirements, **as directed**.
2) Reinforcement: Manufacturer's standard insert material in units to increase rigidity.
3) Exposure: 48 by 12 inches (1219 by 305 mm).
4) Finish: Mill **OR** High-performance organic coating.
5) Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

b. Individual Shingles: Rectangular **OR** Diamond, **as directed**, shingle units.
1) Material: Formed aluminum, 0.020 inch (0.51 mm) thick **OR** 0.032 inch (0.81 mm) thick **OR** thickness as needed to meet performance requirements, **as directed**.
2) Reinforcement: Manufacturer's standard insert material in units to increase rigidity.
3) Exposure: 14 by 14 inches (356 by 356 mm).
4) Finish: Mill **OR** High-performance organic coating, **as directed**.
5) Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

2. Steel Shingles: Factory-formed, interlocking shingle panels **OR** individual shingles, **as directed**.
a. Shingle Panels: Stamped panels resembling multiple shakes **OR** shingles **OR** Spanish tiles **OR** flat tiles **OR** scalloped tiles, **as directed**.
1) Material: Aluminum-zinc alloy-coated **OR** Zinc-coated (galvanized), **as directed**, steel sheet, nominal 0.022 inch (0.56 mm) thick **OR** 0.028 inch (0.71 mm) thick **OR** thickness as needed to meet performance requirements, **as directed**.
2) Exposure: 47-1/4 by 15-13/16 inches (1200 by 402 mm).
3) Finish: Mill **OR** Granular coating **OR** High-performance organic coating, **as directed**.
4) Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

b. Individual Shingles: Rectangular shingle units.
1) Material: Aluminum-zinc alloy coated **OR** Zinc-coated (galvanized), **as directed**, steel sheet, nominal 0.022 inch (0.56 mm) thick **OR** 0.028 inch (0.71 mm) thick **OR** thickness as needed to meet performance requirements, **as directed**.
2) Exposure: 9 by 12 inches (229 by 305 mm).
3) Finish: Mill **OR** Granular coating **OR** High-performance organic coating, **as directed**.
4) Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

3. Copper Shingles: Factory-formed, interlocking shingle panels **OR** individual shingles, **as directed**.
a. Shingle Panels: Stamped panels resembling multiple shakes **OR** shingles, **as directed**.
1) Material: Copper sheet, 12 oz./sq. ft. (0.41 mm thick) **OR** 16 oz./sq. ft. (0.55 mm thick) **OR** weight (thickness) as needed to meet performance requirements, **as directed**.
2) Exposure: 33-1/4 by 10 inches (845 by 254 mm).
3) Finish: Mill **OR** Pre-patinated dark brown **OR** Pre-patinated verdigris, **as directed**.

b. Individual Shingles: Rectangular **OR** Diamond, **as directed**, shingle units.
1) Material: Copper sheet, 12 oz./sq. ft. (0.41 mm thick) **OR** 16 oz./sq. ft. (0.55 mm-thick) **OR** weight (thickness) as needed to meet performance requirements, **as directed**.
2) Exposure: 9-1/2 by 7-1/4 inches (241 by 184 mm).
3) Finish: Mill **OR** Pre-patinated dark brown **OR** Pre-patinated verdigris, **as directed**.

4. Zinc Shingles: Factory-formed, interlocking shingle panels **OR** individual shingles, **as directed**.
a. Shingle Panels: Stamped panels resembling multiple shakes **OR** shingles, **as directed**.
1) Material: Zinc-alloy sheet, 0.027 inch (0.70 mm) thick **OR** thickness as needed to meet performance requirements, **as directed**.
2) Exposure: 47-1/4 by 15-13/16 inches (1200 by 402 mm), **as directed**.
3) Finish: Bright rolled **OR** Preweathered gray **OR** Preweathered black, **as directed**.

b. Individual Shingles: Rectangular **OR** Diamond, **as directed**, shingle units.
   1) Material: Zinc-alloy sheet, 0.027 inch (0.70 mm) thick **OR** thickness as needed to meet performance requirements, **as directed**.
   2) Exposure: 14 by 14 inches (356 by 356 mm).
   3) Finish: Bright rolled **OR** Preweathered gray **OR** Preweathered black, **as directed**.

C. Underlayment
1. Felt Underlayment: ASTM D 226 or ASTM D 4869, Type I **OR** Type II, **as directed**, asphalt-saturated organic felt, nonperforated.
2. Self-Adhering Sheet Underlayment, Polyethylene Faced: ASTM D 1970, a minimum of 40-mil-(1.0-mm-) thick, slip-resisting, polyethylene-film-reinforced top surface laminated to SBS-modified asphalt adhesive, with release paper backing; cold applied. Provide primer for adjoining concrete or masonry surfaces to receive underlayment.
3. Self-Adhering Sheet Underlayment, High Temperature: A minimum of 30- to 40-mil- (0.76- to 1.0-mm-) thick, slip-resisting, polyethylene-film-reinforced top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release paper backing; cold applied. Provide primer for adjoining concrete or masonry surfaces to receive underlayment and when recommended by underlayment manufacturer.
   a. Thermal Stability: Stable after testing at 240 deg F (116 deg C); ASTM D 1970.
   b. Low-Temperature Flexibility: Passes after testing at minus 20 deg F (29 deg C); ASTM D 1970.
4. Slip Sheet: Building paper, 3-lb/100 sq. ft. (0.16-kg/sq. m) minimum, rosin sized.

D. Accessories
1. General: Provide materials and types of fasteners, protective coatings, separators, sealants, and other accessory items as required for a complete roofing system and as recommended by metal-shingle manufacturer unless otherwise indicated.
2. Sheet Metal Flashing and Trim: Metal-shingle manufacturer's flashing and trim components matching shingle material, color, and finish unless otherwise indicated or recommended in writing by metal-shingle manufacturer. Fabricate to sizes and configurations shown or required. Unless otherwise indicated, fabricate sheet metal flashing and trim to comply with recommendations that apply to design, dimensions, metal, and other characteristics of the item in SMACNA's "Architectural Sheet Metal Manual."
3. Ridge Vents: Metal-shingle manufacturer's continuous vented ridge caps matching material and finish of metal shingles with insect screen or insect-resisting geotextile filter strips and with external deflector baffles; for use with specified metal shingles.
   a. Minimum Net Free Area: As required to satisfy Project requirements.
   b. Accessories: Splices, end caps, and other accessories matching metal and finish.
4. Snow Guards: Stop-type **OR** Bar-type, **as directed**, prefabricated aluminum **OR** copper **OR** cast-bronze **OR** zinc **OR** stainless-steel, **as directed**, units, designed to be installed without penetrating metal shingles.
   a. Attachment: Designed to be attached to surface of metal shingles using construction adhesive, silicone or polyurethane sealant, or adhesive tape **OR** mechanically anchored through predrilled holes concealed by the metal shingles, **as directed**.
   b. Finish: Matching the metal shingles.
5. Wood Battens: Pressure-preservative-treated wood complying with requirements in Division 6 Section "Rough Carpentry" **OR** "Miscellaneous Carpentry", **as directed**.
   a. Contoured Rigid Foam: Manufacturers standard rigid foam formed to match underside contour of metal shingles.
6. Metal Battens: Hat channels formed from zinc-coated (galvanized) steel sheet; ASTM A 653/A 653M, G90 (Z275) coating designation, not less than 0.025-inch (0.64-mm) nominal thickness, and complying with requirements in Division 5 Section Cold-Formed Metal Framing."
7. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.
8. Asphalt Roofing Cement: ASTM D 4586, Type II, asbestos free.

9. Sealant: ASTM C 920, one-part elastomeric polymer joint sealant as recommended by metal-shingle manufacturer for installation indicated; of type, grade, class, and use classifications required to seal joints in metal shingles and remain watertight. Where sealant will be exposed, provide in color matching shingle.
10. Sheet Metal Fasteners: Noncorrosive screws, nails, and anchors designed to withstand design loads as recommended in writing by metal-shingle manufacturer.
    a. Exposed Fasteners: Heads matching color of metal shingles using plastic caps or factory-applied coating. Provide metal-backed neoprene or EPDM washers under heads of exposed fasteners bearing on weather side of shingles.
    b. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
    c. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
    d. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
    e. Fasteners for Aluminum-Zinc Alloy-Coated **OR** Zinc-Coated, **as directed**, Steel Sheet: Hot-dip galvanized steel according to ASTM A 153/A 153M, ASTM F 2329, or Series 300 stainless steel.
    f. Fasteners for Copper Sheet: Copper, hardware bronze, or Series 300 stainless steel.
    g. Fasteners for Zinc Sheet: Hot-dip galvanized steel according to ASTM A 153/A 153M, ASTM F 2329, or Series 300 stainless steel.
11. Felt Underlayment Nails: Aluminum, stainless-steel, or hot-dip galvanized-steel wire with low-profile capped heads or disc caps, 1-inch (25-mm) minimum diameter.
    a. Where nails are in contact with metal shingles or flashing, use nails made from same metal as metal shingles.
12. Wood Batten Nails: ASTM F 1667; common or box, steel wire, flat head, and smooth shank; hot-dip galvanized.

E. General Finish Requirements
1. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
2. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

1.3 EXECUTION

A. Examination
1. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
    a. Examine roof sheathing to verify that sheathing joints are supported by framing and blocking, that tops of fasteners are flush with surface, and that installation is within flatness tolerances.
    b. Verify that substrate is sound, dry to the maximum moisture content recommended by metal-shingle manufacturer, smooth, clean, sloped for drainage, and completely anchored and that provision has been made for flashings and penetrations through metal shingles.
    c. Verify that vent stacks and other penetrations through metal shingles have been installed and are securely fastened.
2. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Underlayment Installation

1. General: Comply with metal-shingle and underlayment manufacturers' written installation instructions applicable to products and applications indicated unless more stringent requirements apply.
2. Single-Layer Felt Underlayment: Install on roof deck parallel with and starting at the eaves. Lap sides a minimum of 2 inches (50 mm) over underlying course. Lap ends a minimum of 4 inches (100 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm). Fasten with felt underlayment nails.
    a. Install felt underlayment on roof deck not covered by self-adhering sheet underlayment. Lap sides of felt over self-adhering sheet underlayment not less than 3 inches (75 mm) in direction to shed water. Lap ends of felt not less than 6 inches (152 mm) over self-adhering sheet underlayment.
3. Double-Layer Felt Underlayment: Install on roof deck parallel with and starting at the eaves. Install a 19-inch- (485-mm-) wide starter course at eaves and completely cover with full-width second course. Install succeeding courses lapping previous courses 19 inches (485 mm) in shingle fashion. Lap ends a minimum of 6 inches (152 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm). Fasten with felt underlayment nails.
    a. Apply a continuous layer of asphalt roofing cement over starter course and on felt underlayment surface to be concealed by succeeding courses as each felt course is installed. Apply over entire roof **OR** at locations indicated on Drawings, **as directed**.
    b. Install felt underlayment on roof sheathing not covered by self-adhering sheet underlayment. Lap edges over self-adhering sheet underlayment not less than 3 inches (75 mm) in direction to shed water.
    c. Terminate felt underlayment flush **OR** extended up not less than 4 inches (100 mm), **as directed**, against sidewalls, curbs, chimneys, and other roof projections.
4. Self-Adhering Sheet Underlayment: Install wrinkle free; comply with low-temperature installation restrictions of underlayment manufacturer if applicable. Install at locations indicated below **OR** on Drawings, **as directed**, lapped in direction to shed water. Lap sides not less than 3-1/2 inches (89 mm). Lap ends not less than 6 inches (152 mm), staggered 24 inches (610 mm) between courses. Roll laps with roller. Cover underlayment within seven days.
    a. Prime concrete and masonry surfaces to receive self-adhering sheet underlayment.
    b. Eaves: Extend from edges of eaves 24 inches (610 mm) **OR** 36 inches (914 mm), **as directed**, beyond interior face of exterior wall.
    c. Rakes: Extend from edges of rakes 24 inches (610 mm) **OR** 36 inches (914 mm), **as directed**, beyond interior face of exterior wall.
    d. Valleys: Extend from lowest to highest point 18 inches (455 mm) on each side.
    e. Hips: Extend 18 inches (455 mm) on each side.
    f. Ridges: Extend 36 inches (914 mm) on each side without obstructing continuous ridge vent slot.
    g. Sidewalls: Extend 18 inches (455 mm) beyond sidewalls and return vertically against sidewalls not less than 4 inches (100 mm).
    h. Dormers, Chimneys, Skylights, and Other Roof-Penetrating Elements: Extend 18 inches (455 mm) beyond penetrating elements and return vertically against penetrating elements not less than 4 inches (100 mm).
    i. Roof-Slope Transitions: Extend 18 inches (455 mm) on each roof slope.
5. Metal-Flashed, Open-Valley Underlayment: Install one layer of 36-inch- (914-mm-) wide felt underlayment or self-adhering sheet underlayment centered in valley and running the full length of valley in addition to the underlayment required for metal shingles. Stagger end laps between layers and lap ends of each layer at least 12 inches (305 mm) in direction to shed water.
    a. Solidly cement valley felt underlayment with asphalt roofing cement to the underlayment required for metal shingles.
6. Apply slip sheet with adhesive or tape before installing metal flashing and shingles.

C. Metal-Shingle Installation
1. General: Install metal shingles according to manufacturer's written instructions applicable to products and applications indicated; install level, plumb, and true to line.

2. Felt Interlayment: Install 18-inch- (455-mm-) wide strip of felt underlayment over top portion of first and each succeeding course. Stagger fasten to roof deck with felt underlayment nails.
3. Maintain uniform exposure and coursing of metal shingles throughout roof.
4. Apply sealant between shingles, flashing, trim, and exposed fasteners to achieve a weathertight system.
5. Interlock and overlap shingles and stagger end joints from **OR** align joints of tile-form, **as directed**, shingle courses above and below.
6. Metal Protection: Where dissimilar metals will contact each other, protect against galvanic action by painting contact surfaces with bituminous coating, by applying self-adhering sheet underlayment to each contact surface, or by other permanent separation as recommended by manufacturer of metal shingles or of the metals in contact.
   a. Do not use graphite pencils to mark metal surfaces.

D. Accessory Installation
1. General: Install accessories according to manufacturers' written instructions unless more stringent requirements are indicated.
2. Metal Flashings and Trim: Install metal flashings and trim according to recommendations in NRCA's "The NRCA Roofing and Waterproofing Manual" unless more stringent requirements are indicated.
3. Ridge Vents: Install ridge vents with end closures at locations indicated.
4. Stop-Type Snow Guards: Install rows of snow guards at locations indicated. Space rows apart horizontally, beginning from gutter. Space snow guards apart in each row, offsetting by half this dimension between succeeding rows.
5. Bar-Type Snow Guards: Install rows of snow guards at locations indicated. Space rows apart horizontally, beginning from gutter.
6. Battens: Install battens according to metal-shingle manufacturer's written instructions and as needed to meet performance requirements.
   a. Wood Battens: Install nominal 2-by-2-inch (38-by-38-mm) wood battens horizontally over installed underlayment with ends separated by 1/2 inch (13 mm), at spacing required by metal-shingle manufacturer, and securely fasten to roof deck with wood batten nails.
   b. Metal Battens: Install 1-1/2-inch (38-mm) metal battens horizontally over installed underlayment with ends separated by 1/2 inch (13 mm), at spacing required by metal-shingle manufacturer, and securely fasten to roof deck with sheet metal fasteners.
   c. Intermediate Battens: Install nominal 1-inch- (19-mm-) thick wood battens with double strip of contoured rigid foam horizontally with ends separated by 1/2 inch (13 mm), at spacing required by metal-shingle manufacturer to uniformly support underside of metal shingles between main battens, and securely fasten to roof deck with wood batten nails.
7. Metal Protection: Where dissimilar metals will contact each other, protect against galvanic action by painting contact surfaces with bituminous coating, by applying self-adhering sheet underlayment to each contact surface, or by other permanent separation as recommended by manufacturer of metal shingles or of the metals in contact.

E. Erection Tolerances
1. Installation Tolerances: Shim and align metal shingles within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.
   OR
   Installation Tolerances: Shim and align metal shingles within installed tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

F. Adjusting And Cleaning
1. Remove and replace damaged or deformed metal shingles or metal shingles that do not comply with specified requirements. Replace shingles with damaged or deteriorated finishes and other components of the Work that cannot be successfully repaired by finish touchup or similar minor repair procedures.

2. Remove temporary protective coverings and strippable films as metal shingles are installed unless otherwise indicated in manufacturer's written installation instructions.
3. On completion of installation, clean exposed surfaces of metal shingles according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Remove excess sealants. Maintain metal shingles in a clean condition during construction.
4. Remove excess metal shingles and debris from Project site.

END OF SECTION 07310a

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SECTION 07310b - SLATE SHINGLES

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for slate shingles. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Slate shingles.
b. Underlayment.
c. Snow guards.

C. Definitions
1. Roofing Terminology: See ASTM D 1079 and glossary in NRCA's "The NRCA Roofing and Waterproofing Manual" for definitions of terms related to roofing work in this Section.

D. Submittals
1. Product Data: For each type of product indicated.
2. Samples
a. Slate Shingle: Full size, of each color, size, texture, and shape.
b. Ridge Cap **OR** Vent, **as directed**: 12-inch- (305-mm-) long Sample.
c. Fasteners: Three fasteners of each type, length, and finish.
d. Exposed Valley Lining: 12 inches (305 mm) square.
e. Snow Guard: Full-size unit **OR** Base, bracket, and 12-inch- (300-mm-) long rail, **as directed**.
3. Warranty: Sample of special warranty.

E. Quality Assurance
1. Source Limitations: Obtain each color of slate shingle from single quarry capable of producing slate of consistent quality in appearance and physical properties.
2. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Store underlayment rolls on end, on pallets or other raised surfaces. Do not double stack rolls.
a. Handle, store, and place roofing materials in a manner to avoid significant or permanent damage to roof deck or structural supporting members.
2. Protect unused underlayment from weather, sunlight, and moisture when left overnight or when roofing work is not in progress.

G. Warranty
1. Special Warranty: Standard form in which roofing Installer agrees to repair or replace slate roofing that fails in materials or workmanship within two **OR** five, **as directed**, years from date of Substantial Completion.

1.2 PRODUCTS

A. Slate Shingles
1. Slate Shingles: ASTM C 406, Grade S1 **OR** Grade S2, **as directed**; hard, dense, and sound; chamfered edges, with nail holes machine punched or drilled and countersunk. No broken or

cracked slates, no broken exposed corners, and no broken corners on covered ends that could sacrifice nailing strength or laying of a watertight roof.

a. Thickness: Nominal 3/16 inch (5 mm) **OR** 3/16 to 1/4 inch (5 to 6 mm) **OR** 1/4 to 3/8 inch (6 to 10 mm) **OR** 3/8 to 1/2 inch (10 to 13 mm), **as directed**.
b. Surface Texture: Smooth **OR** Rough, **as directed**.
c. Size: 24 inches (610 mm) long by 14 inches (355 mm) **OR** 12 inches (305 mm) **OR** random widths, but not less than one-half-length, **as directed**, wide.
d. Size: 22 inches (560 mm) long by 14 inches (355 mm) **OR** 12 inches (305 mm) **OR** 11 inches (280 mm) **OR** random widths, but not less than one-half-length, **as directed**, wide.
e. Size: 20 inches (510 mm) long by 14 inches (355 mm) **OR** 12 inches (305 mm) **OR** 11 inches (280 mm) **OR** 10 inches (255 mm) **OR** random widths, but not less than one-half-length, **as directed**, wide.
f. Size: 18 inches (455 mm) long by 14 inches (355 mm) **OR** 12 inches (305 mm) **OR** 11 inches (280 mm) **OR** 10 inches (255 mm) **OR** 9 inches (230 mm) **OR** random widths, but not less than one-half-length, **as directed**, wide.
g. Size: 16 inches (405 mm) long by 14 inches (355 mm) **OR** 12 inches (305 mm) **OR** 11 inches (280 mm) **OR** 10 inches (255 mm) **OR** 9 inches (230 mm) **OR** 8 inches (205 mm) **OR** random widths, but not less than one-half-length, **as directed**, wide.
h. Size: 14 inches (355 mm) long by 12 inches (305 mm) **OR** 11 inches (280 mm) **OR** 10 inches (255 mm) **OR** 9 inches (230 mm) **OR** 8 inches (205 mm) **OR** 7 inches (180 mm) **OR** random widths, but not less than one-half-length, **as directed** wide.
i. Size: 12 inches (305 mm) long by 12 inches (305 mm) **OR** 10 inches (255 mm) **OR** 9 inches (230 mm) **OR** 8 inches (205 mm) **OR** 7 inches (180 mm) **OR** 6 inches (152 mm) **OR** random widths, but not less than one-half-length, **as directed**, wide.
j. Size: 10 inches (255 mm) by 10 inches (255 mm) **OR** 9 inches (230 mm) **OR** 8 inches (205 mm) **OR** 7 inches (180 mm) **OR** 6 inches (152 mm) **OR** random widths, but not less than one-half-length, **as directed**, wide.
k. Nail Holes: Two **OR** Four, **as directed**, per shingle.
l. Butt Shape: Standard square cut.
m. Cut Butt Shape: Standard square cut and pointed **OR** deep bevel **OR** shallow bevel **OR** deep scallop **OR** shallow scallop **OR** round, **as directed**.
n. Color: Black **OR** Gray **OR** Purple **OR** Green **OR** Blue black **OR** Blue gray **OR** Mottled purple and green **OR** Red **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
o. Weather-Exposure Color Change: Unfading **OR** Weathering, **as directed**.

2. Starter Slate: Slate shingles with chamfered nail holes front-side punched.
   a. Length: Exposure of slate shingle plus head lap.
3. Ridge Slate: Slate shingles fabricated with vertical **OR** horizontal, **as directed**, grain orientation.

B. Underlayment Materials

1. Felt Underlayment: ASTM D 226, Type I **OR** Type II, **as directed**, asphalt-saturated organic felt, unperforated.
2. Felt Underlayment: ASTM D 2626, asphalt-saturated and -coated organic felt, mineral surfaced, unperforated.
3. Self-Adhering Sheet Underlayment, Granular Surfaced: ASTM D 1970, minimum of 55-mil- (1.4-mm-) thick sheet; glass-fiber-mat-reinforced, SBS-modified asphalt; mineral-granule surfaced; with release paper backing; cold applied. Provide primer for adjoining concrete or masonry surfaces to receive underlayment, **as directed**.
4. Self-Adhering Sheet Underlayment, Polyethylene Faced: ASTM D 1970, minimum of 40-mil- (1.0-mm-) thick, slip-resisting, polyethylene-film-reinforced top surface laminated to SBS-modified asphalt adhesive, with release paper backing; cold applied. Provide primer for adjoining concrete or masonry surfaces to receive underlayment, **as directed**.
5. Self-Adhering Sheet Underlayment, High Temperature: Minimum of 30- to 40-mil- (0.76- to 1.0-mm-) thick, slip-resisting, polyethylene-film-reinforced top surface laminated to layer of butyl or

SBS-modified asphalt adhesive, with release paper backing; cold applied. Provide primer for adjoining concrete or masonry surfaces to receive underlayment, **as directed**.

a. Thermal Stability: Stable after testing at 240 deg F (116 deg C); ASTM D 1970.
b. Low-Temperature Flexibility: Passes after testing at minus 20 deg F (29 deg C); ASTM D 1970.

C. Snow Guards
1. Snow-Guard Pads: Fabricated copper **OR** cast-bronze **OR** zinc **OR** stainless-steel **OR** aluminum, **as directed**, units, designed to be installed without penetrating slate shingles, and complete with predrilled holes or hooks for anchoring.
2. Snow-Guard Rails: Units fabricated from metal baseplate anchored to adjustable **OR** fixed, **as directed**, bracket and equipped with two **OR** three, **as directed**, bars.
   a. Brackets and Baseplate: Aluminum **OR** Bronze or brass **OR** Stainless steel, **as directed**.
   b. Bars: Aluminum, mill finished **OR** Aluminum, clear anodized **OR** Stainless steel, mill finished, **as directed**.

D. Accessories
1. Asphalt Roofing Cement: ASTM D 4586, Type II, asbestos free.
2. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied.
3. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane **OR** polysulfide **OR** silicone, **as directed**, polymer sealant; of type, grade, class, and use classifications required to seal joints in slate-shingle roofing and remain watertight.
4. Slating Nails: ASTM F 1667, copper, **OR** aluminum-alloy, **OR** stainless-steel, **OR** cut-brass, **as directed**, smooth shanked, wire nails; 0.135-inch (3.4-mm) minimum thickness; sharp pointed; with 3/8-inch- (10-mm-) minimum diameter flat head; of sufficient length to penetrate a minimum of 3/4 inch (19 mm) into sheathing.
   a. Where nails are in contact with metal flashing, use nails made from same metal as flashing.
5. Felt Underlayment Nails: Aluminum, stainless-steel, or hot-dip galvanized-steel wire nails with low-profile capped heads or disc caps, 1-inch (25-mm) minimum diameter.
6. Wood Nailer Strips and Eave Cants: Comply with requirements in Division 06 Section(s) "Rough Carpentry" OR "Miscellaneous Carpentry", **as directed**.
7. Ridge Cap **OR** Vent, **as directed**: Custom-fabricated metal covers with noncorrosive components complete with internal anchoring lag screws, compression plates, and snap-on caps and slate retention channels, **as directed**.
   a. Type: Cap, nonventilating **OR** Vent, with ventilating mesh providing net-free area of 18 sq. in./ft. (380 sq. cm/m) **OR** Vent, with ventilating mesh providing net-free area of 18 sq. in./ft. (380 sq. cm/m) and external baffles, **as directed**.
   b. Metal Components: Copper, 20-oz./sq. ft.- (0.7-mm-) thick sheet **OR** Aluminum, 0.050-inch- (1.3-mm-) thick sheet, with manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin on exposed surfaces, **as directed**.
   c. Accessories: Splices, end caps, and other accessories of matching metal and finish.
8. Track- and Clip-Attachment System: Custom-fabricated slate-shingle attachment system designed for use with notched-slate shingles consisting of extruded-aluminum, **OR** formed stainless-steel, **as directed**, perforated Z-track, screws, and spring clips for anchoring slate to roof deck.

E. Metal Flashing And Trim
1. General: Comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim".
   a. Sheet Metal: Copper **OR** Stainless steel **OR** Zinc-tin alloy-coated stainless steel **OR** Zinc-tin alloy-coated steel **OR** Zinc-tin alloy-coated copper **OR** Anodized aluminum **OR** Aluminum, mill finished, **as directed**.

2. Fabricate sheet metal flashing and trim to comply with recommendations that apply to design, dimensions, metal, and other characteristics of the item in SMACNA's "Architectural Sheet Metal Manual."
   a. Apron Flashings: Fabricate with lower flange extending a minimum of 4 inches (100 mm) **OR** 6 inches (152 mm), **as directed**, over and 4 inches (100 mm) beyond each side of downslope slate shingles and 6 inches (152 mm) up the vertical surface.
   b. Step Flashings: Fabricate with a head lap of 3 inches (75 mm) and a minimum extension of 4 inches (100 mm) **OR** 5 inches (127 mm), **as directed**, both horizontally and vertically.
   c. Cricket **OR** Backer, **as directed**, Flashings: Fabricate with concealed flange extending a minimum of 18 inches (455 mm) **OR** 24 inches (610 mm), **as directed**, beneath upslope slate shingles and 6 inches (152 mm) beyond each side of chimney **OR** skylight, **as directed**, and 6 inches (152 mm) above the roof plane.
   d. Hip Flashings: Fabricate to length of slate shingle and to extend 3 inches (75 mm), **as directed**, beyond joint of hip shingle with adjoining roof shingle.
   e. Open-Valley Flashings: Fabricate in lengths not exceeding 10 feet (3 m) with 1-inch- (25-mm-) high, inverted-V profile at center of valley and equal flange widths of 10 inches (255 mm) **OR** 12 inches (305 mm), **as directed**.
   f. Closed-Valley Flashings: Fabricate in lengths not exceeding 10 feet (3 m) and equal flange widths of 10 inches (255 mm) **OR** 12 inches (305 mm), **as directed**.
   g. Drip Edges: Fabricate in lengths not exceeding 10 feet (3 m) with 2-inch (50-mm) roof-deck flange and 1-1/2-inch (38-mm) fascia flange with 3/8-inch (10-mm) drip at lower edge.
3. Vent-Pipe Flashings: ASTM B 749, Type L51121, at least 1/16 inch (1.6 mm) thick. Provide lead sleeve sized to slip over and turn down into pipe, soldered to skirt at slope of roof and extending at least 4 inches (100 mm) from pipe onto roof.

1.3 EXECUTION

A. Underlayment Installation
   1. General: Comply with underlayment manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.
   2. Single-Layer Felt Underlayment: Install on roof deck parallel with and starting at the eaves. Lap sides a minimum of 2 inches (50 mm) over underlying course. Lap ends a minimum of 4 inches (100 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm). Fasten with felt underlayment nails.
      a. Install felt underlayment on roof deck not covered by self-adhering sheet underlayment. Lap sides of felt over self-adhering sheet underlayment not less than 3 inches (75 mm) in direction to shed water. Lap ends of felt not less than 6 inches (152 mm) over self-adhering sheet underlayment.
   3. Double-Layer Felt Underlayment: Install on roof deck parallel with and starting at the eaves. Install a 19-inch- (485-mm-) wide starter course at eaves and completely cover with full-width second course. Install succeeding courses lapping previous courses 19 inches (485 mm) in shingle fashion. Lap ends a minimum of 6 inches (152 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm). Fasten with felt underlayment nails.
      a. Apply a continuous layer of asphalt roofing cement over starter course and on felt underlayment surface to be concealed by succeeding courses as each felt course is installed. Apply over entire roof **OR** at locations indicated on Drawings, **as directed**.
      b. Install felt underlayment on roof sheathing not covered by self-adhering sheet underlayment. Lap edges over self-adhering sheet underlayment not less than 3 inches (75 mm) in direction to shed water.
      c. Terminate felt underlayment flush **OR** extended up not less than 4 inches (100 mm), **as directed**, against sidewalls, curbs, chimneys, and other roof projections.
   4. Self-Adhering Sheet Underlayment: Install, wrinkle free, on roof deck. Comply with low-temperature installation restrictions of underlayment manufacturer if applicable. Install at locations indicated below **OR** on Drawings, **as directed**, lapped in direction to shed water. Lap

sides not less than 3-1/2 inches (89 mm). Lap ends not less than 6 inches (152 mm), staggered 24 inches (600 mm) between courses. Roll laps with roller. Cover underlayment within seven days.

a. Prime concrete and masonry surfaces to receive self-adhering sheet underlayment.
b. Eaves: Extend from edges of eaves 24 inches (610 mm) **OR** 36 inches (914 mm), **as directed**, beyond interior face of exterior wall.
c. Rakes: Extend from edges of rakes 24 inches (610 mm) **OR** 36 inches (914 mm), **as directed**, beyond interior face of exterior wall.
d. Valleys: Extend from lowest to highest point 18 inches (455 mm) on each side.
e. Hips: Extend 18 inches (455 mm) on each side.
f. Ridges: Extend 36 inches (914 mm) on each side without obstructing continuous ridge vent slot, **as directed**.
g. Sidewalls: Extend 18 inches (455 mm) beyond sidewalls and return vertically against sidewalls not less than 4 inches (100 mm).
h. Dormers, Chimneys, Skylights, and Other Roof-Penetrating Elements: Extend 18 inches (455 mm) beyond penetrating elements and return vertically against penetrating elements not less than 4 inches (100 mm).
i. Roof-Slope Transitions: Extend 18 inches (455 mm) on each roof slope.

5. Metal-Flashed, Open-Valley Underlayment: Install two layers of 36-inch- (914-mm-) wide felt underlayment centered in valley. Stagger end laps between layers at least 72 inches (1830 mm). Lap ends of each layer at least 12 inches (305 mm) in direction to shed water, and seal with asphalt roofing cement. Fasten each layer to roof deck with felt underlayment nails.
   a. Lap roof-deck felt underlayment over first layer of valley felt underlayment at least 6 inches (152 mm).

B. Metal Flashing Installation
1. General: Install metal flashings and other sheet metal to comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim".
   a. Install metal flashings according to recommendations in NRCA's "The NRCA Roofing and Waterproofing Manual."
2. Apron Flashings: Extend lower flange over and beyond each side of downslope slate shingles and up the vertical surface.
3. Step Flashings: Install with a head lap of 3 inches (75 mm) and extend both horizontally and vertically. Install with lower edge of flashing just upslope of, and concealed by, butt of overlying slate shingle. Fasten to roof deck only.
4. Cricket **OR** Backer, **as directed**, Flashings: Install against the roof-penetrating element, extending concealed flange beneath upslope slate shingles and beyond each side.
5. Hip Flashings: Install centrally over hip with lower edge of flashing concealed by butt of overlying slate shingle. Fasten to roof deck.
6. Open **OR** Closed, **as directed**,-Valley Flashings: Install centrally in valleys, lapping ends at least 8 inches (205 mm) in direction to shed water. Fasten upper end of each length to roof deck beneath overlap.
   a. Secure hemmed flange edges into metal cleats spaced 12 inches (305 mm) apart and fastened to roof deck.
   b. Adhere 9-inch- (230-mm-) wide strips of self-adhering sheet to metal flanges and to self-adhering sheet underlayment.
7. Rake Drip Edges: Install over underlayment and fasten to roof deck.
8. Eave Drip Edges: Install beneath underlayment and fasten to roof deck.
9. Pipe Flashings: Form flashing around pipe penetrations and slate shingles. Fasten and seal to slate shingles.

C. Slate-Shingle Installation
1. General: Beginning at eaves, install slate shingles according to manufacturer's written instructions and to details and recommendations in NRCA's "The NRCA Roofing and Waterproofing Manual."
   a. Install wood nailer strip cant at eave edges.

b. Install shingle starter course chamfered face down.

2. Install first and succeeding shingle courses with chamfered face up. Install full-width first course at rake edge.
   a. Offset joints of uniform-width slate shingles by half the shingle width in succeeding courses.
   b. Offset joints of random-width slate shingles a minimum of 3 inches (75 mm) in succeeding courses.
3. Maintain a 3-inch- (75-mm-) **OR** 4-inch- (100-mm-), **as directed**, minimum head lap between succeeding shingle courses.
4. Maintain uniform exposure of shingle courses between eaves and ridge **OR** midway between eaves and ridge and increase head lap of succeeding shingle courses to ensure uniform exposure on remaining shingle courses, **as directed**.
5. Extend shingle starter course and first course 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**, over fasciae at eaves.
6. Extend shingle starter course and succeeding courses 1 inch (25 mm) over fasciae at rakes.
7. Cut and fit slate neatly around roof vents, pipes, ventilators, and other projections through roof.
8. Hang slate with two **OR** four, **as directed**, slating nails for each shingle with nail heads lightly touching slate. Do not drive nails home drawing slates downward or leave nail head protruding enough to interfere with overlapping shingle above.
   a. For vented ridge, terminate slate shingles leaving uniform air space on each side of ridge apex.
9. Ridges: Install ridge slate in saddle **OR** strip saddle **OR** combing, **as directed**, configuration.
   a. Install and anchor wood nailer strips of thicknesses to match abutting courses of slate shingles, terminating nailer strip 3 to 4 inches (75 to 100 mm) from the eave. Cover with felt underlayment strip, extending to underlying slate but concealed by ridge slate.
   b. Lay ridge slate in bed of asphalt roofing cement **OR** butyl sealant, **as directed**.
   c. Anchor ridge slate to supporting wood nailer strip with two **OR** four, **as directed**, nails for each slate shingle without nails penetrating underlying slate.
   d. Extend combing slate over leeward ridge slate by 1/8 to 1/4 inch (3 to 6 mm). Seal ridge joint with elastomeric sealant.
   e. Cover heads of exposed nails at final ridge shingle with asphalt roofing cement **OR** butyl sealant, **as directed**.
10. Hips: Install and anchor slate hips in saddle **OR** mitered **OR** fantail, **as diorected**, configuration.
    a. Install and anchor wood nailer strips of thickness to match abutting courses of slate shingles. Cover nailer strip with felt underlayment strip, extending on to underlying slate but concealed by hip slate. Anchor hip slate to nailer strip with two nails located in upper third of hip-slate length.
    b. Notch starter shingle and first shingle course at hip to fit around nailer strips so no wood is exposed at ridge eave.
    c. Lay hip slate in bed of asphalt roofing cement **OR** butyl sealant, **as directed**.
    d. Seal hip centerline joint with elastomeric sealant.
11. Open Valleys: Cut slate shingles to form straight lines at open valleys, trimming upper concealed corners of shingles. Maintain uniform width of exposed open valley **OR** Widen exposed portion of open valley 1/8 inch in 12 inches (1:96), **as directed**, from highest to lowest point.
    a. Do not nail shingles to valley metal flashings.
12. Closed Valleys: Cut slate shingles to form straight lines at closed valleys, trimming upper concealed corners of shingles. Maintain uniform gap at centerline of valley of 1/2 to 3/4 inch (13 to 19 mm) **OR** 3/4 to 1 inch (19 to 25 mm), **as directed**.
    a. Do not nail shingles to valley metal flashings.

D. Snow-Guard Installation
   1. Snow-Guard Pads: Install rows of snow-guard pads at locations indicated according to manufacturer's written installation instructions. Space rows apart horizontally, beginning from gutter. Space snow guards apart in each row, offsetting by half this dimension between succeeding rows.

2. Snow-Guard Rails: Install rows of snow-guard rails at locations indicated according to manufacturer's written installation instructions. Space rows apart horizontally, beginning from gutter.

E. Accessories Installation
1. Ridge Caps **OR** Vents, **as directed**: Install units according to manufacturer's written instructions.
a. Install slate shingles into retention channels, butting adjacent shingles.

F. Adjusting And Cleaning
1. Remove and replace damaged or broken slate shingles.
2. Remove excess slate and debris from Project site.

END OF SECTION 07310b

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SECTION 07310c - WOOD SHINGLES AND SHAKES

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for wood shingles and shakes. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Wood roof shingles and shakes.
   b. Wood wall shingles and shakes.
   c. Wood-shingle-clad panels.
   d. Underlayment.

C. Definitions
1. CSSB: Cedar Shake & Shingle Bureau.
2. Roofing Terminology: See ASTM D 1079 and glossary in NRCA's "The NRCA Roofing and Waterproofing Manual" for definitions of terms related to roofing work in this Section.

D. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:
   a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that wood shingles and shakes comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body. Include statement indicating costs for each certified wood product.
3. Samples: For each type of wood shingle, shake, ridge and hip unit, and ridge vent indicated.
4. Research/Evaluation Reports: For wood shingles and shakes, from the ICC, **as directed**.
5. Maintenance Data: For wood shingles and shakes to include in maintenance manuals.
6. Warranties: Sample of special warranties.

E. Quality Assurance
1. Grading Agency Qualifications: An independent testing and inspecting agency recognized by authorities having jurisdiction as qualified to label wood shingles and shakes for compliance with referenced grading rules.
2. Forest Certification: Provide shingles and shakes produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
3. Fire-Resistance Characteristics: Where indicated, provide wood shingles and shakes and related roofing materials identical to those of assemblies tested for fire resistance per test method below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.
   a. Exterior Fire-Test Exposure: Class B **OR** Class C, **as directed**; UL 790 or ASTM E 108 with ASTM D 2898, for application and roof slopes indicated.
4. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Store underlayment rolls on end, on pallets or other raised surfaces. Do not double stack rolls.
   a. Handle, store, and place roofing materials in a manner to avoid significant or permanent damage to roof deck or structural supporting members.

2. Protect unused underlayment from weather, sunlight, and moisture when left overnight or when roofing work is not in progress.

G. Warranty
1. Special Warranty: CSSB's standard form in which CSSB agrees to repair or replace wood shingles and shakes that fail in materials within specified warranty period. Material failures include manufacturing defects that result in leaks.
   a. Materials-Only Warranty Period: 20 **OR** 25, **as directed**, years for shingles and shakes, and 20 years for manufactured ridge and hip units, from date of Substantial Completion.

1.2 PRODUCTS

A. Roof Shingles
1. Cedar Roof Shingles: Smooth-sawn western red cedar shingles.
   a. Grading Standards: CSSB's "Grading Rules for Certigrade Red Cedar Shingles."
   b. Grade: No. 1, with starter courses of No. 1 **OR** No. 2 **OR** No. 3, **as directed**.
   c. Size: 16 inches (405 mm) long; 0.40 inch (10 mm) thick **OR** 18 inches (455 mm) long; 0.45 inch (11 mm) thick **OR** 24 inches (610 mm) long; 0.50 inch (13 mm) thick, **as directed**, at butt.
2. Ridge and Hip, **as directed**, Units: Manufactured **OR** Site-fabricated, **as directed**, units of same thickness as roof shingle, 7 inches (180 mm) wide; beveled, alternately overlapped, and nailed.
   a. Grade: No. 1.
   b. Length: 16 inches (405 mm) **OR** 18 inches (455 mm), **as directed**.
3. Fancy-Butt Roof Shingles: Clear heartwood red cedar, No. 1 grade, with butt shape indicated.
   a. Butt Shape: Diagonal **OR** Half Cove **OR** Diamond **OR** Round **OR** Hexagonal **OR** Octagonal **OR** Arrow **OR** Square **OR** Fish Scale, **as directed**.
   b. Grading Standards: CSSB's "Grading Rules for Certigrade Red Cedar Shingles."
   c. Size: 16 inches (405 mm) long; 5 inches (127 mm) wide **OR** 18 inches (455 mm) long; 5 inches (127 mm) wide, **as directed**, by manufacturer's standard thickness.

B. Roof Shakes
1. Cedar Roof Shakes: Handsplit and resawn western red cedar shakes; split face and sawn back.
   a. Grading Standard: CSSB's "Grading Rules for Certi-Split Resawn Cedar Shakes."
   b. Grade: Premium, **OR** No. 1, **as directed**, with starter courses of Premium **OR** No. 1, **as directed**.
   c. Length: 18 inches (455 mm), **OR** 24 inches (610 mm), **as directed**, with 15-inch- (380-mm-) long starter course.
   d. Thickness: 1/2 inch (13 mm) **OR** 3/4 inch (19 mm), **as directed**, at butt.
2. Cedar Roof Shakes: Tapersawn western red cedar shakes; sawn both sides.
   a. Grading Standard: CSSB's "Grading Rules for Certi-Sawn Tapersawn Cedar Shakes."
   b. Grade: Premium, **OR** No. 1, **as directed**, with starter courses of Premium **OR** No. 1 **OR** No. 2, **as directed**.
   c. Length: 18 inches (455 mm), **OR** 24 inches (610 mm), **as directed**, with 15-inch- (380-mm-) long starter course.
   d. Thickness: 5/8 inch (16 mm) **OR** 3/4 inch (19 mm), **as directed**, at butt.
3. Cedar Roof Shakes: Tapersplit western red cedar shakes; handsplit.
   a. Grading Standard: CSSB's "Grading Rules for Certi-Split Resawn Cedar Shakes."
   b. Grade: Premium, with premium starter courses.
   c. Length: 24 inches (610 mm), with 15-inch- (380-mm-) long starter course.
   d. Thickness: 1/2 inch (13 mm) at butt.
4. Cedar Roof Shakes: Straightsplit western red cedar shakes; machine split or handsplit.
   a. Grading Standard: CSSB's "Grading Rules for Certi-Split Resawn Cedar Shakes."
   b. Grade: Premium, with premium starter courses.

c. Length: 18 inches (455 mm) **OR** 24 inches (610 mm), **as directed**, with 15-inch- (380-mm-) long starter course.
d. Thickness: 3/8 to 1/2 inch (10 to 13 mm) at butt.

5. Ridge and Hip, **as directed**, Units: Manufactured **OR** Site-fabricated, **as directed**, units of same grade as shake, 9 inches (230 mm) wide; beveled, alternately overlapped, and nailed.
   a. Type: Handsplit and resawn **OR** Tapersawn, **as directed**.
   b. Length: 18 inches (455 mm) **OR** 24 inches (610 mm), **as directed**.
   c. Thickness: 5/8 inch (16 mm) **OR** 3/4 inch (19 mm), **as directed**, at butt.
6. Southern Yellow Pine Roof Shakes: No. 1 grade, tapersawn southern yellow pine, preservative treated, and graded according to Texas Forest Service's "TFS Grading Rules for Southern Yellow Pine No. 1 Premium Taper-Sawn Shakes." Identify each bundle with an approved inspection tag noting the grade, preservative treatment, and retention.
   a. Size: 18 inches (455 mm) **OR** 24 inches (610 mm), **as directed**, long, 13/16 inch (20 mm) thick at butt.
   b. Texture: Machine-grooved face.
   c. Finish: Water repellent **OR** Factory stained, brown, **as directed**.

C. Wall Shingles
1. Cedar Wall Shingles: Smooth-sawn western red cedar shingles.
   a. Grading Standards: CSSB's "Grading Rules for Certigrade Red Cedar Shingles."
   b. Grade: No. 1 **OR** No. 2 **OR** No. 3, **as directed**.
   c. Size: 16 inches (405 mm) long; 0.40 inch (10 mm) thick **OR** 18 inches (455 mm) long; 0.45 inch (11 mm) thick **OR** 24 inches (610 mm) long; 0.50 inch (13 mm) thick, **as directed**, at butt.
   d. Undercourse Shingle Grade: No. 3 **OR** Undercoursing, **as directed**.
   e. Undercourse Shingle Size: 16 inches (405 mm) long; 0.40 inch (10 mm) thick **OR** 18 inches (455 mm) long; 0.45 inch (11 mm) thick, **as directed**, at butt.
2. Cedar Wall Shingles: Rebutted and rejointed, smooth-sawn **OR** sanded, **as directed**, western red cedar shingles.
   a. Grading Standards: CSSB's "Grading Rules for Certigrade Red Cedar Shingles."
   b. Grade: No. 1 **OR** No. 2, **as directed**.
   c. Size: 16 inches (405 mm) long; 0.40 inch (10 mm) thick **OR** 18 inches (455 mm) long; 0.45 inch (11 mm) thick **OR** 24 inches (610 mm) long; 0.50 inch (13 mm) thick, **as directed**, at butt.
   d. Undercourse Shingle Grade: No. 3 **OR** Undercoursing, **as directed**.
   e. Undercourse Shingle Size: 16 inches (405 mm) long; 0.40 inch (10 mm) thick **OR** 18 inches (455 mm) long; 0.45 inch (11 mm) thick, **as directed**, at butt.
3. Cedar Wall Shingles: Rebutted and rejoined, machine-grooved, smooth-sawn western red cedar.
   a. Grading Standards: CSSB's "Grading Rules for Certigrade Red Cedar Shingles."
   b. Grade: No. 1.
   c. Size: 16 inches (405 mm) long; 0.40 inch (10 mm) thick **OR** 18 inches (455 mm) long; 0.45 inch (11 mm) thick **OR** 24 inches (610 mm) long; 0.50 inch (13 mm) thick, **as directed**, at butt.
   d. Undercourse Shingle Grade: No. 3 **OR** Undercoursing, **as directed**.
   e. Undercourse Shingle Size: 16 inches (405 mm) long; 0.40 inch (10 mm) thick **OR** 18 inches (455 mm) long; 0.45 inch (11 mm) thick, **as directed**, at butt.
4. Fancy-Butt Wall Shingles: Clear heartwood red cedar, No. 1 grade, with butt shape indicated.
   a. Butt Shape: Diagonal **OR** Half Cove **OR** Diamond **OR** Round **OR** Hexagonal **OR** Octagonal **OR** Arrow **OR** Square **OR** Fish Scale, **as directed**.
   b. Grading Standards: CSSB's "Grading Rules for Certigrade Red Cedar Shingles."
   c. Size: 16 inches (405 mm) long; 5 inches (127 mm) wide **OR** 18 inches (455 mm) long; 5 inches (127 mm) wide, **as directed**, by manufacturer's standard thickness.
5. Cedar Wall Shingle Finish: Unfinished **OR** Semitransparent penetrating stain, oil based, factory applied **OR** Semisolid penetrating stain, oil based, factory applied **OR** Oil-based primer, stain blocking, factory applied, **as directed**.

D. Wall Shakes
1. Cedar Wall Shakes: Handsplit and resawn western red cedar shakes; split face and sawn back.
   a. Grading Standard: CSSB's "Grading Rules for Certi-Split Resawn Cedar Shakes."
   b. Outer Course Grade: Premium **OR** No. 1, **as directed**.
   c. Starter Course **OR** Undercourse, **as directed**, Grade: No. 1 **OR** Standard, **as directed**.
   d. Length: 18 inches (455 mm) **OR** 24 inches (610 mm), **as directed**.
   e. Thickness: 1/2 inch (13 mm) **OR** 3/4 inch (19 mm), **as directed**, at butt.
2. Cedar Wall Shakes: Tapersawn western red cedar shakes; sawn both sides.
   a. Grading Standard: CSSB's "Grading Rules for Certi-Sawn Tapersawn Cedar Shakes."
   b. Outer Course Grade: Premium **OR** No. 1 **OR** No. 2, **as directed**.
   c. Starter Course **OR** Undercourse, **as directed**, Grade: No. 1 **OR** No. 2 **OR** No. 3, **as directed**.
   d. Length: 18 inches (455 mm) **OR** 24 inches (610 mm), **as directed**.
   e. Thickness: 5/8 inch (16 mm) **OR** 3/4 inch (19 mm), **as directed**, at butt.
3. Cedar Wall Shakes: Tapersplit western red cedar shakes; handsplit.
   a. Grading Standard: CSSB's "Grading Rules for Certi-Split Resawn Cedar Shakes."
   b. Grade: Premium.
   c. Length: 24 inches (610 mm).
   d. Thickness: 1/2 inch (13 mm) at butt.
   e. Undercourse Shingle Grade: No. 3 **OR** Undercoursing, **as directed**.
   f. Undercourse Shingle Size: 16 inches (405 mm) long; 0.40 inch (10 mm) thick **OR** 18 inches (455 mm) long; 0.45 inch (11 mm) thick, **as directed**, at butt.
4. Cedar Wall Shakes: Straightsplit western red cedar shakes; machine split or handsplit.
   a. Grading Standard: CSSB's "Grading Rules for Certi-Split Resawn Cedar Shakes."
   b. Grade: Premium.
   c. Length: 18 inches (455 mm) **OR** 24 inches (610 mm), **as directed**.
   d. Thickness: 3/8 to 1/2 inch (10 to 13 mm) at butt.
   e. Undercourse Shingle Grade: No. 3 **OR** Undercoursing, **as directed**.
   f. Undercourse Shingle Size: 16 inches (405 mm) long; 0.40 inch (10 mm) thick **OR** 18 inches (455 mm) long; 0.45 inch (11 mm) thick, **as directed**, at butt.
5. Cedar Wall Shake Finish: Unfinished **OR** Semitransparent penetrating stain, oil based, factory applied **OR** Semisolid penetrating stain, oil based, factory applied **OR** Oil-based primer, stain blocking, factory applied, **as directed**.
6. Southern Yellow Pine Wall Shakes: No. 1 grade, tapersawn southern yellow pine, preservative treated, and graded according to Texas Forest Service's "TFS Grading Rules for Southern Yellow Pine No. 1 Premium Taper-Sawn Shakes." Identify each bundle with an approved inspection tag noting the grade, preservative treatment, and retention.
   a. Size: 18 inches (455 mm) **OR** 24 inches (610 mm), **as directed**, long, 13/16 inch (20 mm) thick at butt.
   b. Texture: Machine-grooved face.
   c. Finish: Water repellent **OR** Factory stained, brown, **as directed**.

E. Wood-Shingle-Clad Panels
1. Cedar Shingle Panels: Clear, vertical-grain, western red cedar shingles bonded with exterior-type adhesives to 5/16-inch- (8-mm-) thick, 96-inch- (2400-mm-) long, DOC PS 1 Exterior C-D plywood panels.
   a. Number of Courses per Panel: One **OR** Two **OR** Three **OR** Four, **as directed**.
   b. Butt Style: Straight line **OR** Staggered, **as directed**.
   c. Fancy-Butt Style: Diagonal **OR** Half Cove **OR** Diamond **OR** Round **OR** Hexagonal **OR** Octagonal **OR** Arrow **OR** Square **OR** Fish Scale, **as directed**.
   d. Exposure: 4-1/2 inches (115 mm) **OR** 5 inches (127 mm) **OR** 7 inches (180 mm), **as directed**, per course.
2. Prefabricated Corners: Flush **OR** Flush, with staggered ends **OR** Add-on, **as directed**, type.

F. Wood Treatments

1. Fire-Retardant Treatment: Exterior-type pressure treatment complying with AWPA C1, **as directed**.
2. Pressure-Preservative Treatment: AWPA C34, chromated copper arsenate (CCA) pressure treatment; a minimum of 0.40 lb/cu. ft. (6.4 kg/cu. m).
3. Identification: Attach a label to each bundle of wood shingles or shakes; identify manufacturer, references to model-code approval, type of product, grade, dimensions, and approved grading agency.
   a. Include chemical treatment, method of application, purpose of treatment, and warranties available.

G. Underlayment Materials
1. Felt Underlayment: ASTM D 226 **OR** ASTM D 4869, **as directed**, Type I **OR** Type II, **as directed**, asphalt-saturated organic felt.
2. Felt Interlayment: ASTM D 226 **OR** ASTM D 4869, **as directed**, Type I **OR** Type II, **as directed**, asphalt-saturated organic felt.
3. Self-Adhering Sheet Underlayment, Granular Surfaced: ASTM D 1970, a minimum of 55-mil- (1.4-mm-) thick sheet; glass-fiber-mat-reinforced, SBS-modified asphalt; mineral-granule surfaced; with release paper backing; cold applied. Provide primer for adjoining concrete or masonry surfaces to receive underlayment, **as directed**.
4. Self-Adhering Sheet Underlayment, Polyethylene Faced: ASTM D 1970, a minimum of 40-mil- (1.0-mm-) thick, slip-resisting, polyethylene-film-reinforced top surface laminated to SBS-modified asphalt adhesive, with release paper backing; cold applied. Provide primer for adjoining concrete or masonry surfaces to receive underlayment, **as directed**.

H. Ridge Vents
1. Rigid Ridge Vent: Manufacturer's standard rigid section, high-density polypropylene or other UV-stabilized plastic ridge vent with nonwoven geotextile filter strips and external deflector baffles, **as directed**; for use under ridge shingles and shakes.
2. Flexible Ridge Vent: Manufacturer's standard, compression-resisting, three-dimensional, open-nylon or polyester-mat filter bonded to a nonwoven, nonwicking, geotextile fabric cover, **as directed**; for use under roof shingles and shakes.

I. Accessories
1. Asphalt Roofing Cement: ASTM D 4586, Type II, asbestos free.
2. Drainage Mat: Manufacturer's standard, compression-resisting, three-dimensional, nonwoven, entangled filament, nylon mat designed to permit air movement and drain incidental moisture by gravity.
3. Roofing Nails: ASTM F 1667, aluminum **OR** stainless-steel **OR** hot-dip galvanized-steel, **as directed**, wire nails, sharp pointed, and of sufficient length to penetrate a minimum of 3/4 inch (19 mm) into sheathing.
   a. Use box **OR** shingle, **as directed**,-type nails for wood shingles.
   b. Use box-type nails for wood shakes.
   c. Where nails are in contact with metal flashing, use nails made from same metal as flashing.
4. Roofing Staples: Type 304 or Type 316, stainless-steel staples, 0.05-inch (1.3-mm) thick, with a minimum of 7/16-inch (11-mm) crown width, of sufficient length to penetrate a minimum of 3/4 inch (19 mm) into sheathing.
5. Felt Underlayment and Interlayment, **as directed**, Nails: Aluminum, stainless-steel, or hot-dip galvanized-steel wire nails; with 1-inch- (25-mm-) minimum diameter, low-profile capped heads or disc caps.
6. Wood Lath Strip: Western red cedar, clear heartwood, a minimum of 1-1/2 inches (38 mm) wide.

J. Metal Flashing And Trim
1. General: Comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim"

a. Sheet Metal: Copper **OR** Stainless steel **OR** Zinc-tin alloy-coated stainless steel **OR** Zinc-tin alloy-coated steel **OR** Zinc-tin alloy-coated copper **OR** Anodized aluminum **OR** Aluminum, mill finished, **as directed**.

2. Fabricate sheet metal flashing and trim to comply with recommendations that apply to design, dimensions, metal, and other characteristics of the item in SMACNA's "Architectural Sheet Metal Manual."
   a. Apron Flashings: Fabricate with lower flange extending a minimum of 4 inches (100 mm) **OR** 6 inches (152 mm), **as directed**, over and 4 inches (100 mm) beyond each side of downslope wood roofing and 6 inches (152 mm) up the vertical surface.
   b. Step Flashings: Fabricate with a head lap of 3 inches (75 mm) and a minimum extension of 4 inches (100 mm) **OR** 5 inches (127 mm), **as directed**, both horizontally and vertically.
   c. Cricket **OR** Backer, **as directed**, Flashings: Fabricate with concealed flange extending a minimum of 18 inches (455 mm) **OR** 24 inches (610 mm), **as directed**, beneath upslope wood roofing and 6 inches (152 mm) beyond each side of chimney **OR** skylight, **as directed**, and 6 inches (152 mm) above the roof plane.
   d. Open-Valley Flashings: Fabricate in lengths not exceeding 10 feet (3 m) with 1-inch- (25-mm-) high, inverted-V profile at center of valley and equal flange widths of 10 inches (255 mm) **OR** 12 inches (305 mm), **as directed**.
   e. Drip Edges: Fabricate in lengths not exceeding 10 feet (3 m) with 2-inch (50-mm) roof-deck flange and 1-1/2-inch (38-mm) fascia flange with 3/8-inch (10-mm) drip at lower edge.
3. Vent-Pipe Flashings: ASTM B 749, Type L51121, at least 1/16 inch (1.6 mm) thick. Provide lead sleeve sized to slip over and turn down into pipe, soldered to skirt at slope of roof and extending at least 4 inches (100 mm) from pipe onto roof.

1.3 EXECUTION

A. Underlayment Installation
   1. General: Comply with underlayment manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.
   2. Single-Layer Felt Underlayment: Install on roof deck parallel with and starting at the eaves. Lap sides a minimum of 2 inches (50 mm) over underlying course. Lap ends a minimum of 4 inches (100 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm). Fasten with felt underlayment nails.
      a. Install felt underlayment on roof deck not covered by self-adhering sheet underlayment. Lap sides of felt over self-adhering sheet underlayment not less than 3 inches (75 mm) in direction to shed water. Lap ends of felt not less than 6 inches (152 mm) over self-adhering sheet underlayment.
   3. Double-Layer Felt Underlayment: Install on roof deck parallel with and starting at the eaves. Install a 19-inch- (485-mm-) wide starter course at eaves and completely cover with full-width second course. Install succeeding courses lapping previous courses 19 inches (485 mm) in shingle fashion. Lap ends a minimum of 6 inches (152 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm). Fasten with felt underlayment nails.
      a. Apply a continuous layer of asphalt roofing cement over starter course and on felt underlayment surface to be concealed by succeeding courses as each felt course is installed. Apply over entire roof **OR** at locations indicated on Drawings, **as directed**.
      b. Install felt underlayment on roof sheathing not covered by self-adhering sheet underlayment. Lap edges over self-adhering sheet underlayment not less than 3 inches (75 mm) in direction to shed water.
      c. Terminate felt underlayment flush **OR** extended up not less than 4 inches (100 mm), **as directed**, against sidewalls, curbs, chimneys, and other roof projections.
   4. Self-Adhering Sheet Underlayment: Install, wrinkle free, on roof deck. Comply with low-temperature installation restrictions of underlayment manufacturer if applicable. Install at locations indicated below **OR** on Drawings, **as directed**, lapped in direction to shed water. Lap sides not less than 3-1/2 inches (89 mm). Lap ends not less than 6 inches (152 mm), staggered

24 inches (610 mm) between courses. Roll laps with roller. Cover underlayment within seven days.

a. Prime concrete and masonry surfaces to receive self-adhering sheet underlayment.
b. Eaves: Extend from edges of eaves 24 inches (610 mm) **OR** 36 inches (914 mm), **as directed**, beyond interior face of exterior wall.
c. Rakes: Extend from edges of rakes 24 inches (610 mm) **OR** 36 inches (914 mm), **as directed**, beyond interior face of exterior wall.
d. Valleys: Extend from lowest to highest point 18 inches (455 mm) on each side.
e. Hips: Extend 18 inches (455 mm) on each side.
f. Ridges: Extend 36 inches (914 mm) on each side without obstructing continuous ridge vent slot, **as directed**.
g. Sidewalls: Extend 18 inches (455 mm) beyond sidewalls and return vertically against sidewalls not less than 4 inches (100 mm).
h. Dormers, Chimneys, Skylights, and Other Roof-Penetrating Elements: Extend 18 inches (455 mm) beyond penetrating elements and return vertically against penetrating elements not less than 4 inches (100 mm).
i. Roof-Slope Transitions: Extend 18 inches (455 mm) on each roof slope.

5. Metal-Flashed, Open-Valley Underlayment: Install two layers of 36-inch- (914-mm-) wide felt underlayment centered in valley. Stagger end laps between layers at least 72 inches (1830 mm). Lap ends of each layer at least 12 inches (305 mm) in direction to shed water, and seal with asphalt roofing cement. Fasten each layer to roof deck with felt underlayment nails.
   a. Lap roof-deck felt underlayment over first layer of valley felt underlayment at least 6 inches (152 mm).

B. Metal Flashing Installation
1. General: Install metal flashings and other sheet metal to comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim".
   a. Install metal flashings according to recommendations for wood roofing in NRCA's "The NRCA Roofing and Waterproofing Manual."
2. Apron Flashings: Extend lower flange over and beyond each side of downslope wood roofing and up the vertical surface.
3. Step Flashings: Install with a head lap of 3 inches (75 mm) and extend both horizontally and vertically. Install with lower edge of flashing just upslope of, and concealed by, butt of overlying shingle or shake. Fasten to roof deck only.
4. Cricket **OR** Backer, **as directed**, Flashings: Install against the roof-penetrating element, extending concealed flange beneath upslope wood roofing and beyond each side.
5. Open-Valley Flashings: Install centrally in valleys, lapping ends at least 8 inches (205 mm) in direction to shed water. Fasten upper end of each length to roof deck beneath overlap.
   a. Secure hemmed flange edges into metal cleats spaced 12 inches (305 mm) apart and fastened to roof deck.
   b. Adhere 9-inch- (230-mm-) wide strip of self-adhering sheet to metal flanges and to self-adhering sheet underlayment.
6. Rake Drip Edges: Install over underlayment and fasten to roof deck.
7. Eave Drip Edges: Install beneath underlayment and fasten to roof deck.
8. Pipe Flashings: Form flashing around pipe penetrations and wood roofing. Fasten and seal to wood roofing.

C. Roof-Shingle Installation
1. General: Install wood-shingle roofing according to manufacturer's written instructions and to recommendations in CSSB's "New Roof Construction Manual" and NRCA's "The NRCA Roofing and Waterproofing Manual."
2. Install drainage mat perpendicular to roof slope in parallel courses, butting edges and ends to form a continuous layer, and fasten to roof deck.
3. Install single **OR** double, **as directed**,-layer wood-shingle starter course along lowest roof edge. Extend starter course 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, over fascia and 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, over rake edge.

a. Offset joints of double-layer starter course a minimum of 1-1/2 inches (38 mm).

4. Install first course of wood shingles directly over starter course and in continuous straight-line courses across roof deck. Install second and succeeding courses of wood shingles in continuous straight-line courses across roof deck. Extend 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, over rake edge.
   a. Offset joints between shingles in succeeding courses a minimum of 1-1/2 inches (38 mm). Limit alignment of vertical joints in every third course to not exceed 10 percent of joints.
   b. Space shingles a minimum of 1/4 inch (6 mm) and a maximum of 3/8 inch (10 mm) apart.
   c. Fasten each shingle with two nails **OR** staples, **as directed**, spaced 3/4 to 1 inch (19 to 25 mm) from edge of shingle and 1-1/2 to 2 inches (38 to 50 mm) above butt line of succeeding course. Drive fasteners flush with top surface of shingles without crushing wood.
   d. Maintain weather exposure of 5 inches (127 mm) for 16-inch- (405-mm-) **OR** 5-1/2 inches (140 mm) for 18-inch- (455-mm-) **OR** 7-1/2 inches (190 mm) for 24-inch- (610-mm-), **as directed**, long shingles.
5. Open Valleys: Cut and fit wood shingles at open valleys, trimming upper concealed corners of shingles. Maintain uniform width of exposed open valley **OR** Widen exposed portion of open valley 1/8 inch in 12 inches (1:96), **as directed**, from highest to lowest point.
6. Fancy-Butt Shingles: Install one **OR** two **OR** three, **as directed**, courses of fancy-butt shingles in continuous straight-line courses across roof deck. Center each shingle in succeeding courses between the two shingles below it with 1/8-inch (3-mm) space between shingles.
   a. Maintain weather exposure of 5 inches (127 mm).
7. Ridge Vents: Install continuous ridge vents over wood shingles according to manufacturer's written instructions. Fasten with roofing nails of sufficient length to penetrate roof sheathing.
8. Ridge and Hip, **as directed**, Units: Install units over wood shingles trimmed at apex. Maintain same exposure dimension of units as roof-shingle exposure. Lap units at ridges to shed water away from direction of prevailing winds. Alternate overlaps of units and fasten with concealed roofing nails of sufficient length to penetrate sheathing.
   a. Install concealed strip of felt underlayment over apex shingles and fasten with felt underlayment nails.
   b. Fasten ridge units to cover ridge vent without obstructing airflow.

D. Roof-Shake Installation
1. General: Install wood-shake roofing according to manufacturer's written instructions and to recommendations in CSSB's "New Roof Construction Manual" and NRCA's "The NRCA Roofing and Waterproofing Manual."
2. Install drainage mat perpendicular to roof slope in parallel courses, butting edges and ends to form a continuous layer, and fasten to roof deck.
3. Install single **OR** double, **as directed**,-layer wood-shake starter course along lowest roof edge. Extend starter course 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, over fascia and 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, over rake edge.
   a. Offset joints of double-layer starter course a minimum of 1-1/2 inches (38 mm).
4. Install first course of wood shakes directly over starter course and in continuous straight-line courses across roof deck. Install second and succeeding courses of wood shakes in continuous straight-line courses across roof deck. Extend 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, over rake edge.
   a. Install 18-inch- (455-mm-) wide strip of felt interlayment over top portion of first and each succeeding course. Set bottom edge of felt interlayment at a distance of twice the weather-exposure dimension above the shake butt. Stagger fasten to roof deck with felt underlayment nails.
   b. Offset joints between shakes in succeeding courses a minimum of 1-1/2 inches (38 mm).
   c. Space shakes a minimum of 3/8 inch (10 mm) and a maximum of 5/8 inch (16 mm) apart.
   d. Fasten each shake with two nails **OR** staples, **as directed**, spaced 3/4 to 1 inch (19 to 25 mm) from edge of shake and 1-1/2 to 2 inches (38 to 50 mm) above butt line of succeeding course. Drive fasteners flush with top surface of shakes without crushing wood.

e. Maintain weather exposure of 5-1/2 inches (140 mm) for 18-inch- (455-mm-) **OR** 7-1/2 inches (190 mm) for 18-inch- (455-mm-) **OR** 7-1/2 inches (190 mm) for 24-inch- (610-mm-) **OR** 10 inches (255 mm) for 24-inch- (610-mm-), **as directed**, long shakes.

5. Open Valleys: Cut and fit wood shakes at open valleys, trimming upper concealed corners of shakes. Maintain uniform width of exposed open valley **OR** Widen exposed portion of open valley 1/8 inch in 12 inches (1:96), **as directed**, from highest to lowest point.
6. Ridge Vents: Install continuous ridge vents over wood shakes according to manufacturer's written instructions. Fasten with roofing nails of sufficient length to penetrate sheathing.
7. Ridge and Hip, **as directed**, Units: Install units over wood shakes trimmed at apex. Maintain same exposure dimension of units as roof-shake exposure. Lap units at ridges to shed water away from direction of prevailing winds. Alternate overlaps of units and fasten with concealed roofing nails of sufficient length to penetrate sheathing.
   a. Install concealed strip of felt underlayment over apex shakes and fasten with felt underlayment nails.
   b. Fasten ridge units to cover ridge vent without obstructing airflow.

E. Wall-Shingle Installation, Single Coursed
1. Install wood wall shingles according to manufacturer's written instructions and recommendations in CSSB's "Exterior and Interior Wall Manual."
2. Install drainage mat horizontally, in parallel courses, over surface to receive wood shingles, butting edges and ends to form a continuous layer; fasten to wall sheathing.
3. Install wood shingles, beginning at base of wall, with a double-layer starter course in a continuous straight line. Offset joints of double-layer starter course a minimum of 1-1/2 inches (38 mm).
   a. Extend starter course 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, below top of foundation wall.
4. Install first course of wood shingles over starter course. Install second and succeeding courses of wood shingles. Offset joints between shingles in succeeding courses a minimum of 1-1/2 inches (38 mm).
   a. Install shingles in continuous straight-line courses.
      OR
      Install shingle courses with butt lines staggered 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, from true butt line.
   b. Install primed shingles with sides abutting **OR** Space shingles 1/8 to 1/4 inch (3 to 6 mm) apart, **as directed**.
   c. Fasten each shingle with two concealed nails **OR** staples driven parallel to butt, **as directed**, spaced 3/4 to 1 inch (19 to 25 mm) from edge of shingle and 1 inch (25 mm) above butt line of succeeding course. For shingles wider than 8 inches (205 mm), add two concealed fasteners, spaced 1 inch (25 mm) apart, to the center of shingle. Drive fasteners flush with top surface of shingles without crushing wood.
   d. Maintain weather exposure of 7-1/2 inches (190 mm) for 16-inch- (405-mm-) **OR** 8-1/2 inches (215 mm) for 18-inch- (455-mm-) **OR** 11-1/2 inches (290 mm) for 24-inch- (610-mm-), **as directed**, long shingles.
   e. Interior Corner Treatment: Butted against wood stop **OR** Laced with flashing behind, **as directed**.
   f. Exterior Corner Treatment: Butted against corner boards **OR** Laced **OR** Mitered, **as directed**.
5. Fancy-Butt Shingles: Install fancy-butt shingles where indicated, in continuous straight-line courses along wall. Center each shingle in succeeding courses between the two shingles below it with primed shingles abutting **OR** 1/8-inch (3-mm) space between shingles, **as directed**.
   a. Maintain weather exposure of 7-1/2 inches (190 mm).
   b. Interior Corner Treatment: Butted against wood stop.
   c. Exterior Corner Treatment: Butted against corner boards **OR** Mitered, **as directed**.

F. Wall-Shingle Installation, Double Coursed
1. Install wood wall shingles in continuous straight-line courses according to manufacturer's written instructions and recommendations in CSSB's "Exterior and Interior Wall Manual."

2. Install drainage mat horizontally, in parallel courses, over surface to receive wood shingles, butting edges and ends to form a continuous layer; fasten to wall sheathing.
3. Install double-layer undercourse of wood shingles beginning at base of wall. Offset joints of each undercourse layer a minimum of 1-1/2 inches (38 mm). Fasten with a single center-and-top nail **OR** staple driven parallel to butt, **as directed**.
   a. Extend undercourse 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, below top of foundation wall.
   b. Fasten two layers of lath wood strips at base of undercourse to match thickness of double-layer undercourse. Extend 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, below top of foundation wall.
4. Install succeeding undercourse layers against wood lath strip, **as directed**. Offset joints between undercourse and outer course a minimum of 1-1/2 inches (38 mm).
   a. Fasten with a single center-and-top nail **OR** staple driven parallel to butt, **as directed**.
5. Install single wood lath strip on first and succeeding outer courses to match thickness of undercourse and at height that results in specified outer course weather exposure.
6. Install first and succeeding outer courses of wood shingles directly over undercourses, projecting 1/2 inch (13 mm) below undercourse **OR** lath strips, **as directed**. Offset joints between shingles and undercourse a minimum of 1-1/2 inches (38 mm). Offset joints between shingles in succeeding outer courses a minimum of 1-1/2 inches (38 mm).
   a. Install primed outer shingles with sides abutting **OR** Space outer shingles 1/8 to 1/4 inch (3 to 6 mm) apart, **as directed**.
   b. Fasten each shingle with two exposed nails **OR** staples driven parallel to butt, **as directed**, spaced 3/4 to 1 inch (19 to 25 mm) from edge of shingle and 2 inches (50 mm) above butt line of succeeding course. For outer course shingles wider than 8 inches (205 mm), add two concealed fasteners, spaced 1 inch (25 mm) apart, to the center of shingle. Drive fasteners flush with top surface of shingles without crushing wood.
   c. Maintain weather exposure of 12 inches (305 mm) for 16-inch- (405-mm-) **OR** 14 inches (355 mm) for 18-inch- (455-mm-) **OR** 16 inches (405 mm) for 24-inch- (610-mm-), **as directed**, long shingles.
   d. Interior Corner Treatment: Butted against wood stop **OR** Laced with flashing behind, **as directed**.
   e. Exterior Corner Treatment: Butted against corner boards **OR** Laced **OR** Mitered, **as directed**.

G. Wall-Shake Installation, Single Coursed
1. Install wood wall shakes according to manufacturer's written instructions and recommendations in CSSB's "Exterior and Interior Wall Manual."
2. Install drainage mat horizontally, in parallel courses, over surface to receive wood shakes, butting edges and ends to form a continuous layer; fasten to wall sheathing.
3. Install wood shakes, beginning at base of wall, with a double-layer starter course in a continuous straight line. Offset joints of double-layer starter course a minimum of 1-1/2 inches (38 mm).
   a. Extend starter course 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, below top of foundation wall.
4. Install first course of wood shakes over starter course. Install second and succeeding course of wood shakes. Offset joints between shakes in succeeding courses a minimum of 1-1/2 inches (38 mm).
   a. Install shakes in continuous straight-line courses.
      OR
      Install shake courses with butt lines staggered 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, from true butt line.
   b. Install primed shakes with sides abutting **OR** Space shingles 1/8 to 1/4 inch (3 to 6 mm) apart, **as directed**.
   c. Fasten each shake with two concealed nails **OR** staples driven parallel to butt, **as directed**, spaced 3/4 to 1 inch (19 to 25 mm) from edge of shake and 1 inch (25 mm) above butt line of succeeding course. For shakes wider than 8 inches (205 mm), add two

concealed fasteners, spaced 1 inch (25 mm) apart, to the center of shake. Drive fasteners flush with top surface of shakes without crushing wood.

d. Maintain weather exposure of 7-1/2 inches (190 mm) for 16-inch- (405-mm-) **OR** 8-1/2 inches (215 mm) for 18-inch- (455-mm-) **OR** 11-1/2 inches (290 mm) for 24-inch- (610-mm-), **as directed**, long shakes.

e. Interior Corner Treatment: Butted against wood stop **OR** Laced with flashing behind, **as directed**.

f. Exterior Corner Treatment: Butted against corner boards **OR** Laced **OR** Mitered, **as directed**.

H. Wall-Shake Installation, Double Coursed

1. Install wood wall shakes in continuous straight-line courses according to manufacturer's written instructions and recommendations in CSSB's "Exterior and Interior Wall Manual."
2. Install drainage mat horizontally, in parallel courses, over surface to receive wood shakes, butting edges and ends to form a continuous layer; fasten to wall sheathing.
3. Install double-layer undercourse of wood shingles beginning at base of wall. Offset joints of each undercourse layer a minimum of 1-1/2 inches (38 mm). Fasten with a single center-and-top nail **OR** staple driven parallel to butt, **as directed**.
   a. Extend undercourse 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, below top of foundation wall.
   b. Fasten two layers of lath wood strips at base of undercourse to match thickness of double-layer undercourse. Extend 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**, below top of foundation wall.
4. Install succeeding undercourse layers against wood lath strip, **as directed**. Offset joints between undercourse and outer course a minimum of 1-1/2 inches (38 mm).
   a. Fasten with a single center-and-top nail **OR** staple driven parallel to butt, **as directed**.
5. Install single wood lath strip on first and succeeding outer courses to match thickness of undercourse and at height that results in specified outer course weather exposure.
6. Install first and succeeding outer courses of wood shakes directly over undercourses, projecting 1/2 inch (13 mm) below undercourse **OR** lath strips, **as directed**. Offset joints between shakes and undercourse shingles a minimum of 1-1/2 inches (38 mm). Offset joints between shakes in succeeding outer courses a minimum of 1-1/2 inches (38 mm).
   a. Install primed outer shakes with sides abutting **OR** Space outer shakes 1/4 to 3/8 inch (6 to 10 mm) apart, **as directed**.
   b. Fasten each shake with two exposed nails **OR** staples driven parallel to butt, **as directed**, spaced 3/4 to 1 inch (19 to 25 mm) from edge of shake and 2 inches (50 mm) above butt line of succeeding course. For shakes wider than 8 inches (205 mm), add two concealed fasteners, spaced 1 inch (25 mm) apart, to the center of shake. Drive fasteners flush with top surface of shake without crushing wood.
   c. Maintain weather exposure of 12 inches (305 mm) for 16-inch- (405-mm-) **OR** 14 inches (355 mm) for 18-inch- (455-mm-) **OR** 18 inches (455 mm) for 24-inch- (610-mm-), **as directed**, long shakes.
   d. Interior Corner Treatment: Butted against wood stop **OR** Laced with flashing behind, **as directed**.
   e. Exterior Corner Treatment: Butted against corner boards **OR** Laced **OR** Mitered, **as directed**.

I. Wood-Shingle-Clad Panel Installation

1. Install wood-shingle-clad panels and corner units, **as directed**, according to manufacturer's written instructions.
2. Install panels level, plumb, true, and aligned with adjacent materials.
3. Install panels working from the lowest level to the top of the wall area.

END OF SECTION 07310c

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SECTION 07310d - COMPOSITE RUBBER SHINGLES

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for composite rubber shingles. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.
2. Furnish and install this Majestic Slate Tile Roof System in strict accordance with specifications and drawings approved by EcoStar.
3. Metal flashing work is not covered in this specification since EcoStar does **NOT** warrant metal flashing. EcoStar advises that metal flashing and securement of metal should be to industry standards (SMACNA) to prevent the metal from pulling free or buckling. EcoStar also suggests that all flashing metal be copper, stainless steel or an equally long-term material.
4. EcoStar Attic Guard Ridge Ventilation product must be used on those projects that will be using a ridge ventilation system. If a ridge ventilation system is not to be used on the project, another form of ventilation may be used, but will not be covered by any EcoStar warranties. EcoStar advises that a ridge style venting system be utilized to insure the best possible air movement and to provide the best aesthetic appearance to the roofing system.

B. Definitions
1. Roofing Terminology: Refer to ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definitions of terms related to roofing work in this Section.

C. Submittals
1. Submit an “EcoStar Gold Star Project Survey” to EcoStar Technical Department for approval **PRIOR** to the job start to enable the Technical Department to approve and assign a job number to the project.
2. The “EcoStar Gold Star Project Survey Form” must be filled out completely and accurately to include any prior deviations approved from this specification, including a roof drawing showing all dimensions, all penetrations, and roof slope.
3. When an EcoStar Gold Star Warranty is desired, EcoStar must be contacted **PRIOR** to project bid and installation. Information may be required for wind design and slope requirements.
4. Product Data: For each type of product indicated.
5. Samples: For the following products, of sizes indicated.
   a. Composite Rubber Shingle: Full size, of each color, size, texture, and shape.
   b. Ridge Vent System: 12 inches (300 mm) long.
   c. Fasteners: Three fasteners of each type, length, and finish.
   d. Underlayment: 12 inches (300 mm) square.

D. Quality Assurance
1. To qualify for an EcoStar Gold Star Warranty, an authorized EcoStar Gold Star Applicator must install system.
2. There shall be no deviation made from this specification without written approval from EcoStar prior to the start of the roofing project.
3. For an EcoStar Gold Star Warranty, upon completion of the installation, an inspection must be conducted by a Technical Representative of EcoStar to ascertain that the roofing system has been installed according to EcoStar’s most current published specifications and details. This inspection is not intended to be a Final Inspection for the benefit of the Owner, but for the benefit of EcoStar to determine whether a warranty shall be issued.
4. Class C Testing Requirements:
   a. Fire Resistance - UL 790 Test Standard
   b. Class 4 Impact Resistance - UL 2218 Test Standard

c. 110 mph wind load - PA100-95 Test Standard
d. Wind uplift - 105 lbs / sq ft - UL 1897 Test Standard

5. Class A Testing Requirements:
   a. Fire Resistance - UL 790 Test Standard
   b. Class 4 Impact Resistance - UL 2218 Test Standard

E. Product Delivery, Storage And Handling
1. Deliver materials in original unopened packages.
2. Packages shall be labeled with manufacturer's name, brand name, installation instructions and identification of various items.
3. All tile materials must be stored between 45^{O} F. and 80^{O} F. If exposed to lower temperatures, restore to 45^{O} F minimum temperature before using.
4. Store all materials in a dry protected area. Damaged materials must **NOT** be used. Installed materials found to be damaged shall be replaced at Gold Star Authorized Applicator's expense.

F. Job Conditions (Cautions And Warnings)
1. Contact EcoStar Technical Department for procedures when installing a Majestic Slate Tile Roof System during temperatures less than 45^{O} F.
2. Do not install the Majestic Slate Tile Roof System directly over existing asphalt shingles or existing tile roof systems. All existing roof materials **MUST** be removed prior to installation of the Majestic Slate Tile System.
3. Roofing surface must be free of ice, water, or snow prior to and during the roofing project.

G. Warranty
1. Roofing materials manufacturer will provide the warranty for those materials supplied by the manufacturer when the project is completed by a manufacturer's authorized applicator and all required materials have been utilized within the roof system.
2. Only when a manufacturer's technical representative has inspected and approved the completed installation will a warranty be issued.
3. The warranty is available for all types of buildings and structures.
4. The warranty period is expressed on the warranty certificate, which reflects the inclusive dates of coverage.
5. The warranty does NOT cover the aesthetic appearance of the Majestic Slate - Tiles. Care should be taken by the authorized applicator to ensure that proper blending of the tiles occurs. When improper blending occurs the aesthetic appearance of the roof can be effected negatively. Blending should occur from a minimum of seven bundles from each pallet. It is highly suggested that all material be on site to blend from.
6. Only products supplied by EcoStar, a Division of Carlisle SynTec Incorporated, are included in the warranty unless otherwise specified and approved in writing by EcoStar, a Division of Carlisle SynTec Incorporated.

1.2 PRODUCTS

A. Manufacturer
1. All Components of the Majestic Slate - Tile Roof System are to be products manufactured or supplied by EcoStar, a Division of Carlisle SynTec Incorporated, or approved equivalent.

B. Class C Tile Roofing System
1. Slate Tiles/Shingles: Tiles made of Starloy™, 100% recycled rubber and plastic compound, 12" wide by 18" long with a nominal thickness of 1/4". Weight shall be determined by the following acceptable tile exposures:
   7" 241 - 258 lbs per square
   6-1/2" 259 - 278 lbs per square
   6" 280 - 300 lbs per square

a. Color: As selected from manufacturer's standard colors, unless directed otherwise.

2. Underlayment
   a. AquaGuard - a roofing underlayment recognized for use as an alternative to Type 30 roofing underlayment, consisting of spunbonded polypropylene coated with a layer of U.V. stabilized polypropylene on both sides, meeting requirements of ASTM D2626, referred to as 30 lb and without perforations.
   b. Glacier Guard ice and water underlayment - Granular Surface (55 mil), Smooth Surface (40 mil), or Smooth Surface High Temperature (40 mil), a composite membrane consisting of fiberglass reinforced rubberized asphalt laminated to an impermeable polyethylene film layer (Smooth Surface and Smooth Surface High Temperature) or coated with a granular surface providing maximum skid resistance (Granular Surface).

C. Class A Tile Roofing System
1. Slate Tiles/Shingles: Tiles made of Starloy™, 100% recycled rubber and plastic compound, 12" wide by 18" long with a nominal thickness of 1/4". Weight shall be determined by the following acceptable tile exposures:
   7" 258 - 276 lbs per square
   6-1/2" 278 - 294 lbs per square
   6" 300 - 321 lbs per square
   a. Color: As selected from manufacturer's standard colors, unless directed otherwise.
2. Underlayment
   a. VersaShield - One layer of Elk VersaShield meeting or exceeding the requirements of ASTM D226.
   b. Glacier Guard ice & water underlayment - Granular Surface (55 mil), Smooth Surface (40 mil), or Smooth Surface High Temperature (40 mil), a composite membrane consisting of fiberglass reinforced rubberized asphalt laminated to an impermeable polyethylene film layer (Smooth Surface and Smooth Surface High Temperature) or coated with a granular surface providing maximum skid resistance (Granular Surface).

D. Fasteners
1. AquaGuard/VersaShield
   a. Roofing nails with one inch (1") diameter round or square head, plastic or metal, and 3/4" long shank. Metal parts of fastener are to be corrosion resistant.
2. Tile Fasteners
   a. EcoStar Roofing Nail with a 3/8" diameter head and a minimum of 1-1/2" long shank made from stainless steel. Nails can be supplied either as a hand drive style or in coils for use in pneumatic tools.

1.3 EXECUTION

A. Substrate Criteria
1. The Building owner or Owner's Representative is responsible for providing and determining that the substrate is suitable to receive the Majestic Slate Tile Roof System and the authorized EcoStar Gold Star Applicator should not proceed until all defects have been corrected.
2. The Majestic Slate Roof System may only be applied over:
   a. Minimum ½" plywood or OSB decking
   b. Minimum 1" tongue and groove wood decking
   c. Approved metal deck systems - for specifics contact roofing materials manufacturer.
3. Minimum slope of substrate for installation of Majestic Slate Roof System shall be a minimum of 3/12 for 6" exposure installation and a minimum of 6/12 for 7" exposure installation. Contact the EcoStar Technical Department for approval of applications on lower slopes or exceptions to this requirement.

B. Substrate Preparation

1. The Building Owner or Owner's Representative is responsible for ensuring that all wet or damaged substrate has been removed in a re-roofing application.
2. Existing roof material **MUST** be removed and a clean substrate free of foreign material be provided prior to the installation of the Majestic Slate Tile Roof System. Majestic Slate Tiles may **NOT** be installed directly over any existing roof material or system.

C. Installation
1. Flashing and Sheet Metal:
   a. Install sheet metal and flashing metal in all valleys and where required on projections furnish in accordance with Division 07 Section "Sheet Metal Flashing And Trim".
   b. Where required, install metal starter strip at all eaves and roof edges. Furnish metal in accordance with Division 07 Section "Sheet Metal Flashing And Trim".
   c. The roofing materials manufacturer suggests that all metal work be made from copper, stainless steel or an equally long-term material.
2. Underlayment:
   a. AquaGuard:
      1) Apply 41.5" wide sheet over complete deck, lapping the area covered with Glacier Guard ice and water underlayment. Lap end joints 6" and side joints 4" and double through valleys.
      2) Do not leave exposed to weather more than 90 days after beginning of installation without written approval of owner.
      3) Do not leave any fastener heads exposed. Nail only in areas to be covered by lapping of underlayment.
   b. VersaShield:
      1) Apply 42" wide sheet over complete deck, covering the entire roof deck **INCLUDING** those areas with Glacier Guard Ice & Water underlayment. Lap end joints 4" and side joints 6".
      2) Lap the VersaShield 6" from both sides over all hips, valleys, and ridges.
      3) Where the roof meets a vertical surface, carry the VersaShield 3" to 4" up the surface.
      4) Do not leave exposed to weather more than **60** days after beginning of installation without written approval of owner.
      5) Do not leave any fastener heads exposed. Nail only in areas to be covered by lapping of underlayment.
   c. Glacier Guard Ice and water underlayment:
      1) Lap end joints 6" and side joints 3.5"
      2) Apply continuous 36" wide sheet in valley centered over valley.
      3) Apply rows of 36" wide sheets along all eaves and rakes. Lap end joints 6" and side joints 3.5".
      4) Apply rows of 36" wide sheets along and around all dormers and roof projections. Lap end joints 6" and side joints 3.5".
      5) When applicable install as far as it can be installed on any head walls or vertical walls a minimum of 12".
      6) Do not leave Glacier Guard Granular Surface exposed to weather more than 14 days after beginning of installation. Do not leave Glacier Guard Smooth Surface exposed to weather more than 30 days after beginning of installation. Do not leave Glacier Guard Smooth Surface High Temp exposed to the weather more than 60 days after the beginning of installation.
3. Tile/Shingle Installation
   a. After installing underlayment and before installing the tiles, clean the surface of debris and dirt.
   b. Beginning at the eave, install a layer of tiles gapped a minimum of 3/8" between tiles and any projections, with two roofing fasteners per tile (in location shown on tiles). This layer of tiles will become the starter row. Install another layer of tiles in the same manner as the first with the exception of the second layer having a 1/2 tile offset to the first layer.

c. Continue installing tiles per the chosen exposure.

d. Care must be taken to place tiles so color variations are evenly distributed over the entire roof area. Tiles between bundles and pallets **MUST** be shuffled to insure even distribution of color variations. "Patchy" or "Blotching" in appearance is not acceptable and the applicator will be required to correct. It is recommended that work not begin until all roofing materials have been delivered to the job site.

e. It is the responsibility of the applicator to ensure that all tiles are bent back in a downward curve prior to installation. **Do not install tiles with an upward curve**.

f. Either an open or closed valley design may be used.
   1) With an open valley design leave a minimum of 2" on each side of the center of the valley exposed and uncovered by the roof tiles. A V-Style or W-Style Valley metal may be used.
   2) With a closed valley design cut the tiles in a straight line to fit no closer than 3/8" against tile of adjoining roof slope.

g. Minimum Fastening - No less than 2 approved fasteners per tile, with a minimum length of 1-1/2", shall be used.

h. CAUTION: When using a pneumatic nailer, care shall be taken to ensure that nails are not over driven causing the tiles to curl upward. If tiles have been installed with over-driven nails causing the ends of the tile to curve upward, tiles will never lay flat. Over-driven tiles must be removed and re-nailed properly.

i. Install EcoStar Attic Guard ridge vent system per the manufacturer's application instructions, and then place the Majestic Slate - Universal Hip/Ridge Tile over the ridge vent. A minimum 2.5" stainless steel, hand-driven EcoStar fastener should be used on a ventilated hip/ridge to fasten the hip/ridge tile to the deck. A minimum 2" stainless steel, hand-driven EcoStar fastener should be used on an unventilated hip/ridge to fasten the hip/ridge tile to the deck. Place fasteners in the location marked on the tile. Majestic Slate - Universal Hip/Ridge Tile must be installed with 6" exposure.

j. Tiles may not be installed if the tiles have been stored in temperatures lower than 45^{O} F. If tiles have been stored in temperatures below 45^{O} F., tiles must be brought back to an ambient material temperature of 45^{O} F. As the temperature rises, tiles will expand beyond the designed installation pattern if the product is installed while cold or frozen.

k. Do not install tiles directly adjacent to each other. A minimum gap of 3/8" must be maintained between installed tiles.

l. After the initial row of tiles has been installed, it is recommended that a chalk line be placed parallel to the roof edge and running perpendicular to the first row of tiles. This chalk line will ensure that the tiles stay true and plumb to the roof edge throughout installation.

m. Care must be taken to minimize foot traffic over completed areas of the roof. Tiles will show mud and dirt and cause appearance problems. The removal of dirt and debris is the responsibility of the applicator.

n. Tiles can be slippery when wet, caution should be exhibited with early morning dew and after rain. The tile manufacturer suggests the use of toe boards and OSHA approved harnesses and safety equipment at all time.

o. Upon completion of the roof system installation, inspect and remove all debris from roof, sweep clean and wash with a mild, non-bleaching detergent.

END OF SECTION 07310d

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SECTION 07310e - CLAY ROOF TILES

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for clay roof tiles. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Clay roof tiles.
   b. Underlayment.
   c. Snow guards.

C. Definitions
1. Roofing Terminology: See ASTM D 1079, glossaries in TRI/WSRCA's "Concrete and Clay Roof Tile Design Criteria Installation Manual for Moderate Climate Regions," and NRCA's "The NRCA Roofing and Waterproofing Manual" for definitions of terms related to roofing work in this Section.

D. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:
   a. Product Test Reports for Credit SS 7.2: For clay roof tiles, documentation indicating compliance with Solar Reflectance Index requirement.
3. Samples: For each type of clay roof tile and accessory tile indicated.
4. Material test reports.
5. Research/evaluation reports.
6. Maintenance data.
7. Warranties: Sample of special warranties.

E. Quality Assurance
1. Fire-Test-Response Characteristics: Provide clay roof tiles and related roofing materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
   a. Exterior Fire-Test Exposure: Class A **OR** Class B **OR** Class C, **as directed**; UL 790 or ASTM E 108, for application and roof slopes indicated.
2. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Store underlayment rolls on end, on pallets or other raised surfaces. Do not double stack rolls.
   a. Handle, store, and place roofing materials in a manner to avoid significant or permanent damage to roof deck or structural supporting members.
2. Protect unused underlayment from weather, sunlight, and moisture when left overnight or when roofing work is not in progress.

G. Warranty
1. Special Warranty: Standard form in which manufacturer agrees to repair or replace clay roof tiles that fail in materials within specified warranty period.
   a. Materials-Only Warranty Period: 50 years from date of Substantial Completion.

1.2 PRODUCTS

A. Clay Roof Tiles
1. Clay Roof Tiles: ASTM C 1167, molded- or extruded-clay roof tile units of shape and configuration indicated, kiln fired to vitrification, and free of surface imperfections. Provide with fastening holes prepunched at factory before firing.
a. Durability: Grade 1 **OR** Grade 2 **OR** Grade 3, **as directed**.
b. High-Profile Shape: Type I, Spanish or "S" **OR** Type I, tapered mission, two piece **OR** Type I, straight mission, two piece **OR** Type I, straight barrel mission, two piece **OR** Type I, Greek, two piece **OR** Type I, Roman, two piece, **as directed**.
c. Low-Profile Shape: Type II, French interlocking.
d. Flat Shape: Type III, flat shingle **OR** Type III, flat interlocking, **as directed**.
1) Provide clay roof tiles of diminishing widths for circular bays or round towers.
e. Solar Reflectance Index: Provide clay roof tile with Solar Reflectance Index not less than 29 when calculated according to ASTM E 1980, based on testing of identical products by a qualified testing agency.
f. Finish and Texture: Matte, smooth **OR** Matte, striated **OR** Glazed, smooth, **as directed**.
g. Color: Terra cotta **OR** Brown **OR** Red **OR** Blended red **OR** Buff, **as directed**.
h. High **OR** Low, **as directed**,-Profile-Shape Accessory Tiles: Ridge, ridge vent, ridge end, hip and hip starter, header course, L-shaped rake edge, roll rake edge, starter, end band, terminal, eave closure, and top fixture, **as directed**, units, in color matching clay roof tiles.
i. Flat-Shape Accessory Tiles: Ridge and closed ridge end, hip and hip starter, header course, L-shaped rake edge, starter, end band, and terminal, **as directed**, units, in color matching clay roof tiles.

B. Accessories
1. Asphalt Roofing Cement: ASTM D 4586, Type II, asbestos free.
2. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied.
3. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane **OR** silicone, **as directed**,-based joint sealant; Type M **OR** Type S, **as directed**, Grade NS, Class 25, Use NT related to exposure, and, as applicable to joint substrates indicated, Use O.
4. Roofing Asphalt: ASTM D 312, Type IV.
5. Cold-Applied Adhesive: Manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive specially formulated for compatibility and use with underlayments.
6. Foam Adhesive: Two-component, polyurethane expanding adhesive recommended for application by clay roof tile manufacturer.
OR
Mortar: ASTM C 270, Type M, natural color **OR** with ASTM C 979, pigmented mortar matching the color of clay roof tiles for exposed-to-view mortar, and natural color for concealed-from-view mortar, **as directed**.
7. Eave Closure: Manufacturer's standard EPDM **OR** copper **OR** stainless-steel **OR** galvanized-steel **OR** aluminum, mill finish, **as directed**, eave closure formed to shape of clay roof tile.
8. Wood Nailers, Beveled Cant Strips and Wood Battens: Comply with requirements for pressure-preservative-treated wood in Division 06 Section(s) "Rough Carpentry" OR "Miscellaneous Carpentry", **as directed**.
9. Mesh Fabric: 18-by-14 (1.1-by-1.4-mm) mesh of PVC-coated, glass-fiber thread.

C. Fasteners
1. Roofing Nails: ASTM F 1667, copper, 0.135-inch- (3.4-mm-) **OR** aluminum, 0.1055-inch- (2.7-mm-) **OR** hot-dip galvanized-steel, 0.1055-inch- (2.7-mm-), **as directed**, diameter shank, sharp-pointed, conventional roofing nails with barbed shanks; minimum 3/8-inch- (10-mm-) diameter head; of sufficient length to penetrate 3/4 inch (19 mm) into wood battens **OR** solid wood decking **OR** roof-deck sheathing, **as directed**.

a. Where nails are in contact with metal flashing, use nails made from same metal as flashing.

2. Felt Underlayment Nails: Aluminum, stainless-steel, or hot-dip galvanized-steel wire with low-profile capped heads or disc caps, 1-inch (25-mm) minimum diameter.
3. Wood Batten Nails: ASTM F 1667; common or box, steel wire, flat head, and smooth shank.
4. Wire Ties: Copper **OR** Brass **OR** Stainless steel, **as directed**, 0.083-inch (2.1-mm) minimum diameter.
5. Twisted-Wire-Tie System: Continuously twisted, two-wire unit with loops formed 6 inches (152 mm) apart, minimum 0.1-inch- (2.5-mm-) diameter brass wire and 0.06-inch- (1.5-mm-) diameter brass tie wires **OR** 0.1-inch- (2.5-mm-) diameter copper wire and 0.06-inch- (1.5-mm-) diameter brass tie wires **OR** 0.083-inch- (2.1-mm-) diameter stainless-steel wire and 0.037-inch- (0.94-mm-) diameter stainless-steel tie wires **OR** 0.083-inch- (2.1-mm-) diameter galvanized-steel wire and 0.037-inch- (0.94-mm-) diameter galvanized-steel tie wires, **as directed**, with matching-metal folding clip anchors.
6. Single-Line, Wire-Tie System: Interconnecting eave-to-ridge system, minimum 0.1-inch- (2.5-mm-) diameter brass **OR** 0.09-inch- (2.3-mm-) diameter galvanized-steel, **as directed**, wire, preformed to accommodate clay roof tile type and application indicated.
7. Hook Nails: One-piece wind lock and clay roof tile fastener system, minimum 0.1-inch- (2.5-mm-) diameter brass **OR** 0.09-inch- (2.3-mm-) diameter galvanized-steel, **as directed**, wire, for direct deck nailing.
8. Tile Locks: Brass **OR** Copper **OR** Stainless-steel **OR** Hot-dip galvanized-steel, **as directed**, 0.1-inch- (2.5-mm-) diameter wire device designed to secure butt edges of overlaid clay roof tiles.
9. Storm Clips: Brass **OR** Stainless-steel **OR** Hot-dip galvanized-steel, **as directed**, strap-type, 0.04-by-1/2-inch (1.0-by-13-mm), L-shaped retainer clips designed to secure side edges of clay roof tiles. Provide with two fastener holes in base flange.

D. Underlayment Materials
1. Felt Underlayment: ASTM D 226, Type II, asphalt-saturated organic felt, unperforated.
2. Felt Underlayment: ASTM D 2626, asphalt-saturated and -coated organic felt, dusted with fine mineral surfacing on both sides, unperforated.
3. Roll Roofing Underlayment: ASTM D 6380, Class M, Type II, asphalt-saturated and -coated organic felt, mineral-granule surfaced.
4. Self-Adhering Sheet Underlayment, Granular Surfaced: ASTM D 1970, a minimum of 55-mil- (1.4-mm-) thick sheet; glass-fiber-mat-reinforced, SBS-modified asphalt; mineral-granule surfaced; with release paper backing; cold applied. Provide primer for adjoining concrete or masonry surfaces to receive underlayment, **as directed**.
5. Self-Adhering Sheet Underlayment, Polyethylene Faced: ASTM D 1970, a minimum of 40-mil- (1.0-mm-) thick, slip-resisting, polyethylene-film-reinforced top surface laminated to SBS-modified asphalt adhesive, with release paper backing; cold applied. Provide primer for adjoining concrete or masonry surfaces to receive underlayment, **as directed**.

E. Snow Guards
1. Snow-Guard Pads: Fabricated copper **OR** cast-bronze **OR** zinc **OR** stainless-steel **OR** aluminum, **as directed**, units, designed to be installed without penetrating roof tiles, and complete with predrilled holes or hooks for anchoring.
2. Snow-Guard Rails: Units fabricated from metal baseplate anchored to adjustable **OR** fixed, **as directed**, bracket and equipped with two **OR** three, **as directed**, bars.
   a. Brackets and Baseplate: Aluminum **OR** Bronze or brass **OR** Stainless steel, **as directed**.
   b. Bars: Aluminum, mill finished **OR** Aluminum, clear anodized **OR** Stainless steel, mill finished, **as directed**.

F. Metal Flashing And Trim
1. General: Comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim".
   a. Sheet Metal: Copper **OR** Stainless steel **OR** Zinc-tin alloy-coated stainless steel **OR** Zinc-tin alloy-coated steel **OR** Zinc-tin alloy-coated copper **OR** Anodized aluminum **OR** Aluminum, mill finished, **as directed**.

2. Fabricate sheet metal flashing and trim to comply with recommendations that apply to design, dimensions, metal, and other characteristics of the item in SMACNA's "Architectural Sheet Metal Manual."
   a. Apron Flashings: Fabricate with lower flange extending a minimum of 4 inches (100 mm) **OR** 6 inches (152 mm), **as directed**, over and 4 inches (100 mm) beyond each side of downslope tile roofing and 6 inches (152 mm) up the vertical surface.
   b. Step Flashings: Fabricate with a head lap of 3 inches (75 mm) and a minimum extension of 4 inches (100 mm) **OR** 5 inches (127 mm), **as directed**, both horizontally and vertically.
   c. Channel Flashings: Fabricate with vertical surface extending a minimum of 4 inches (100 mm) **OR** 5 inches (127 mm), **as directed**, above the clay roof tile and 4 inches (100 mm) **OR** 6 inches (152 mm), **as directed**, beneath the tile roofing, with a 1-inch- (25-mm-) high vertical return to form a runoff channel.
   d. Rake Pan Flashings: Fabricate with vertical surface extending over fasciae and 6 inches (152 mm) beneath the tile roofing, with a 1-inch- (25-mm-) high vertical return to form a runoff channel.
   e. Cricket **OR** Backer, **as directed**, Flashings: Fabricate with concealed flange extending a minimum of 18 inches (455 mm) **OR** 24 inches (610 mm), **as directed**, beneath upslope tile roofing, 6 inches (152 mm) beyond each side of chimney **OR** skylight, **as directed**, and 6 inches (152 mm) above the roof plane.
   f. Closed **OR** Open, **as directed**,-Valley Flashings: Fabricate in lengths not exceeding 10 feet (3 m), with 1-inch- (25-mm-) high, inverted-V profile at center of valley and with equal flange widths of 10 inches (255 mm) **OR** 12 inches (305 mm), **as directed**.
   g. Drip Edges: Fabricate in lengths not exceeding 10 feet (3 m), with 2-inch (50-mm) roof-deck flange and 1-1/2-inch (38-mm) fascia flange with 3/8-inch (10-mm) drip at lower edge.
3. Sheet Metal Ridge Vent: Fabricate from 16-oz./sq. ft.- (0.55-mm-) thick copper sheet, terminating each side in V-shaped external baffles with venting holes producing net-free ventilating area of 2.65 sq. in./ft. (56 sq. cm/m).
4. Vent-Pipe Flashings: ASTM B 749, Type L51121, at least 1/16 inch (1.6 mm) thick. Provide lead sleeve sized to slip over and turn down into pipe, soldered to skirt at slope of roof and extending at least 4 inches (100 mm) from pipe onto roof.

1.3 EXECUTION

A. Underlayment Installation
   1. General: Comply with clay roof tile manufacturer's written instructions and recommendations in NRCA's "The NRCA Roofing and Waterproofing Manual."
      a. Cover ridge **OR** hip, **as directed**, wood nailers with underlayment strips.
   2. Single-Layer Felt Underlayment: Install on roof deck parallel with and starting at the eaves. Lap sides a minimum of 2 inches (50 mm) over underlying course. Lap ends a minimum of 4 inches (100 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm). Fasten with felt underlayment **OR** roofing, **as directed**, nails.
      a. Install felt underlayment on roof deck not covered by self-adhering sheet underlayment. Lap sides of felt over self-adhering sheet underlayment not less than 3 inches (75 mm) in direction to shed water. Lap ends of felt not less than 6 inches (152 mm) over self-adhering sheet underlayment.
   3. Double-Layer Felt Underlayment: Install on roof deck parallel with and starting at the eaves. Install a 19-inch- (485-mm-) wide starter course at eaves and completely cover with full-width second course. Install succeeding courses lapping previous courses 19 inches (485 mm) in shingle fashion. Lap ends a minimum of 6 inches (152 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm). Fasten with felt underlayment **OR** roofing, **as directed**, nails.
      a. Apply a continuous layer of asphalt roofing cement over starter course and on felt underlayment surface to be concealed by succeeding courses as each felt course is installed. Apply over entire roof **OR** at locations indicated on Drawings, **as directed**.

b. Install felt underlayment on roof sheathing not covered by self-adhering sheet underlayment. Lap edges over self-adhering sheet underlayment not less than 3 inches (75 mm) in direction to shed water.

4. Double-Layer Felt/Roll Roofing Underlayment:
   a. Install single layer of felt underlayment on roof deck parallel with and starting at the eaves. Lap sides a minimum of 2 inches (50 mm) over underlying course. Lap ends a minimum of 4 inches (100 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm). Fasten with felt underlayment **OR** roofing, **as directed**, nails.
   b. Install roll roofing underlayment, in parallel courses, in same direction as felt underlayment. Lap ends a minimum of 6 inches (152 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm).
      1) Mechanically fasten over felt underlayment.
      2) Adhere to felt underlayment with solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature **OR** uniform coating of cold-applied adhesive **OR** uniform coating of asphalt roofing cement, **as directed**.
   c. Terminate felt underlayment flush **OR** extended up not less than 4 inches (100 mm), **as directed**, against chimneys, sidewalls, curbs, and other projections.
5. Self-Adhering Sheet Underlayment: Install wrinkle free; comply with low-temperature installation restrictions of underlayment manufacturer if applicable. Install at locations indicated below **OR** on Drawings, **as directed**, lapped in direction to shed water. Lap sides not less than 3-1/2 inches (89 mm). Lap ends not less than 6 inches (152 mm), staggered 24 inches (610 mm) between succeeding courses. Roll laps with roller. Cover underlayment within seven days.
   a. Prime concrete and masonry surfaces to receive self-adhering sheet underlayment.
   b. Extend self-adhering sheet underlayment over entire roof deck.
      OR
      Extend self-adhering sheet underlayment over roof deck as follows:
      1) Eaves: Extend from edges of eaves 24 inches (610 mm) **OR** 36 inches (914 mm), **as directed**, beyond interior face of exterior wall.
      2) Rakes: Extend from edges of rakes 24 inches (610 mm) **OR** 36 inches (914 mm), **as directed**, beyond interior face of exterior wall.
      3) Valleys: Extend from lowest to highest point 18 inches (455 mm) on each side.
      4) Hips: Extend 18 inches (455 mm) on each side.
      5) Ridges: Extend 36 inches (914 mm) on each side without obstructing continuous ridge vent slot, **as directed**.
      6) Sidewalls: Extend 18 inches (455 mm) beyond sidewalls and return vertically against sidewalls not less than 4 inches (100 mm).
      7) Dormers, Chimneys, Skylights, and Other Roof-Penetrating Elements: Extend 18 inches (455 mm) beyond penetrating elements and return vertically against penetrating elements not less than 4 inches (100 mm).
      8) Roof-Slope Transitions: Extend 18 inches (455 mm) on each roof slope.
6. Double-Layer Felt/Self-Adhering Sheet Underlayment:
   a. Install single layer of felt underlayment on roof deck parallel with and starting at the eaves. Lap sides a minimum of 2 inches (50 mm) over underlying course. Lap ends a minimum of 4 inches (100 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm). Fasten with felt underlayment **OR** roofing, **as directed**, nails.
   b. Install self-adhering sheet underlayment, wrinkle free, on felt underlayment. Comply with low-temperature installation restrictions of underlayment manufacturer if applicable. Lap sides not less than 3-1/2 inches (89 mm) in direction to shed water. Lap ends not less than 6 inches (152 mm), staggered 24 inches (610 mm) between succeeding courses. Roll laps with roller. Cover underlayment within seven days.
7. Metal-Flashed, Open-Valley Underlayment: Install two layers of 36-inch- (914-mm-) wide felt underlayment centered in valley. Stagger end laps between layers at least 72 inches (1830 mm). Lap ends of each layer at least 12 inches (305 mm) in direction to shed water, and seal with asphalt roofing cement. Fasten each layer to roof deck with felt underlayment nails.
   a. Lap roof-deck felt underlayment over first layer of valley felt underlayment at least 6 inches (152 mm).

B. Metal Flashing Installation
1. General: Install metal flashings and other sheet metal to comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim".
   a. Install metal flashings according to clay roof tile manufacturer's written instructions and recommendations in NRCA's "The NRCA Roofing and Waterproofing Manual."
2. Apron Flashings: Extend lower flange over and beyond each side of downslope tile roofing and up the vertical surface.
3. Step Flashings: Install with a head lap of 3 inches (75 mm) and extend both horizontally and vertically. Install with lower edge of flashing just upslope of, and concealed by, butt of overlying tile. Fasten to roof deck only.
4. Cricket **OR** Backer, **as directed**, Flashings: Install against roof-penetrating elements, extending concealed flange beneath upslope tile roofing and beyond each side.
5. Open-Valley Flashings: Install centrally in valleys, lapping ends at least 8 inches (205 mm) in direction to shed water. Fasten upper end of each length to roof deck beneath overlap.
   a. Secure hemmed flange edges into metal cleats spaced 12 inches (305 mm) apart and fastened to roof deck.
   b. Adhere 9-inch- (230-mm-) wide strips of self-adhering sheet to metal flanges and to self-adhering sheet underlayment.
6. Channel Flashings: Install over underlayment and fasten to roof deck.
7. Rake Pan Flashings: Install over underlayment and fasten to roof deck.
8. Rake Drip Edges: Install over underlayment and fasten to roof deck.
9. Eave Drip Edges: Install beneath underlayment and fasten to roof deck.
10. Pipe Flashings: Form flashing around pipe penetrations and tile roofing. Fasten and seal to tile roofing.
11. Sheet Metal Ridge Vents: Install centrally, and mechanically fasten to wood ridge. Adhere each side to clay roof tile with elastomeric sealant.
    a. Install fabric mesh over roof-deck air ventilation gaps to prevent insect entry.

C. Wood Nailers And Battens, **as directed**
1. Install wood nailers at ridges **OR** hips **OR** rakes, **as directed**, and securely fasten to roof deck.
2. Install beveled wood cant at eaves and securely fasten to roof deck.
3. Install nominal 1-by-2-inch (25-by-50-mm) wood battens horizontally over 1/2-inch- (13-mm-) high, pressure-preservative-treated wood lath strips **OR** in 48-inch (1200-mm) lengths with ends separated by 1/2 inch (13 mm), **as directed**, at spacing required by clay roof tile manufacturer, and securely fasten to roof deck.
   a. Install nominal 1-by-2-inch (25-by-50-mm) wood counter battens vertically spaced 24 inches (610 mm) apart and securely fasten to roof deck.

D. Clay Roof Tile Installation
1. General: Install clay roof tiles according to manufacturer's written instructions, to recommendations in TRI/WSRCA's "Concrete and Clay Roof Tile Design Criteria Installation Manual for Moderate Climate Regions," and to NRCA's "The NRCA Roofing and Waterproofing Manual."
   a. Maintain uniform exposure and coursing of clay roof tiles throughout roof.
   b. Extend tiles 2 inches (50 mm) over eave fasciae.
   c. Nail Fastening: Drive nails to clear the clay roof tile so the tile hangs from the nail and is not drawn up.
      1) Install wire through nail holes of cut tiles that cannot be nailed directly to roof deck, and fasten to nails driven into deck.
   d. Wire-Tie Fastening: Install wire-tie systems and fasten clay roof tiles according to manufacturer's written instructions.
   e. Foam-Adhesive **OR** Mortar, **as directed**, Setting: Install clay roof tile according to TRI/FRSA's "Concrete and Clay Roof Tile Installation Manual."
   f. Install storm clips to capture edges of longitudinal sides of clay roof tiles and securely fasten to roof deck.

g. Install clay roof tile locks to support and lock overlying tile butts to underlying tiles.
h. Cut and fit clay roof tiles neatly around roof vents, pipes, ventilators, and other projections through roof. Fill voids with mortar.
i. Install clay roof tiles with color blend approved by the Owner.

2. Flat Shingle Clay Roof Tile Installation:
   a. Maintain 2-inch (50-mm) head lap between succeeding courses of clay roof tiles.
   b. Offset joints by half the clay roof tile width in succeeding courses.
   c. Extend clay roof tiles 1 inch (25 mm) over fasciae at rakes.
   d. Install ridge tiles in V-ridge **OR** saddle **OR** mitered, **as directed**, configuration with laps facing away from prevailing wind. Seal laps with asphalt roofing cement **OR** butyl sealant **OR** elastomeric sealant, **as directed**.
      1) Close voids where ridge tiles meet clay roof tiles with ridge closure tiles **OR** mortar struck with face of ridge cover tiles, **as directed**.
   e. Install hip tiles in V-ridge **OR** saddle **OR** mitered, **as directed**, configuration. Seal laps with asphalt roofing cement **OR** butyl sealant **OR** elastomeric sealant, **as directed**.
      1) Fill voids with mortar where hip tiles meet clay roof tiles, and strike mortar flush with face of hip cover tiles.
3. Flat Interlocking Clay Roof Tile Installation:
   a. Provide minimum 3-inch (75-mm) lap between succeeding courses of clay roof tiles.
   b. Offset joints by half the clay roof tile width in succeeding courses.
   c. Install L-shaped rake tiles.
   d. Install ridge tiles in V-ridge **OR** saddle **OR** mitered, **as directed**, configuration with laps facing away from prevailing wind. Seal laps with asphalt roofing cement **OR** butyl sealant **OR** elastomeric sealant, **as directed**.
      1) Close voids where ridge tiles meet clay roof tiles with ridge closure tiles **OR** mortar struck with face of ridge cover tiles, **as directed**.
   e. Install hip tiles in V-ridge **OR** saddle **OR** mitered, **as directed**, configuration. Seal laps with asphalt roofing cement **OR** butyl sealant **OR** elastomeric sealant, **as directed**.
      1) Fill voids with mortar where hip tiles meet clay roof tiles, and strike mortar flush with face of hip cover tiles.
4. Low-Profile, Interlocking Clay Roof Tile Installation:
   a. Provide minimum 3-inch (75-mm) lap between succeeding courses of clay roof tiles.
   b. Install L-shaped rake tiles.
   c. Install ridge tiles with laps facing away from prevailing wind. Seal laps with asphalt roofing cement **OR** butyl sealant **OR** elastomeric sealant, **as directed**.
5. High-Profile Clay Roof Tile Installation:
   a. Install tile **OR** sheet metal **OR** EPDM, **as directed**, eave closure.
   b. Provide minimum 3-inch (75-mm) lap between succeeding courses of clay roof tiles.
   c. Install L-shaped **OR** roll, **as directed**, rake tiles.
   d. Install ridge tiles with laps facing away from prevailing wind. Seal laps with asphalt roofing cement **OR** butyl sealant **OR** elastomeric sealant, **as directed**.
6. Open Valleys: Cut clay roof tiles at open valleys to form straight lines. Maintain uniform width of exposed open valley **OR** Widen exposed portion of open valley 1/8 inch in 12 inches (1:96), **as directed**, from highest to lowest point.
   a. Drill or notch cut valley tiles and wire-tie to fastener placed clear of valley metal flashings.
   b. Do not nail tiles to metal flashings.
7. Closed Valleys: Cut clay roof tiles at closed valleys to form straight lines, trimming upper concealed corners of tiles. Maintain uniform gap at centerline of valley of 1/2 to 3/4 inch (13 to 19 mm) **OR** 3/4 to 1 inch (19 to 25 mm), **as directed**.
   a. Drill or notch cut valley tiles and wire-tie to fastener placed clear of valley metal flashings.
   b. Do not nail tiles to metal flashings.

E. Snow-Guard Installation
1. Snow-Guard Pads: Install rows of snow-guard pads at locations indicated, according to manufacturer's written installation instructions. Space rows apart horizontally, beginning from

gutter. Space snow guards apart in each row, offsetting by half this dimension between succeeding rows.

2. Snow-Guard Rails: Install rows of snow-guard rails at locations indicated, according to manufacturer's written installation instructions. Space rows apart horizontally, beginning from gutter.

F. Adjusting And Cleaning
   1. Remove and replace damaged or broken clay roof tiles.
   2. Remove excess clay roof tiles and debris from Project site.

END OF SECTION 07310e

Task	Specification	Specification Description
07310	01352	No Specification Required
07313	01352	No Specification Required
07313	07310c	Wood Shingles And Shakes
07314	07310b	Slate Shingles
07315	07310a	Metal Shingles

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SECTION 07410 - METAL ROOF PANELS

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for metal roof panels. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Exposed-fastener, lap-seam metal roof panels.
   b. Concealed-fastener, lap-seam metal roof panels.
   c. Standing-seam metal roof panels.
   d. Batten-seam metal roof panels.
   e. Horizontal-seam (Bermuda-type) metal roof panels.
   f. Foamed-insulation-core metal roof panels.
   g. Metal soffit panels.

C. Definitions
1. Metal Roof Panel Assembly: Metal roof panels, attachment system components, miscellaneous metal framing, thermal insulation, and accessories necessary for a complete weathertight roofing system.

D. Performance Requirements
1. General Performance: Metal roof panels shall comply with performance requirements without failure due to defective manufacture, fabrication, installation, or other defects in construction.
2. Delegated Design: Design metal roof panel assembly, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
3. Air Infiltration: Air leakage through assembly of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) of roof area when tested according to ASTM E 1680 at the following test-pressure difference:
   a. Test-Pressure Difference (for roofs with slopes of 30 degrees or less): Negative 1.57 lbf/sq. ft. (75 Pa).
   b. Test-Pressure Difference (for roofs with slopes steeper than 30 degrees): Positive and negative 1.57 lbf/sq. ft. (75 Pa).
   c. Positive Preload Test-Pressure Difference: Greater than or equal to 15.0 lbf/sq. ft. (720 Pa) and the greater of 75 percent of building live load or 50 percent of building design positive wind-pressure difference.
   d. Negative Preload Test-Pressure Difference: 50 percent of design wind-uplift-pressure difference.
4. Water Penetration: No water penetration when tested according to ASTM E 1646 at the following test-pressure difference:
   a. Test-Pressure Difference (for roofs with slopes of 30 degrees or less): 2.86 lbf/sq. ft. (137 Pa).
   b. Test-Pressure Difference (for roofs with slopes steeper than 30 degrees): 20 percent of positive design wind pressure, but not less than 6.24 lbf/sq. ft. (300 Pa) and not more than 12.0 lbf/sq. ft. (575 Pa).
   c. Positive Preload Test-Pressure Difference: Greater than or equal to 15.0 lbf/sq. ft. (720 Pa) and the greater of 75 percent of building live load or 50 percent of building design positive wind-pressure difference.
   d. Negative Preload Test-Pressure Difference: 50 percent of design wind-uplift-pressure difference.

5. Hydrostatic-Head Resistance: No water penetration when tested according to ASTM E 2140.
6. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
   a. Uplift Rating: UL 30 **OR** UL 60 **OR** UL 90, **as directed**.
7. FMG Listing: Provide metal roof panels and component materials that comply with requirements in FMG 4471 as part of a panel roofing system and that are listed in FMG's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FMG markings.
   a. Fire/Windstorm Classification: Class 1A-60 **OR** Class 1A-75 **OR** Class 1A-90 **OR** Class 1A-105 **OR** Class 1A-120, **as directed**.
   b. Hail Resistance: MH **OR** SH, **as directed**.
8. Structural Performance: Provide metal roof panel assemblies capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated, based on testing according to ASTM E 1592:
   a. Wind Loads: Determine loads based on the following minimum design wind pressures:
      1) Uniform pressure of 20 lbf/sq. ft. (957 Pa) **OR** 30 lbf/sq. ft. (1436 Pa), **as directed**, acting inward or outward.
         OR
         Uniform pressure as indicated on Drawings.
   b. Snow Loads: 25 lbf/sq. ft. (1197 Pa) **OR** 30 lbf/sq. ft. (1436 Pa) **OR** 35 lbf/sq. ft. (1676 Pa), **as directed**.
   c. Deflection Limits: Metal roof panel assemblies shall withstand wind and snow loads with vertical deflections no greater than 1/180 **OR** 1/240, **as directed**, of the span.
9. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
10. Thermal Performance: Provide insulated metal roof panel assemblies with thermal-resistance value (R-value) indicated when tested according to ASTM C 518.
11. Energy Performance
    a. Provide roof panels with solar reflectance index not less than 78 **OR** 29, **as directed**, when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency.
       OR
       Energy Performance: Provide roof panels that are listed on the U.S. Department of Energy's ENERGY STAR Roof Products Qualified Product List for low-slope **OR** steep-slope, **as directed**, roof products.
       OR
       Energy Performance: Provide roof panels with initial solar reflectance not less than 0.70 and emissivity not less than 0.75 when tested according to CRRC-1.

E. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
   a. Product Test Reports for Credit SS 7.2: For roof panels, indicating that panels comply with solar reflectance index requirement.
   b. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: Indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content.
      1) Include statement indicating costs for each product having recycled content.
3. Shop Drawings: Show fabrication and installation layouts of metal roof panels; details of edge conditions, side-seam and endlap joints, panel profiles, corners, anchorages, trim, flashings, closures, and accessories; and special details. Distinguish between factory- and field-assembled work.
4. Samples: For each type of exposed finish required.

5. Delegated-Design Submittal: For metal roof panel assembly indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   a. Snow Retention System Calculations: Include calculation of number and location of snow guards based on snow load, roof slope, panel length and finish, and seam type and spacing.
6. Coordination Drawings: Roof plans, drawn to scale, based on input from installers of the items involved.
7. Manufacturer Certificates: Signed by manufacturer certifying that roof panels comply with energy performance requirements specified in "Performance Requirements" Article.
   a. Submit evidence of meeting performance requirements.
8. Product test reports.
9. Field quality-control reports.
10. Maintenance data.
11. Warranties: Samples of special warranties.

F. Quality Assurance
1. Installer Qualifications: An employer of workers trained and approved by manufacturer.
2. Surface-Burning Characteristics: Provide metal roof panels having insulation core material with the following surface-burning characteristics as determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   a. Flame-Spread Index: 25 or less.
   b. Smoke-Developed Index: 450 or less.
3. Fire-Resistance Ratings: Where indicated, provide metal roof panels identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   a. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.
   b. Combustion Characteristics: ASTM E 136.
4. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver components, sheets, metal roof panels, and other manufactured items so as not to be damaged or deformed. Package metal roof panels for protection during transportation and handling.
2. Unload, store, and erect metal roof panels in a manner to prevent bending, warping, twisting, and surface damage.
3. Stack metal roof panels on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal roof panels to ensure dryness. Do not store metal roof panels in contact with other materials that might cause staining, denting, or other surface damage.
4. Protect strippable protective covering on metal roof panels from exposure to sunlight and high humidity, except to extent necessary for period of metal roof panel installation.
5. Protect foam-plastic insulation as follows:
   a. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
   b. Protect against ignition at all times. Do not deliver foam-plastic insulation materials to Project site before installation time.
   c. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

H. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace metal roof panel assemblies that fail in materials or workmanship within two years from date of Substantial Completion.

2. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal roof panels that show evidence of deterioration of factory-applied finishes within 10 **OR** 20, **as directed**, years from date of Substantial Completion.
3. Special Weathertightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace metal roof panel assemblies that fail to remain weathertight, including leaks, within five **OR** 10, **as directed**, years from date of Substantial Completion.
4. Special Weathertightness Warranty for Standing-Seam Metal Roof Panels: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within 20 years from date of Substantial Completion.

1.2 PRODUCTS

A. Panel Materials
1. Metallic-Coated Steel Sheet: Restricted flatness steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
   a. Recycled Content: Provide steel sheet with average recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
   b. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality.
   c. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40 (Class AZM150 coating designation, Grade 275); structural quality.
   d. Surface: Smooth, flat **OR** Embossed, **as directed**, finish.
   e. Exposed Coil-Coated Finish:
      1) 2-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      2) 3-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      3) 4-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat and clear coats. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      4) Mica Fluoropolymer: AAMA 621. 2-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      5) Metallic Fluoropolymer: AAMA 621. 3-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      6) FEVE Fluoropolymer: AAMA 621. 2-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      7) Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
      8) Plastisol: Epoxy primer and vinyl plastisol topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 3.8 mil (0.97 mm) for topcoat.

f. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

2. Aluminum Sheet: Coil-coated sheet, ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.
   a. Surface: Smooth, flat **OR** Embossed, **as directed**, finish.
   b. Exposed Coil-Coated Finish:
      1) 2-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      2) 3-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      3) 4-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat and clear coats. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      4) Mica Fluoropolymer: AAMA 620. 2-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      5) Metallic Fluoropolymer: AAMA 620. 3-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      6) FEVE Fluoropolymer: AAMA 620. 2-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      7) Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
      8) Plastisol: Epoxy primer and vinyl plastisol topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 3.8 mil (0.97 mm) for topcoat.
   c. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

3. Copper Sheet: ASTM B 370, cold-rolled copper sheet, H00 temper.
   a. Exposed Finish: Apply the following finish, as specified or indicated on Drawings:
      1) Natural finish.
      2) Brushed Satin: CDA M32-06x (Mechanical Finish: directionally textured, medium satin; Coating: clear organic, air drying, as specified below):
      3) Mirror Polished: CDA M22-06x (Mechanical Finish: buffed, specular; Coating: clear organic, air drying, as specified below):
         a) Clear, Organic Coating: Clear, air-drying, acrylic lacquer specially developed for coating copper-alloy products, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
      4) Pre-patinated: ASTM B 882. Copper sheets artificially aged by chemical reaction to convert surface to inorganic crystalline structure with color range and durability of naturally formed patina.

4. Panel Sealants:

a. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
b. Joint Sealant: ASTM C 920; elastomeric polyurethane, polysulfide, or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal roof panels and remain weathertight; and as recommended in writing by metal roof panel manufacturer.
c. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

B. Field-Installed Thermal Insulation
1. Polyethylene Vapor Retarders: ASTM D 4397, 6 mils (0.15 mm) thick, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).
2. Unfaced, Polyisocyanurate Board Insulation: ASTM C 591, Type II, compressive strength of 35 psi (240 kPa), with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, based on tests performed.
3. Faced, Polyisocyanurate Board Insulation: ASTM C 1289, Type I, Class 1 aluminum foil **OR** Type II, Class 1 or 2 felt or glass-fiber mat, Grade 3 **OR** Type V, oriented-strand-board facing, **as directed**, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, based on tests performed on unfaced core.
4. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.60-lb/cu. ft. (26-kg/cu. m) minimum density unless otherwise indicated; with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively.
5. Molded-Polystyrene Board Insulation: ASTM C 578, Type I, 0.9 lb/cu. ft. (15 kg/cu. m) **OR** Type II, 1.35 lb/cu. ft. (22 kg/cu. m), **as directed**, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively.
6. Unfaced, Glass-Fiber Board Insulation: ASTM C 612, Type IA or Types IA and IB; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; and with a nominal density of 3 lb/cu. ft. (48 kg/cu. m).
7. Mineral-Fiber-Blanket Insulation: ASTM C 665, type indicated below; consisting of fibers manufactured from glass, slag wool, or rock wool.
   a. Type I (blankets without membrane covering), passing ASTM E 136 for combustion characteristics.
   b. Type II (blankets with nonreflective membrane covering), Category 1 (membrane is a vapor retarder), Class A (membrane-faced surface with a flame-spread index of 25 or less).
   c. Type III (blankets with reflective membrane covering), Category 1 (membrane is a vapor retarder), Class A (membrane-faced surface with a flame-spread index of 25 or less).
8. Metal Building Insulation: ASTM C 991, Type I, or NAIMA 202 **OR** ASTM C 991, Type II, **as directed**, glass-fiber-blanket insulation; 0.5-lb/cu. ft. (8-kg/cu. m) density; 2-inch- (50-mm-) wide, continuous, vapor-tight edge tabs; and with a flame-spread index of 25 or less.
   a. Vapor-Retarder Facing: ASTM C 1136, with permeance not greater than 0.02 perm (1.15 ng/Pa x s x sq. m) when tested according to ASTM E 96, Desiccant Method:
      1) Composition: Polypropylene faced, scrim reinforced, and kraft-paper backing **OR** Foil faced, scrim reinforced, and kraft-paper backing with vapor-retarder coating **OR** Polypropylene faced, scrim reinforced, and foil backing **OR** Vinyl faced, scrim reinforced, and foil backing **OR** Vinyl faced, scrim reinforced, and polyester backing, **as directed**.
   b. Insulation Retainer Strips: 0.019-inch- (0.48-mm-) thick, formed, galvanized-steel or PVC retainer clips colored to match insulation facing.
   c. Thermal Spacer Blocks: Fabricated from extruded polystyrene, 1 inch (25 mm) thick.

C. Underlayment Materials
1. Self-Adhering, High-Temperature Sheet: 30 to 40 mils (0.76 to 1.0 mm) thick minimum, consisting of slip-resisting, polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
   a. Thermal Stability: Stable after testing at 240 deg F (116 deg C); ASTM D 1970.

b. Low-Temperature Flexibility: Passes after testing at minus 20 deg F (29 deg C); ASTM D 1970.

2. Felts: ASTM D 226, Type II (No. 30) **OR** Type I (No. 15), **as directed**, asphalt-saturated organic felts.
3. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.

D. Substrate Boards
1. Gypsum Board: Type X, of thickness indicated, with water-resistant-treated core and with water-repellent paper bonded to core's face, back, and long edges. ASTM C 1396/C 1396M.
2. Glass-Mat Gypsum Sheathing Board: ASTM C 1177/C 1177M; Regular, 1/2 inch (13 mm) **OR** Type X, 5/8 inch (16 mm), **as directed**.
3. Perlite Board: ASTM C 728, 1 inch (25 mm) thick.
4. Substrate-Board Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FMG 4470, designed for fastening substrate board to substrate.

E. Miscellaneous Metal Framing
1. Miscellaneous Metal Framing, General: ASTM C 645, cold-formed metallic-coated steel sheet, ASTM A 653/A 653M, G40 (Z120) hot-dip galvanized **OR** ASTM A 653/A 653M, G60 (Z180) hot-dip galvanized, **as directed**, or coating with equivalent corrosion resistance unless otherwise indicated.
2. Hat-Shaped, Rigid Furring Channels:
   a. Nominal Thickness: As indicated **OR** As required to meet performance requirements **OR** 0.025 inch (0.64 mm) **OR** 0.040 inch (1.02 mm), **as directed**.
   b. Depth: As indicated **OR** 7/8 inch (22 mm) **OR** 1-1/2 inches (38 mm), **as directed**.
3. Cold-Rolled Furring Channels: Minimum 1/2-inch- (13-mm-) wide flange.
   a. Nominal Thickness: As indicated **OR** As required to meet performance requirements **OR** 0.064 inch (1.63 mm), **as directed**.
   b. Depth: As indicated **OR** 3/4 inch (19 mm), **as directed**.
   c. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with nominal thickness of 0.040 inch (1.02 mm).
   d. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.57-mm-) diameter wire, or double strand of 0.048-inch- (1.22-mm-) diameter wire.
4. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (32 mm), wall attachment flange of 7/8 inch (22 mm), and depth required to fit insulation thickness indicated.
   a. Nominal Thickness: As indicated **OR** As required to meet performance requirements **OR** 0.025 inch (0.64 mm), **as directed**.
5. Fasteners for Miscellaneous Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten miscellaneous metal framing members to substrates.

F. Miscellaneous Materials
1. Panel Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of metal roof panels by means of plastic caps or factory-applied coating. Provide EPDM, PVC, or neoprene sealing washers.
2. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

G. Exposed-Fastener, Lap-Seam Metal Roof Panels
1. General: Provide factory-formed metal roof panels designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps. Include accessories required for weathertight installation.
2. Corrugated-Profile, Exposed-Fastener Metal Roof Panels: Formed with alternating curved ribs spaced at 2.67 inches (68 mm) o.c. across width of panel.

a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: As selected by the Owner from manufacturer's full range.

b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: As selected by Architect from manufacturer's full range.

c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: As selected by Architect from manufacturer's full range.

d. Panel Coverage: 21.3 inches (541 mm) **OR** 29.3 inches (744 mm) **OR** 34.67 inches (881 mm) **OR** 37.3 inches (947 mm) **OR** 42.67 inches (1084 mm) **OR** 45.3 inches (1151 mm), **as directed**.

e. Panel Height: 0.5 inch (13 mm) **OR** 0.875 inch (22 mm), **as directed**.

3. Tapered-Rib-Profile, Exposed-Fastener Metal Roof Panels: Formed with raised, trapezoidal major ribs and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between major ribs.

a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: As selected by the Owner from manufacturer's full range.

b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: As selected by the Owner from manufacturer's full range.

c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: As selected by the Owner from manufacturer's full range.

d. Material: Copper sheet, 16-oz./sq. ft. weight (0.55-mm thickness) **OR** 20-oz./sq. ft. weight (0.68-mm thickness), **as directed**.
   1) Exterior Finish: Brushed satin (lacquered) **OR** Mirror polished, **as directed**.

e. Major-Rib Spacing: 6 inches (152 mm) **OR** 8 inches (203 mm) **OR** 9 inches (229 mm) **OR** 12 inches (305 mm), **as directed**, o.c.

f. Panel Coverage: 24 inches (610 mm) **OR** 36 inches (914 mm), **as directed**.

g. Panel Height: 0.625 inch (16 mm) **OR** 0.75 inch (19 mm) **OR** 1.0 inch (25 mm) **OR** 1.25 inches (32 mm) **OR** 1.5 inches (38 mm), **as directed**.

4. Vee-Rib-Profile, Exposed-Fastener Metal Roof Panels: Formed with raised, V-shaped ribs and recesses that are approximately same size, evenly spaced across panel width, and with rib/recess sides angled at approximately 45 degrees.
   a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm) **OR** 0.064-inch (1.63-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm) **OR** 0.064-inch (1.63-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm), **as directed**, thick.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   d. Rib Spacing: 5.3 inches (135 mm) **OR** 7.2 inches (183 mm) **OR** 12 inches (305 mm), **as directed**, o.c.
   e. Panel Coverage: 30 inches (762 mm) **OR** 32 inches (813 mm) **OR** 36 inches (914 mm) **OR** 40 inches (1016 mm), **as directed**.
   f. Panel Height: 1.375 inches (35 mm) **OR** 1.5 inches (38 mm) **OR** 1.75 inches (44 mm) **OR** 2.0 inches (51 mm) **OR** 3.0 inches (76 mm), **as directed**.
5. Box-Rib-Profile, Exposed-Fastener Metal Roof Panels: Formed with raised, box-shaped ribs that are wider than recesses, evenly spaced across panel width, and with rib/recess sides angled 60 degrees or more.
   a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   d. Rib Spacing: 2.67 inches (68 mm) **OR** 4.0 inches (102 mm) **OR** 5.3 inches (135 mm) **OR** 6.0 inches (152 mm), **as directed**, o.c.
   e. Panel Coverage: 24 inches (610 mm) **OR** 28 inches (711 mm) **OR** 30 inches (762 mm) **OR** 32 inches (813 mm) **OR** 36 inches (914 mm), **as directed**.

f. Panel Height: 0.625 inch (16 mm) **OR** 1.0 inch (25 mm) **OR** 1.5 inches (38 mm) **OR** 2.0 inches (51 mm), **as directed**.

6. Deep-Box-Rib-Profile, Exposed-Fastener Metal Roof Panels: Formed with raised, box-shaped ribs that are wider than recesses, evenly spaced across panel width, and with rib/recess sides angled more than 60 degrees.
   a. Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm) **OR** 0.064-inch (1.63-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   b. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm) **OR** 0.064-inch (1.63-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm), **as directed**, thick.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   d. Rib Spacing: 12 inches (305 mm), **as directed**, o.c.
   e. Panel Coverage: 24 inches (610 mm), **as directed**.
   f. Panel Height: 3 inches (76 mm) **OR** 4 inches (102 mm).**as directed**.

H. Concealed-Fastener, Lap-Seam Metal Roof Panels
   1. General: Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners and factory-applied sealant in side laps. Include accessories required for weathertight installation.
   2. Tapered-Rib-Profile, Concealed-Fastener Metal Roof Panels: Formed with raised, trapezoidal major rib at panel edge and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between major rib and panel edge.
      a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
         1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
         2) Color: As selected by the Owner from manufacturer's full range.
      b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
         1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
         2) Color: As selected by the Owner from manufacturer's full range.
      c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
         1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
         2) Color: As selected by the Owner from manufacturer's full range.

d. Panel Coverage: 12 inches (305 mm) **OR** 16 inches (406 mm) **OR** 18 inches (457 mm), **as directed**.
e. Panel Height: 1.0 inch (25 mm) **OR** 1.5 inches (38 mm) **OR** 1.75 inches (44 mm), **as directed**.

3. Standing-Seam-Profile, Concealed-Fastener Metal Roof Panels: Formed with raised, curved-top, standing-seam-shaped major rib at panel edge and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between major rib and panel edge.
   a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   d. Material: Copper sheet, 16-oz./sq. ft. weight (0.55-mm thickness) **OR** 20-oz./sq. ft. weight (0.68-mm thickness), **as directed**.
      1) Exterior Finish: Brushed satin (lacquered) **OR** Mirror polished, **as directed**.
   e. Panel Coverage: 10 inches (254 mm) **OR** 12 inches (305 mm) **OR** 16 inches (406 mm) **OR** 18 inches (457 mm), **as directed**.
   f. Panel Height: 1.0 inch (25 mm) **OR** 1.25 inches (32 mm) **OR** 1.5 inches (38 mm), **as directed**.

4. Batten-Seam-Profile, Concealed-Fastener Metal Roof Panels: Formed with raised, batten-seam-shaped major rib at panel edge and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between major rib and panel edge.
   a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   d. Panel Coverage: 10 inches (254 mm) **OR** 12 inches (305 mm) **OR** 14 inches (356 mm) **OR** 15 inches (381 mm) **OR** 18 inches (457 mm) **OR** 24 inches (610 mm) **OR** 36 inches (914 mm), **as directed**.

e. Panel Height: 0.75 inch (19 mm) **OR** 1.25 inches (32 mm) **OR** 1.5 inches (38 mm), **as directed**.
f. Batten Width: 1.5 inches (38 mm) **OR** 2.0 inches (51 mm), **as directed**.

I. Standing-Seam Metal Roof Panels
1. General: Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.
a. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1514.
b. Aluminum Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1637.
2. Vertical-Rib, Snap-Joint, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels, and snapping panels together.
a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As selected by the Owner from manufacturer's full range.
b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As selected by the Owner from manufacturer's full range.
c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As selected by the Owner from manufacturer's full range.
d. Material: Copper sheet, 16-oz./sq. ft. weight (0.55-mm thickness) **OR** 20-oz./sq. ft. weight (0.68-mm thickness), **as directed**,.
1) Exterior Finish: Brushed satin (lacquered) **OR** Mirror polished, **as directed**.
e. Batten: Same material, finish, and color as roof panels.
f. Clips: Fixed **OR** Floating to accommodate thermal movement, **as directed**.
1) Material: 0.028-inch- (0.71-mm-) **OR** 0.064-inch- (1.63-mm-), **as directed**, nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
2) Material: 0.025-inch- (0.64-mm-) **OR** 0.062-inch- (1.59-mm-), **as directed**, thick, stainless-steel sheet.
g. Panel Coverage: 10 inches (254 mm) **OR** 12 inches (305 mm) **OR** 14 inches (356 mm) **OR** 16 inches (406 mm) **OR** 18 inches (457 mm) **OR** 24 inches (610 mm), **as directed**.
h. Panel Height: 1.0 inch (25 mm) **OR** 1.5 inches (38 mm) **OR** 1.75 inches (44 mm), **as directed**.
3. Vertical-Rib, Seamed-Joint, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels, and mechanically seaming panels together.

a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: As selected by the Owner from manufacturer's full range.

b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: As selected by the Owner from manufacturer's full range.

c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: As selected by the Owner from manufacturer's full range.

d. Material: Copper sheet, 16-oz./sq. ft. weight (0.55-mm thickness) **OR** 20-oz./sq. ft. weight (0.68-mm thickness), **as directed**.
   1) Exterior Finish: Brushed satin (lacquered) **OR** Mirror polished, **as directed**.

e. Batten: Same material, finish, and color as roof panels.

f. Clips: Fixed **OR** Floating to accommodate thermal movement, **as directed**.
   1) Material: 0.028-inch- (0.71-mm-) **OR** 0.064-inch- (1.63-mm-), **as directed**, nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
   2) Material: 0.025-inch- (0.64-mm-) **OR** 0.062-inch- (1.59-mm-), **as directed**, thick, stainless-steel sheet.

g. Joint Type: Single folded **OR** Double folded **OR** As standard with manufacturer, **as directed**.

h. Panel Coverage: 12 inches (305 mm) **OR** 14 inches (356 mm) **OR** 16 inches (406 mm) **OR** 18 inches (457 mm) **OR** 20 inches (508 mm) **OR** 24 inches (610 mm), **as directed**.

i. Panel Height: 1.5 inches (38 mm) **OR** 2.0 inches (51 mm) **OR** 2.5 inches (64 mm), **as directed**.

4. Trapezoidal-Rib, Snap-Joint, Standing-Seam Metal Roof Panels: Formed with raised trapezoidal ribs at panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels, and snapping panels together.
   a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 28-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   c. Clips: Fixed **OR** Floating to accommodate thermal movement, **as directed**.
      1) Material: 0.028-inch- (0.71-mm-) **OR** 0.064-inch- (1.63-mm-), **as directed**, nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.

d. Panel Coverage: 12 inches (305 mm) **OR** 18 inches (457 mm) **OR** 24 inches (610 mm), **as directed**.
e. Panel Height: 3 inches (76 mm).

5. Trapezoidal-Rib, Seamed-Joint, Standing-Seam Metal Roof Panels: Formed with raised trapezoidal ribs at panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels, and mechanically seaming panels together.
   a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   c. Clips: Fixed **OR** Floating to accommodate thermal movement, **as directed**.
      1) Material: 0.028-inch- (0.71-mm-) **OR** 0.064-inch- (1.63-mm-), **as directed**, nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
   d. Joint Type: Single folded **OR** Double folded **OR** As standard with manufacturer, **as directed**.
   e. Panel Coverage: 12 inches (305 mm) **OR** 18 inches (457 mm) **OR** 24 inches (610 mm), **as directed**.
   f. Panel Height: 2.7 inches (69 mm) **OR** 3.0 inches (76 mm), **as directed**.

6. Integral-Standing-Seam Metal Roof Panels: Formed with integral ribs at panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and lapping and interconnecting side edges of adjacent panels.
   a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   d. Material: Copper sheet, 16-oz./sq. ft. weight (0.55-mm thickness) **OR** 20-oz./sq. ft. weight (0.68-mm thickness), **as directed**.
      1) Exterior Finish: Brushed satin (lacquered) **OR** Mirror polished, **as directed**.
   e. Clips: Fixed **OR** Floating to accommodate thermal movement, **as directed**.

1) Material: 0.028-inch- (0.71-mm-) **OR** 0.064-inch- (1.63-mm-), **as directed**, nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
2) Material: 0.025-inch- (0.64-mm-) **OR** 0.062-inch- (1.59-mm-), **as directed**, thick, stainless-steel sheet.

f. Panel Coverage: 12 inches (305 mm) **OR** 16 inches (406 mm) **OR** 18 inches (457 mm), **as directed**.

g. Panel Height: 1.0 inch (25 mm) **OR** 1.5 inches (38 mm) **OR** 2.0 inches (51 mm), **as directed**.

J. Batten-Seam Metal Roof Panels

1. General: Provide factory-formed metal roof panel assembly designed to be installed by covering vertical side edges of adjacent panels with battens and mechanically attaching panels to supports using concealed clips. Include battens and accessories required for weathertight installation.
2. Narrow-Profile, Snap-on-Batten-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between ribs; designed for independent installation by mechanically attaching panels to supports using concealed clips located under 1 side of panels and engaging opposite edge of adjacent panels, and installation of 3/8-to-1/2-inch- (10-to-13-mm-) wide, snap-on battens over panel joints.
   a. Panel Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   b. Panel Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   c. Panel Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   d. Panel Material: Copper sheet, 16-oz./sq. ft. weight (0.55-mm thickness) **OR** 20-oz./sq. ft. weight (0.68-mm thickness), **as directed**.
      1) Exterior Finish: Brushed satin (lacquered) **OR** Mirror polished, **as directed**.
   e. Batten Material: Same material, finish, and color as roof panels.
   f. Clips: One **OR** Two, **as directed**, piece.
      1) Material: 0.028-inch- (0.71-mm-) **OR** 0.064-inch- (1.63-mm-), **as directed,** nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
      2) Material: 0.025-inch- (0.64-mm-) **OR** 0.062-inch- (1.59-mm-), **as directed**, thick, stainless-steel sheet.
   g. Sealant: Factory applied in top **OR** on each side, **as directed**, of battens.
   h. Panel Coverage: 12 inches (305 mm) **OR** 14 inches (356 mm) **OR** 16 inches (406 mm) **OR** 18 inches (457 mm) **OR** 20 inches (508 mm), **as directed**.
   i. Batten Height: 1.0 inch (25 mm) **OR** 1.25 inches (32 mm) **OR** 1.5 inches (38 mm) **OR** 1.75 inches (44 mm) **OR** 2.0 inches (51 mm), **as directed**.
3. Wide-Profile, Snap-on-Batten-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between ribs; designed for independent installation by mechanically attaching panels to supports using concealed clips located between and engaging edges of adjacent panels, and installing snap-on battens over panel joints.

a. Panel Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: As selected by the Owner from manufacturer's full range.

b. Panel Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: As selected by the Owner from manufacturer's full range.

c. Panel Material: Aluminum sheet, 0.024 inch (0.061 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm), **as directed**, thick.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: As selected by the Owner from manufacturer's full range.

d. Panel Material: Copper sheet, 16-oz./sq. ft. weight (0.55-mm thickness) **OR** 20-oz./sq. ft. weight (0.68-mm thickness), **as directed**.
   1) Exterior Finish: Brushed satin (lacquered) **OR** Mirror polished, **as directed**.

e. Batten Material: Same material, finish, and color as roof panels.

f. Clips: One piece.
   1) Material: 0.028-inch- (0.71-mm-) **OR** 0.064-inch- (1.63-mm-), **as directed**, nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
   2) Material: 0.025-inch- (0.64-mm-) **OR** 0.062-inch- (1.59-mm-), **as directed**, thick, stainless-steel sheet.

g. Sealant: Factory applied on each side of battens.

h. Panel Coverage: 12 inches (305 mm) **OR** 14 inches (356 mm) **OR** 16 inches (406 mm) **OR** 18 inches (457 mm) **OR** 22 inches (559 mm) **OR** 24 inches (610 mm), **as directed**.

i. Batten Height: 1.0 inch (25 mm) **OR** 1.5 inches (38 mm) **OR** 1.75 inches (44 mm) **OR** 1.88 inches (48 mm) **OR** 2.0 inches (51 mm), **as directed**.

4. Seamed-Batten Metal Roof Panels: Formed with vertical ribs at panel edges and intermediate stiffening ribs symmetrically spaced **OR** smooth, flat pan, **as directed**, between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels, and installing mechanically seamed battens over panel joints.

a. Panel Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: As selected by the Owner from manufacturer's full range.

b. Panel Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: As selected by the Owner from manufacturer's full range.

c. Panel Material: Aluminum sheet, 0.024 inch (0.061 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm), **as directed**, thick.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: As selected by the Owner from manufacturer's full range.

d. Panel Material: Copper sheet, 16-oz./sq. ft. weight (0.55-mm thickness) **OR** 20-oz./sq. ft. weight (0.68-mm thickness), **as directed**.
   1) Exterior Finish: Brushed satin (lacquered) **OR** Mirror polished, **as directed**.
e. Batten Material: Same material, finish, and color as roof panels.
f. Clips: One **OR** Two, **as directed**, piece.
   1) Material: 0.028-inch- (0.71-mm-) **OR** 0.064-inch- (1.63-mm-), **as directed**, nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
   2) Material: 0.025-inch- (0.64-mm-) **OR** 0.062-inch- (1.59-mm-), **as directed**, thick, stainless-steel sheet.
g. Sealant: Factory applied on each side of clips under battens.
h. Panel Coverage: 12 inches (305 mm) **OR** 16 inches (406 mm) **OR** 18 inches (457 mm), **as directed**.
i. Batten Height: 2.0 inches (51 mm) **OR** 2.375 inches (60 mm) **OR** 3.0 inches (76 mm), **as directed**.

K. Horizontal-Seam (Bermuda-Type) Metal Roof Panels
1. Horizontal-Seam (Bermuda-Type) Metal Roof Panels: Formed with horizontal seam at panel edges and smooth, flat pan; designed to be installed in sequential installation by engaging lower edge of each panel to upper edge of panel below and mechanically attaching panels to supports using concealed clips located under upper edge of panels.
   a. Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   b. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   c. Material: Aluminum sheet, 0.032 inch (0.81 mm) thick.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer, **as directed**.
      2) Color: As selected by the Owner from manufacturer's full range.
   d. Material: Copper sheet, 16-oz./sq. ft. weight (0.55-mm thickness) **OR** 20-oz./sq. ft. weight (0.68-mm thickness), **as directed**.
      1) Exterior Finish: Brushed satin (lacquered) **OR** Mirror polished, **as directed**.
   e. Clips: One piece.
      1) Material: 0.028-inch- (0.71-mm-) nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
      2) Material: 0.025-inch- (0.64-mm-) thick, stainless-steel sheet.
   f. Seal: Factory-applied sealant or vinyl weatherseal in seam.
   g. Exposure: 9.5 inches (241 mm) **OR** 11 inches (279 mm), **as directed**, nominal.
   h. Seam Height: 1.0 inch (25 mm) **OR** 1.5 inches (38 mm), **as directed**.

L. Foamed-Insulation-Core Metal Roof Panels
1. General: Provide factory-formed and -assembled metal roof panels fabricated from two sheets of metal with insulation core foamed-in-place during fabrication with joints between panels designed to form weathertight seals. Include accessories required for weathertight installation.
   a. Panel Performance:
      1) Flatwise Tensile Strength: 30 psi (200 kPa) when tested according to ASTM C 297/C 297M.

2) Humid Aging: Volume increase not greater than 6.0 percent and no delamination or metal corrosion when tested for 7 days at 140 deg F (60 deg C) and 100 percent relative humidity according to ASTM D 2126.
3) Heat Aging: Volume increase not greater than 2.0 percent and no delamination, surface blistering, or permanent bowing when tested for 7 days at 200 deg F (93 deg C) according to ASTM D 2126.
4) Cold Aging: Volume decrease not more than 1.0 percent and no delamination, surface blistering, or permanent bowing when tested for 7 days at minus 20 deg F (29 deg C) according to ASTM D 2126.
5) Fatigue: No evidence of delamination, core cracking, or permanent bowing when tested to a 20-lbf/sq. ft. (958-kPa) positive and negative wind load and with deflection of L/180 for 2 million cycles.
6) Autoclave: No delamination when exposed to 2-psi (13.8-kPa) pressure at a temperature of 212 deg F (100 deg C) for 2-1/2 hours.
7) Fire-Test-Response Characteristics: Class A according to ASTM E 108.

b. Insulation Core: Modified isocyanurate or polyurethane foam using a non-CFC blowing agent, with maximum flame-spread and smoke-developed indexes of 25 and 450, respectively.
1) Closed-Cell Content: 90 percent when tested according to ASTM D 2856.
2) Density: 2.0 to 2.6 lb/cu. ft. (32 to 42 kg/cu. m) when tested according to ASTM D 1622.
3) Compressive Strength: Minimum 20 psi (140 kPa) when tested according to ASTM D 1621.
4) Shear Strength: 26 psi (179 kPa) when tested according to ASTM C 273.

2. Lap-Seam-Profile, Foamed-Insulation-Core Metal Roof Panels: Formed for lapping side edges of adjacent panels and mechanically attaching to supports using exposed fasteners in side laps.
a. Facings: Fabricate panel with exterior and interior facings of same material and thickness.
1) Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
2) Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
3) Exterior Facing Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
a) Color: As selected by the Owner from manufacturer's full range.
4) Interior Facing Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
a) Color: As selected by the Owner from manufacturer's full range.

b. Batten: Same material, finish, and color as exterior facings of roof panels.
c. Panel Coverage: 24 inches (610 mm) **OR** 30 inches (762 mm) **OR** 36 inches (914 mm) **OR** 39.6 inches (1000 mm) **OR** 40 inches (1016 mm) **OR** 44.5 inches (1130 mm), **as directed**.
d. Panel Thickness: 1.0 inch (25 mm) **OR** 1.5 inches (38 mm) **OR** 2.0 inches (51 mm) **OR** 2.5 inches (64 mm) **OR** 3.0 inches (76 mm) **OR** 4.0 inches (102 mm) **OR** 5.0 inches (127 mm) **OR** 6.0 inches (152 mm), **as directed**.

3. Standing-Seam-Profile, Foamed-Insulation-Core Metal Roof Panels: Formed with vertical tongue-and-groove ribs at panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between ribs; designed for sequential installation by interlocking tongue-and-groove panel edges and mechanically attaching panels to supports using concealed clips located between and engaging edges of adjacent panels, and mechanically seaming panels together.
a. Facings: Fabricate panel with exterior and interior facings of same material and thickness.
1) Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.

2) Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
3) Exterior Facing Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
a) Color: As selected by the Owner from manufacturer's full range.
4) Interior Facing Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
a) Color: As selected by the Owner from manufacturer's full range.

b. Joint Type: Single folded **OR** Double folded **OR** As standard with manufacturer, **as directed**.
c. Panel Coverage: 36 inches (914 mm) **OR** 42 inches (1067 mm), **as directed**.
d. Panel Thickness: 2.0 inches (51 mm) **OR** 2.5 inches (64 mm) **OR** 3.0 inches (76 mm) **OR** 4.0 inches (102 mm) **OR** 5.0 inches (127 mm) **OR** 6.0 inches (152 mm), **as directed**.

4. Batten-Seam-Profile, Foamed-Insulation-Core Metal Roof Panels: Formed with vertical or tapered tongue-and-groove ribs at panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between ribs; designed for sequential installation by interlocking tongue-and-groove panel edges and mechanically attaching panels to supports using concealed clips located between and engaging edges of adjacent panels, and installing snap-on battens over panel joints.
a. Facings: Fabricate panel with exterior and interior facings of same material and thickness.
1) Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) nominal thickness.
2) Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) nominal thickness.
3) Exterior Facing Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
a) Color: As selected by the Owner from manufacturer's full range.
4) Interior Facing Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
a) Color: As selected by the Owner from manufacturer's full range.

b. Batten: Same material, finish, and color as exterior facings of roof panels.
c. Clips: One piece; 0.064-inch- (1.63-mm-) **OR** 0.097-inch- (2.50-mm-), **as directed**, nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
d. Panel Coverage: 36 inches (914 mm) **OR** 39.6 inches (1000 mm), **as directed**.
e. Panel Thickness: 1.75 inches (44 mm) **OR** 2.0 inches (51 mm) **OR** 2.5 inches (64 mm) **OR** 3.0 inches (76 mm) **OR** 4.0 inches (102 mm) **OR** 5.0 inches (127 mm) **OR** 6.0 inches (152 mm), **as directed**.

M. Metal Soffit Panels
1. General: Provide factory-formed metal soffit panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners and factory-applied sealant in side laps. Include accessories required for weathertight installation.
2. Metal Soffit Panels: Match profile and material of metal roof panels.
a. Finish: Match finish and color of metal roof panels **OR** Match finish and color of metal wall panels **OR** As indicated on Drawings, **as directed**.
b. Sealant: Factory applied within interlocking joint.
3. Flush-Profile Metal Soffit Panels: Solid **OR** Perforated, **as directed**, panels formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between panel edges; with flush joint between panels.
a. Material: Same material, finish, and color as metal roof panels.

b. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: Match finish and color of metal roof panels **OR** Match finish and color of metal wall panels **OR** As selected by the Owner from manufacturer's full range, **as directed**.

c. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: Match finish and color of metal roof panels **OR** Match finish and color of metal wall panels **OR** As selected by the Owner from manufacturer's full range, **as directed**.

d. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: Match finish and color of metal roof panels **OR** Match finish and color of metal wall panels **OR** As selected by the Owner from manufacturer's full range, **as directed**.

e. Material: Copper sheet, 16-oz./sq. ft. weight (0.55-mm thickness) **OR** 20-oz./sq. ft. weight (0.68-mm thickness), **as directed**.
   1) Exterior Finish: Brushed satin (lacquered) **OR** Mirror polished, **as directed**.

f. Panel Coverage: 8 inches (203 mm) **OR** 12 inches (305 mm) **OR** 16 inches (406 mm) **OR** 20 inches (508 mm), **as directed**.

g. Panel Height: 0.875 inch (22 mm) **OR** 1.0 inch (25 mm) **OR** 1.5 inches (38 mm) **OR** 3.0 inches (76 mm), **as directed**.

h. Sealant: Factory applied within interlocking joint.

4. Reveal-Joint-Profile Metal Soffit Panels: Solid **OR** Perforated, **as directed**, panels formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between panel edges; with recessed reveal joint between panels.
   a. Material: Same material, finish, and color as metal roof panels.
   b. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: Match finish and color of metal roof panels **OR** Match finish and color of metal wall panels **OR** As selected by the Owner from manufacturer's full range, **as directed**.
   c. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: Match finish and color of metal roof panels **OR** Match finish and color of metal wall panels **OR** As selected by the Owner from manufacturer's full range, **as directed**.

d. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: Match finish and color of metal roof panels **OR** Match finish and color of metal wall panels **OR** As selected by the Owner from manufacturer's full range, **as directed**.

e. Material: Copper sheet, 16-oz./sq. ft. weight (0.55-mm thickness) **OR** 20-oz./sq. ft. weight (0.68-mm thickness), **as directed**.
   1) Exterior Finish: Brushed satin (lacquered) **OR** Mirror polished, **as directed**.

f. Panel Coverage: 8 inches (203 mm) **OR** 12 inches (305 mm) **OR** 16 inches (406 mm) **OR** 20 inches (508 mm), **as directed**.

g. Panel Height: 0.75 inch (19 mm) **OR** 1.0 inch (25 mm) **OR** 1.5 inches (38 mm), **as directed**.

5. V-Groove-Profile Metal Soffit Panels: Solid **OR** Perforated, **as directed**, panels formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm),flat pan, **as directed**, between panel edges; with V-groove joint between panels.
   a. Material: Same material, finish, and color as metal roof panels.
   b. Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: Match finish and color of metal roof panels **OR** Match finish and color of metal wall panels **OR** As selected by the Owner from manufacturer's full range, **as directed**.
   c. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: Match finish and color of metal roof panels **OR** Match finish and color of metal wall panels **OR** As selected by the Owner from manufacturer's full range, **as directed**.
   d. Material: Aluminum sheet, 0.024 inch (0.65 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: Match finish and color of metal roof panels **OR** Match finish and color of metal wall panels **OR** As selected by the Owner from manufacturer's full range, **as directed**.
   e. Panel Coverage: 6 inches (152 mm) **OR** 12 inches (305 mm) **OR** 14 inches (356 mm), **as directed**.
   f. Panel Height: 0.375 inch (10 mm) **OR** 0.44 inch (11 mm) **OR** 0.50 inch (13 mm) **OR** 0.625 inch (16 mm), **as directed**.

N. Accessories
   1. Roof Panel Accessories: Provide components approved by roof panel manufacturer and as required for a complete metal roof panel assembly including trim, copings, fasciae, corner units, ridge closures, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels unless otherwise indicated.
      a. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal roof panels.

b. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal roof panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

c. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.

2. Flashing and Trim: Formed from same material as roof panels, prepainted with coil coating, minimum 0.018 inch (0.45 mm) thick. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal roof panels.

3. Gutters: Formed from same material roof panels. Match profile of gable trim, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch- (2400-mm-) long sections, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Furnish gutter supports spaced a maximum of 36 inches (900 mm) o.c., fabricated from same metal as gutters. Provide wire ball strainers of compatible metal at outlets. Finish gutters to match metal roof panels **OR** roof fascia and rake trim, **as directed**.

4. Downspouts: Formed from same material as roof panels. Fabricate in 10-foot- (3-m-) long sections, complete with formed elbows and offsets, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual". Finish downspouts to match gutters.

5. Roof Curbs: Fabricated from same material as roof panels, minimum 0.048 inch (1.2 mm) thick; with bottom of skirt profiled to match roof panel profiles, and welded top box and integral full-length cricket. Fabricate curb subframing of minimum 0.0598-inch- (1.5-mm-) thick, angle-, C-, or Z-shaped steel sheet. Fabricate curb and subframing to withstand indicated loads, of size and height indicated. Finish roof curbs to match metal roof panels.

a. Insulate roof curb with 1-inch- (25-mm-) thick, rigid insulation.

O. Snow Guards

1. Snow Guards: Prefabricated, noncorrosive units designed to be installed without penetrating metal roof panels, and complete with predrilled holes, clamps, or hooks for anchoring.

a. Surface-Mounted, Plastic, Stop-Type Snow Guards: Clear **OR** Integral color, **as directed**, polycarbonate stops designed for attachment to pan surface of metal roof panels using construction adhesive, silicone or polyurethane sealant, or adhesive tape.

b. Surface-Mounted, Metal, Stop-Type Snow Guards: Cast-aluminum stops designed for attachment to pan surface of metal roof panel using construction adhesive, silicone or polyurethane sealant, or adhesive tape.

c. Surface-Mounted, Copper, Stop-Type Snow Guards: Bronze-alloy stops designed for attachment to pan surface of copper roof panel using solder.

d. Seam-Mounted, Stop-Type Snow Guards: Cast-aluminum **OR** Malleable-iron **OR** Clear polycarbonate **OR** Colored polycarbonate, **as directed**, stops designed for attachment to vertical ribs of standing-seam metal roof panels with stainless-steel set screws.

e. Seam-Mounted, Bar-Type Snow Guards: Aluminum **OR** stainless-steel, **as directed**, rods or bars held in place by stainless-steel clamps attached to vertical ribs of standing-seam metal roof panels.

1) Aluminum Finish: Mill **OR** Clear anodized, **as directed**.

2) Stainless-Steel Finish: Mill **OR** No. 2B **OR** No. 4, **as directed**.

P. Fabrication

1. Fabricate and finish metal roof panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes and as necessary to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.

2. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

3. Fabricate metal roof panel side laps with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will seal weathertight and minimize noise from movements within panel assembly.
4. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of item indicated.
   a. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
   b. End Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
   c. End Seams for Other Than Aluminum: Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
   d. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
   e. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
   f. Fabricate cleats and attachment devices of size and metal thickness recommended by SMACNA's "Architectural Sheet Metal Manual" or by metal roof panel manufacturer for application, but not less than thickness of metal being secured.

Q. Finishes
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
3. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

1.3 EXECUTION

A. Preparation
1. Clean substrates of substances harmful to insulation, including removing projections capable of interfering with insulation attachment.
2. Substrate Board: Install substrate boards over roof deck **OR** sheathing, **as directed**, on entire roof surface. Attach with substrate-board fasteners.
   a. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
   b. Comply with UL **OR** FMG, **as directed**, requirements for fire-rated construction.
3. Miscellaneous Framing: Install subpurlins, eave angles, furring, and other miscellaneous roof panel support members and anchorage according to metal roof panel manufacturer's written instructions.
   a. Soffit Framing: Wire tie or clip furring channels to supports, as required to comply with requirements for assemblies indicated.

B. Underlayment Installation
1. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated below **OR** on Drawings, a**s directed**, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches (150 mm) staggered 24 inches (600 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Extend underlayment into gutter trough. Roll laps with roller. Cover underlayment within 14 days.
   a. Roof perimeter for a distance up from eaves of 24 inches (600 mm) **OR** 36 inches (914 mm), **as directed**, beyond interior wall line.

b. Valleys, from lowest point to highest point, for a distance on each side of 18 inches (460 mm), **as directed**. Overlap ends of sheets not less than 6 inches (150 mm).
c. Rake edges for a distance of 18 inches (460 mm).
d. Hips and ridges for a distance on each side of 12 inches (300 mm).
e. Roof to wall intersections for a distance from wall of 18 inches (460 mm).
f. Around dormers, chimneys, skylights, and other penetrating elements for a distance from element of 18 inches (460 mm).

2. Felt Underlayment: Apply at locations indicated below **OR** on Drawings, **as directed**, in shingle fashion to shed water, and with lapped joints of not less than 2 inches (50 mm).
   a. Apply over entire roof surface.
   b. Apply on roof not covered by self-adhering sheet underlayment. Lap over edges of self-adhering sheet underlayment not less than 3 inches (75 mm), in shingle fashion to shed water.
3. Apply slip sheet over underlayment before installing metal roof panels.
4. Install flashings to cover underlayment to comply with requirements specified in Division 07 Section "Sheet Metal Flashing And Trim".

C. Thermal Insulation Installation
1. Polyethylene Vapor Retarder: Extend vapor retarder to extremities of areas to be protected from vapor transmission. Repair tears or punctures immediately before concealment by other work.
2. Board Insulation: Extend insulation in thickness indicated to cover entire roof. Comply with installation requirements in Division 07 Section "Building Insulation".
   a. Erect insulation and hold in place with Z-shaped furring members spaced 24 inches (610 mm) **OR** 600 mm, **as directed**, o.c. Securely attach narrow flanges of furring members to roof deck with screws spaced 24 inches (600 mm) o.c.
3. Blanket Insulation: Install insulation concurrently with metal roof panel installation, in thickness indicated to cover entire roof, according to manufacturer's written instructions and as follows:
   a. Set vapor-retarder-faced units with vapor retarder to warm side **OR** in location indicated, **as directed**, of construction unless otherwise indicated. Do not obstruct ventilation spaces.
   b. Tape joints and ruptures in vapor retarder and seal each continuous area of insulation to surrounding construction to ensure airtight installation.
   c. Install blankets straight and true in one-piece lengths with both sets of facing tabs sealed. Comply with the following installation method:
      1) Over-Framing Installation: Extend insulation and vapor retarder over and perpendicular to top flange of secondary framing members. Hold in place by panels fastened to secondary framing.
      2) Between-Purlin Installation: Extend insulation and vapor retarder between purlins. Carry vapor-retarder facing tabs up and over purlin, overlapping adjoining facing of next insulation course maintaining continuity of retarder. Hold in place with bands and crossbands below insulation.
      3) Over-Purlin-with-Spacer-Block Installation: Extend insulation and vapor retarder over and perpendicular to top flange of secondary framing members. Install layer of filler insulation over first layer to fill space formed by roof panel standoffs. Hold in place by panels fastened to standoffs.
      4) Two-Layers-between-Purlin-with-Spacer-Block Installation: Extend insulation and vapor retarder between purlins. Carry vapor-retarder facing tabs up and over purlins, overlapping adjoining facing of next insulation course maintaining continuity of retarder. Install layer of filler insulation over first layer to fill space between purlins formed by thermal spacer blocks. Hold in place with bands and crossbands below insulation.
   d. Retainer Strips: Install retainer strips at each longitudinal insulation joint, straight and taut, nesting with secondary framing to hold insulation in place.
   e. Thermal Spacer Blocks: Where metal roof panels attach directly to purlins, install thermal spacer blocks.

D. Metal Roof Panel Installation, General
   1. Provide metal roof panels of full length from eave to ridge unless otherwise indicated or restricted by shipping limitations.
   2. Thermal Movement. Rigidly fasten metal roof panels to structure at one and only one location for each panel. Allow remainder of panel to move freely for thermal expansion and contraction. Predrill panels for fasteners.
      a. Point of Fixity: Fasten each panel along a single line of fixing located at eave **OR** ridge **OR** center of panel length **OR** locations indicated on Drawings, **as directed**.
      b. Avoid attaching accessories through roof panels in a manner that will inhibit thermal movement.
   3. Install metal roof panels as follows:
      a. Commence metal roof panel installation and install minimum of 300 sq. ft. (27.8 sq. m.) in presence of factory-authorized representative.
      b. Field cutting of metal panels by torch is not permitted.
      c. Install panels perpendicular to purlins.
      d. Locate and space fastenings in uniform vertical and horizontal alignment.
      e. Provide metal closures at rake edges **OR** rake walls, **as directed**, and each side of ridge **OR** ridge and hip, **as directed**, caps.
      f. Flash and seal metal roof panels with weather closures at eaves, rakes, and perimeter of all openings.
      g. Install ridge **OR** ridge and hip, **as directed**, caps as metal roof panel work proceeds.
      h. End Splices: Locate panel end splices over, but not attached to, structural supports. Stagger panel end splices to avoid a four-panel splice condition.
      i. Install metal flashing to allow moisture to run over and off metal roof panels.
   4. Fasteners:
      a. Steel Roof Panels: Use stainless-steel fasteners for surfaces exposed to the exterior and galvanized-steel fasteners for surfaces exposed to the interior.
      b. Aluminum Roof Panels: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior and aluminum or galvanized-steel fasteners for surfaces exposed to the interior.
      c. Copper Roof Panels: Use copper, stainless-steel, or hardware-bronze fasteners.
   5. Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.
   6. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.
      a. Coat back side of roof panels with bituminous coating where roof panels will contact wood, ferrous metal, or cementitious construction.
   7. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal roof panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal roof panel manufacturer.
      a. Seal metal roof panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal roof panel manufacturer.
      b. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants".

E. Metal Roof Panel Installation
   1. Lap-Seam Metal Roof Panels: Fasten metal roof panels to supports with fasteners at each lapped joint at location and spacing recommended by manufacturer.
      a. Apply panels and associated items for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.
      b. Lap ribbed or fluted sheets one full rib corrugation.
      c. Provide metal-backed neoprene or EPDM washers under heads of exposed fasteners bearing on weather side of metal roof panels.

d. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
e. Install screw fasteners with power tools having controlled torque adjusted to compress washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.
f. Provide sealant tape at lapped joints of metal roof panels and between panels and protruding equipment, vents, and accessories.
g. Apply a continuous ribbon of sealant tape to weather-side surface of fastenings on end laps, and on side laps of nesting-type panels; on side laps of corrugated nesting-type, ribbed, or fluted panels; and elsewhere as needed to make panels weatherproof to driving rains.
h. At panel end splices, nest panels with minimum 6-inch (150-mm) end lap, sealed with butyl-rubber sealant and fastened together by interlocking clamping plates.

2. Standing-Seam Metal Roof Panels: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended by manufacturer.
a. Install clips to supports with self-tapping fasteners.
b. Install pressure plates at locations indicated in manufacturer's written installation instructions.
c. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
d. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.

3. Batten-Seam Metal Roof Panels: Fasten metal roof panels to supports with concealed clips at each batten-seam joint at location, spacing, and with fasteners recommended by manufacturer.
a. Install clips to supports with self-drilling fasteners.
b. Apply battens to metal roof panel seams, fully engaged to provide weathertight joints.

4. Horizontal-Seam (Bermuda-Type) Metal Roof Panels: Fasten metal roof panels to supports with concealed clips at each horizontal-seam joint at location, spacing, and with fasteners recommended by manufacturer. Start at eave and work upward toward ridge.
a. Install clips to supports with self-drilling fasteners.

F. Foamed-Insulation-Core Metal Roof Panel Installation
1. General: Apply continuous ribbon of sealant to panel joint on concealed side of insulated metal roof panels as vapor seal; apply sealant to panel joint on exposed side of panels for weather seal.
2. Lap-Seam, Foamed-Insulation-Core Metal Roof Panels: Fasten insulated metal roof panels to supports with fasteners at each lapped joint at location and spacing recommended by manufacturer.
a. Lap ribbed or fluted sheets one full rib corrugation. Apply panels and associated items for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.
b. Provide metal-backed washers under heads of exposed fasteners bearing on weather side of insulated metal roof panels.
c. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
d. Provide sealant tape at lapped joints of insulated metal roof panels and between panels and protruding equipment, vents, and accessories.
e. Apply a continuous ribbon of sealant tape to panel side laps and elsewhere as needed to make panels weatherproof to driving rains.
f. Apply snap-on battens to insulated metal roof panel seams to conceal fasteners.

3. Standing-Seam, Foamed-Insulation-Core Metal Roof Panels: Fasten insulated metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended by manufacturer.
a. Install clips to supports with self-tapping fasteners.

b. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so cleat, insulated metal roof panel, and factory-applied side-lap sealant are completely engaged.

4. Batten-Seam, Foamed-Insulation-Core Metal Roof Panels: Fasten insulated metal roof panels to supports with concealed clips at each batten-seam joint at location, spacing, and with fasteners recommended by manufacturer.
   a. Apply battens to insulated metal roof panel seams, fully engaged to provide weathertight joints.

G. Metal Soffit Panel Installation
1. In addition to complying with requirements in "Metal Roof Panel Installation, General" Article, install metal soffit panels to comply with requirements in this article.
2. Metal Soffit Panels: Provide metal soffit panels full width of soffits. Install panels perpendicular to support framing.
   a. Flash and seal panels with weather closures where metal soffit panels meet walls and at perimeter of all openings.
3. Metal Fascia Panels: Align bottom of panels and fasten with blind rivets, bolts, or self-tapping screws. Flash and seal panels with weather closures where fasciae meet soffits, along lower panel edges, and at perimeter of all openings.

H. Accessory Installation
1. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
   a. Install components required for a complete metal roof panel assembly including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
2. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
   a. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
   b. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (600 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).
3. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 36 inches (914 mm) o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.
4. Downspouts: Join sections with telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1500 mm) o.c. in between.
   a. Provide elbows at base of downspouts to direct water away from building.
   b. Connect downspouts to underground drainage system indicated.
5. Roof Curbs: Install curbs at locations indicated on Drawings. Install flashing around bases where they meet metal roof panels.
6. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to metal roof panels as recommended by manufacturer.

I. Snow Guard Installation

1. Stop-Type Snow Guards: Attach snow guards to metal roof panels with adhesive, sealant, or adhesive tape, as recommended by manufacturer. Do not use fasteners that will penetrate metal roof panels.
   a. Provide rows of snow guards, at locations indicated on Drawings, spaced apart, beginning from gutter, with each snow guard centered between panel ribs.
2. Bar-Type Snow Guards: Attach bar supports to vertical ribs of standing-seam metal roof panels with clamps or set screws. Do not use fasteners that will penetrate metal roof panels.
   a. Provide rows of snow guards, at locations indicated on Drawings, spaced apart, beginning from gutter.

J. Erection Tolerances
1. Installation Tolerances: Shim and align metal roof panel units within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

K. Field Quality Control
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect metal roof panel installation, including accessories. Report results in writing.
2. Remove and replace applications of metal roof panels where inspections indicate that they do not comply with specified requirements.
3. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

L. Cleaning
1. Remove temporary protective coverings and strippable films, if any, as metal roof panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of metal roof panel installation, clean finished surfaces as recommended by metal roof panel manufacturer. Maintain in a clean condition during construction.
2. Replace metal roof panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07410

SECTION 07410a - SHEET METAL ROOFING

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for sheet metal roofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Flat-seam metal roofing, custom fabricated.
b. Standing-seam metal roofing, custom fabricated **OR** on-site, roll formed, **as directed**.
c. Batten-seam metal roofing, custom fabricated **OR** on-site, roll formed, **as directed**.
d. Horizontal-seam (Bermuda-type) metal roofing, custom fabricated.

C. Performance Requirements
1. General Performance: Sheet metal roofing system including, but not limited to, metal roof panels, cleats, clips, anchors and fasteners, sheet metal flashing integral with sheet metal roofing, fascia panels, trim, battens, **as directed**, underlayment, and accessories shall comply with requirements indicated without failure due to defective manufacture, fabrication, installation, or other defects in construction. Sheet metal roofing shall remain watertight.
2. Thermal Movements: Provide sheet metal roofing that allows for thermal movements from ambient and surface temperature changes. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
3. Energy Performance: Provide metal roofing with solar reflectance index not less than 78 **OR** 29, **as directed**, when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency.

D. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:
a. Product Test Reports for Credit SS 7.2: For roof panels, indicating that panels comply with Solar Reflectance Index requirement.
3. Shop Drawings: Show fabrication and installation layouts of sheet metal roofing, including plans, elevations, expansion joint locations, and keyed details. Distinguish between shop- and field-assembled work.
a. Include details for forming, joining, and securing sheet metal roofing, including pattern of seams, termination points, fixed points, expansion joints, roof penetrations, edge conditions, special conditions, connections to adjoining work, and details of accessory items.
4. Samples: For each exposed product and for each finish specified.
5. Coordination Drawings: Roof plans drawn to scale with coordinated details for penetrations and roof-mounted items.
6. Portable Roll-Forming Equipment Certificate: Issued by UL for equipment manufacturer's portable roll-forming equipment capable of producing panels that comply with UL requirements.
7. Product test reports.
8. Maintenance data.
9. Warranties: Sample of special warranties.

E. Quality Assurance

1. Roll-Formed Sheet Metal Roofing Fabricator Qualifications: Fabricator authorized by portable roll-forming equipment manufacturer to fabricate and install sheet metal roofing units required for this Project, and who maintains current UL certification of its portable roll-forming equipment.
2. UL-Certified, Portable Roll-Forming Equipment: UL-certified, portable roll-forming equipment capable of producing roofing panels for sheet metal roofing assemblies that comply with UL 580 for Class 30 **OR** Class 60 **OR** Class 90, **as directed**, wind-uplift resistance. Maintain UL certification of portable roll-forming equipment for duration of sheet metal roofing work.
3. Sheet Metal Roofing Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" unless more stringent requirements are specified or shown on Drawings.
4. Copper Roofing Standard: Comply with CDA's "Copper in Architecture Handbook." Conform to dimensions and profiles shown unless more stringent requirements are indicated.
5. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Do not store sheet metal roofing materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal roofing materials away from uncured concrete and masonry.
2. Protect strippable protective covering on sheet metal roofing from exposure to sunlight and high humidity, except to the extent necessary for the period of sheet metal roofing installation.

G. Warranty
1. Special Warranty: Warranty form at the end of this Section in which Installer agrees to repair or replace components of sheet metal roofing that fail in materials or workmanship within two years from date of Substantial Completion.
2. Special Warranty on Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace sheet metal roofing that shows evidence of deterioration of factory-applied finishes within 20 **OR** 10, **as directed**, years from date of Substantial Completion.

1.2 PRODUCTS

A. Roofing Sheet Metals
1. General: Protect mechanical and other finishes on exposed surfaces from damage by applying a strippable, temporary protective film before shipping.
2. Metallic-Coated Steel Sheet: Restricted flatness steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
   a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality.
   b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40 (Class AZM150 coating designation, Grade 275); structural quality.
   c. Thickness: Nominal 0.022 inch (0.56 mm) **OR** 0.028 inch (0.71 mm), **as directed**, unless otherwise indicated.
      1) Batten Caps: Nominal 0.028 inch (0.71 mm) thick.
   d. Surface: Smooth, flat **OR** Embossed, **as directed**.
   e. Exposed Coil-Coated Finish:
      1) Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      2) Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      3) Four-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat and clear coats. Prepare, pretreat,

and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

4) Mica Fluoropolymer: AAMA 621. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

5) Metallic Fluoropolymer: AAMA 621. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

6) FEVE Fluoropolymer: AAMA 621. Two-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

7) Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.

8) Plastisol: Epoxy primer and vinyl plastisol topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 3.8 mils (0.97 mm) for topcoat.

f. Color: As selected from manufacturer's full range.

g. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

3. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required.

a. Thickness: 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, unless otherwise indicated.

1) Batten Caps: 0.050 inch (1.27 mm) thick.

b. As-Milled Finish: Mill **OR** One-side bright mill **OR** Standard one-side bright **OR** Standard two-side bright, **as directed**, finish.

c. Alclad Finish: Metallurgically bonded surfacing to both sides, forming a composite aluminum sheet with reflective luster.

d. Surface: Smooth, flat **OR** Embossed, **as directed**.

e. Factory Prime Coating: Where painting after installation is indicated, pretreat with white or light-colored, factory-applied, baked-on epoxy primer coat; minimum dry film thickness of 0.2 mil (0.005 mm).

f. Exposed Coil-Coated Finish:

1) Two-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

2) Three-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

3) Four-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat and clear coats. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

4) Mica Fluoropolymer: AAMA 620. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

5) Metallic Fluoropolymer: AAMA 620. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight

in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

6) FEVE Fluoropolymer: AAMA 620. Two-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

7) Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.

8) Plastisol: Epoxy primer and vinyl plastisol topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 3.8 mil (0.97 mm) for topcoat.

g. Color: As selected from manufacturer's full range.

h. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

4. Copper Sheet: ASTM B 370, cold-rolled copper sheet, H00 temper, 16 oz./sq. ft. (0.55 mm thick) **OR** 20 oz./sq. ft. (0.70 mm thick), **as directed**, unless otherwise indicated.

a. Batten Caps: 20 oz./sq. ft. (0.70 mm thick).

b. Non-Patinated Exposed Finish: Mill

c. Non-Patinated Exposed, Lacquered Finish: Finish designations for copper alloys comply with the system defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products."

1) Brushed Satin (Lacquered): M32-06x (Mechanical Finish: directionally textured, medium satin; with clear organic coating); coating of "Incralac" waterborne **OR** solvent-borne, **as directed**, methyl methacrylate copolymer lacquer with UV inhibitor, applied by air spray in two coats per manufacturer's written instructions to a total thickness of 1 mil (0.025 mm).

2) Mirror Polished (Lacquered): M22-06x (Mechanical Finish: buffed, specular; with clear organic coating); coating of "Incralac" waterborne **OR** solvent-borne, **as directed**, air-drying, methyl methacrylate copolymer lacquer with UV inhibitor, applied by air spray in two coats per manufacturer's written instructions to a total thickness of 1 mil (0.025 mm).

d. Pre-Patinated Copper-Sheet Finish: Dark brown **OR** Verdigris, **as directed**, pre-patinated according to ASTM B 882.

5. Zinc-Tin Alloy-Coated Copper Sheet: ASTM B 370, cold-rolled copper sheet, H00 temper, coated on both sides with a zinc-tin alloy (50 percent zinc, 50 percent tin).

a. Weight (Thickness): 16-oz./sq. ft. (0.55-mm) **OR** 20-oz./sq. ft. (0.70-mm), **as directed**, uncoated weight (thickness), with 0.787-mil (0.020-mm) coating thickness applied to each side.

1) Batten Caps: 20-oz./sq. ft. (0.70-mm) uncoated weight (thickness), with 0.787-mil (0.020-mm) coating thickness applied to each side unless otherwise indicated.

6. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304, dead soft, fully annealed.

a. Thickness: 0.016 inch (0.40 mm) **OR** 0.019 inch (0.48 mm), **as directed**, unless otherwise indicated.

1) Batten Caps: 0.019 inch (0.48 mm) thick.

b. Surface: Smooth, flat **OR** Embossed, **as directed**.

c. Finish: 2D (dull, cold rolled) **OR** 2B (bright, cold rolled) **OR** 3 (coarse, polished directional satin) **OR** 4 (polished directional satin), **as directed**.

1) Remove tool and die marks and stretch lines or blend into finish.

2) Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.

3) When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

7. Zinc-Tin Alloy-Coated Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304, dead-soft, fully annealed stainless-steel sheet, coated on both sides with a zinc-tin alloy (50 percent zinc, 50 percent tin), with factory-applied gray preweathering.
   a. Thickness: 0.015-inch (0.38-mm) **OR** 0.018-inch (0.46-mm) **OR** 0.024-inch (0.61-mm), **as directed**, minimum uncoated thickness, with 0.787-mil (0.020-mm) coating thickness applied to each side.
      1) Batten Caps: 0.018-inch- (0.46-mm-) minimum uncoated thickness, with 0.787-mil (0.020-mm) coating thickness applied to each side unless otherwise indicated.
8. Zinc-Tin Alloy-Coated Steel Sheet: ASTM A 625/A 625M; single-reduced, black-steel sheet, coated on both sides with a zinc-tin alloy (50 percent zinc, 50 percent tin), with factory-applied shop coat, **as directed**.
   a. Thickness: 0.012-inch (0.31-mm) **OR** 0.014-inch (0.36-mm), **as directed**, uncoated thickness, with 0.787-mil (0.020-mm) coating thickness applied to each side.
      1) Batten Caps: 0.014-inch (0.36-mm) uncoated thickness, with 0.787-mil (0.020-mm) coating thickness applied to each side unless otherwise indicated.
   b. Exposed Coil-Coated Finish: Manufacturer's standard two-coat fluoropolymer complying with performance requirements in AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      1) Color: As selected from manufacturer's full range.
   c. Field-Applied Finish: Manufacturer's standard waterborne acrylic emulsion paint primer and finish coat.
      1) Color: As selected from manufacturer's full range.
9. Zinc Sheet: Zinc, 99 percent pure, alloyed with a maximum of 1 percent copper and titanium; with manufacturer's standard factory-applied, flexible, protective back coating.
   a. Thickness: 0.027 inch (0.70 mm) **OR** 0.032 inch (0.80 mm), **as directed**, unless otherwise indicated.
      1) Batten Caps: 0.032 inch (0.80 mm) thick.
   b. Finish: Bright rolled **OR** Preweathered gray **OR** Preweathered black, **as directed**.
10. Titanium Sheet: ASTM B 265, Grade 1.
   a. Thickness: 0.015 inch (0.38 mm) **OR** 0.020 inch (0.51 mm), **as directed**, unless otherwise indicated.
      1) Batten Caps: 0.020 inch (0.51 mm) thick.
   b. Surface: Smooth, flat **OR** Embossed, **as directed**.
   c. Finish: Low **OR** Medium, **as directed**, matte.
   d. Color Anodic Finish (Light-Interference Phenomenon): Silver **OR** Gold **OR** Purple **OR** Blue **OR** Match sample **OR** As selected from manufacturer's full range of colors and color densities, **as directed**.

B. Underlayment Materials
1. Polyethylene Sheet: 6-mil- (0.15-mm-) thick polyethylene sheet complying with ASTM D 4397.
2. Felts: ASTM D 226, Type II (No. 30) **OR** Type I (No. 15), **as directed**, asphalt-saturated organic felts.
3. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils (0.76 to 1.0 mm) thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
   a. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F (116 deg C).
   b. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F (29 deg C).
4. Slip Sheet: Building paper, 3-lb/100 sq. ft. (0.16-kg/sq. m) minimum, rosin sized.

C. Miscellaneous Materials

1. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for a complete roofing system and as recommended by fabricator for sheet metal roofing.
2. Wood Battens: Lumber complying with requirements in Division 05 Section(s) "Historic Treatment Of Ornamental Metal" OR Division 06 Section(s) "Miscellaneous Carpentry", **as directed**, and treated with exterior-type fire retardant.
3. Snap-On Seams: Provide snap-on seams integrated with panel-edge profile as recommended by portable roll-forming equipment manufacturer to produce sheet metal roofing assemblies that comply with UL 580 for wind-uplift resistance classification specified in "Quality Assurance" Article.
4. Snap-on Batten Caps: Provide batten clips integrated with snap-on caps as recommended by portable roll-forming equipment manufacturer to produce sheet metal roofing assemblies that comply with UL 580 for wind-uplift resistance classification specified in "Quality Assurance" Article.
5. Fasteners: Wood screws, annular-threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads.
    a. General:
        1) Exposed Fasteners: Heads matching color of sheet metal roofing using plastic caps or factory-applied coating.
        2) Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
        3) Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
    b. Fasteners for Zinc-Coated **OR** Aluminum-Zinc Alloy-Coated, a**s directed**, Steel Sheet: Hot-dip galvanized steel according to ASTM A 153/A 153M, ASTM F 2329, or Series 300 stainless steel.
    c. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
    d. Fasteners for Copper **OR** Zinc-Tin Alloy-Coated Copper, **as directed**, Sheet: Copper, hardware bronze, or Series 300 stainless steel.
    e. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.
    f. Fasteners for Zinc-Tin Alloy-Coated Steel **OR** Stainless-Steel, **as directed**, Sheet: Series 300 stainless steel.
    g. Fasteners for Zinc Sheet: Hot-dip galvanized steel according to ASTM A 153/A 153M, ASTM F 2329, or Series 300 stainless steel.
    h. Fasteners for Titanium Sheet: Titanium or Series 300 stainless steel.
6. Solder:
    a. For Zinc-Coated (Galvanized) Steel: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead or Grade Sn60, 60 percent tin and 40 percent lead.
    b. For Copper: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead.
    c. For Stainless Steel: ASTM B 32, Grade Sn60, with an acid flux of type recommended by stainless-steel sheet manufacturer.
    d. For Zinc-Tin Alloy-Coated Steel **OR** Stainless Steel **OR** Copper, **as directed**: ASTM B 32, 100 percent tin.
    e. For Zinc: ASTM B 32, 40 percent tin and 60 percent lead with low antimony, as recommended by manufacturer.
7. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
8. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane **OR** polysulfide **OR** silicone, **as directed**, polymer sealant as recommended by portable roll-forming equipment manufacturer for installation indicated, **as directed**; low modulus; of type, grade, class, and use classifications required to seal joints in sheet metal roofing and remain watertight.
9. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

10. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

D. Accessories
1. Sheet Metal Accessories: Provide components required for a complete sheet metal roofing assembly including trim, copings, fasciae, corner units, clips, flashings, sealants, gaskets, fillers, metal closures, closure strips, and similar items. Match material and finish of sheet metal roofing unless otherwise indicated.
   a. Provide accessories as recommended by portable roll-forming equipment manufacturer to produce sheet metal roofing assemblies that comply with UL 580 for wind-uplift resistance classification specified in "Quality Assurance" Article.
   b. Cleats: For mechanically seaming into joints and formed from the following materials:
      1) Metallic-Coated Steel **OR** Aluminum, **as directed**, Roofing: 0.0250-inch- (0.64-mm-), **as directed**, thick stainless steel.
      2) Copper **OR** Zinc-Tin Alloy-Coated Copper, **as directed**, Roofing: 16-oz./sq. ft. (0.55-mm), **as directed**, copper sheet.
      3) Stainless-Steel **OR** Titanium, **as directed**, Roofing: 0.0250-inch- (0.64-mm-), **as directed**, thick stainless steel.
      4) Zinc-Tin Alloy-Coated Stainless-Steel **OR** Zinc-Tin Alloy-Coated Steel, **as directed**, Roofing: Manufacturer's preformed cleats or cleats fabricated from manufacturer's thickest flat-stock sheet.
      5) Zinc Roofing: Manufacturer's preformed stainless-steel cleats.
   c. Clips: Minimum 0.0625-inch- (1.6-mm-) thick, stainless-steel panel clips designed to withstand negative-load requirements.
   d. Backing Plates: Plates at roofing splices, fabricated from material recommended by SMACNA.
   e. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible-closure strips; cut or premolded to match sheet metal roofing profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
   f. Flashing and Trim: Formed from same material and with same finish as sheet metal roofing, minimum 0.018 inch (0.46 mm) thick.
2. Pipe Flashing: Premolded, EPDM pipe collar with flexible aluminum ring bonded to base.
3. Roof Curbs: Fabricated from same material and finish as sheet metal roofing, minimum thickness matching the sheet metal roofing; with bottom of skirt profiled to match roof panel profiles; with weatherproof top box and integral full-length cricket. Fabricate curb subframing of nominal 0.062-inch- (1.59-mm-) thick, angle-, C-, or Z-shaped galvanized steel or stainless-steel sheet. Fabricate curb and subframing to withstand indicated loads of size and height indicated. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.
   a. Insulate curbs with 1-inch- (25-mm-) thick, rigid insulation.
   b. Install wood nailers at tops of curbs.

E. Snow Guards
1. Snow Guards, General: Prefabricated, noncorrosive units designed to be installed without penetrating sheet metal roofing; complete with predrilled holes, clamps, or hooks for anchoring.
2. Surface-Mounted, Plastic, Stop-Type Snow Guards: Clear **OR** Integral-color, **as directed**, polycarbonate stops designed for attachment to panel surface of sheet metal roofing using construction adhesive, silicone or polyurethane sealant, or adhesive tape.
3. Surface-Mounted, Metal, Stop-Type Snow Guards: Cast-aluminum stops designed for attachment to panel surface of sheet metal roofing using construction adhesive, silicone or polyurethane sealant, or adhesive tape.
4. Surface-Mounted, Copper, Stop-Type Snow Guards: Bronze-alloy stops designed for attachment to panel surface of copper roofing using solder.
5. Seam-Mounted, Stop-Type Snow Guards: Cast-aluminum **OR** Malleable-iron **OR** Clear polycarbonate **OR** Colored polycarbonate, **as directed**, stops designed for attachment to vertical ribs of standing-seam sheet metal roofing with stainless-steel set screws.

6. Seam-Mounted, Bar-Type Snow Guards: Rail- or fence-type assembly consisting of aluminum or stainless-steel rods, bars, or pipe held in place by stainless-steel clamps attached to vertical ribs of standing-seam sheet metal roofing.
   a. Aluminum Finish: Mill **OR** Clear anodized, **as directed**.
   b. Stainless-Steel Finish: Mill **OR** Enamel, **as directed**.

F. Fabrication
1. General: Custom fabricate sheet metal roofing to comply with details shown and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions (panel width and seam height), geometry, metal thickness, and other characteristics of installation indicated. Fabricate sheet metal roofing and accessories at the shop to greatest extent possible.
   a. Flat-Seam Roofing: Form flat-seam panels from metal sheets 20 by 28 inches (510 by 710 mm) with 1/2-inch (13-mm) notched and folded edges.
   b. Standing-Seam Roofing: Form standing-seam panels with finished seam height of 1 inch (25 mm) **OR** of 1-1/2 inches (38 mm) **OR** as indicated, **as directed**.
   c. Batten-Seam Roofing: Form batten-seam panels with sides turned up 2-1/8 inches (54 mm) **OR** as indicated, **as directed**, with 1/2-inch (13-mm) flange turned toward center of pan.
   d. Horizontal-Seam (Bermuda-Type) Roofing: Form horizontal-seam (Bermuda-type) panels with upper edges turned up and extending above batten 1/2 inch (13 mm).
2. General: Fabricate roll-formed sheet metal roofing panels with UL-certified, portable roll-forming equipment capable of producing roofing panels for sheet metal roofing assemblies that comply with UL 580 for wind-uplift resistance classification specified in "Quality Assurance" Article. Fabricate roll-formed sheet metal according to equipment manufacturer's written instructions and to comply with details shown.
3. Fabrication Tolerances: Fabricate sheet metal roofing that is capable of installation to a tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.
4. Fabrication Tolerances: Fabricate sheet metal roofing that is capable of installation to tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."
5. Form exposed sheet metal work to fit substrates without excessive oil canning, buckling, and tool marks; true to line and levels indicated; and with exposed edges folded back to form hems.
   a. Lay out sheet metal roofing so transverse seams, if required, are made in direction of flow with higher panels overlapping lower panels.
   b. Offset transverse seams from each other 12 inches (300 mm) minimum.
   c. Fold and cleat eaves and transverse seams in the shop.
   d. Form and fabricate sheets, seams, strips, cleats, valleys, ridges, edge treatments, integral flashings, and other components of metal roofing to profiles, patterns, and drainage arrangements shown on Drawings and as required for leakproof construction.
6. Expansion Provisions: Fabricate sheet metal roofing to allow for expansion in running work sufficient to prevent leakage, damage, and deterioration of the Work. Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with butyl sealant concealed within joints.
7. Sealant Joints: Where movable, nonexpansion-type joints are indicated or required to produce weathertight seams, form metal to provide for proper installation of elastomeric sealant in compliance with SMACNA standards.
8. Metal Protection: Where dissimilar metals will contact each other, protect against galvanic action by painting contact surfaces with bituminous coating, by applying self-adhering sheet underlayment to each contact surface, or by other permanent separation as recommended by fabricator of sheet metal roofing or manufacturers of the metals in contact.
9. Sheet Metal Accessories: Custom fabricate flashings and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated. Obtain field measurements for accurate fit before shop fabrication.

a. Form exposed sheet metal accessories without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
b. Seams:
1) Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
OR
Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength, **as directed**.
c. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant.
d. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
e. Fabricate cleats and attachment devices of sizes as recommended by SMACNA's "Architectural Sheet Metal Manual" for application, but not less than thickness of metal being secured.
10. Do not use graphite pencils to mark metal surfaces.

1.3 EXECUTION

A. Preparation
1. Lay out and nail battens to wood sheathing **OR** screw battens to wood sheathing **OR** screw battens to metal deck, **as directed**, before installation of sheet metal roofing.
a. Space fasteners not more than 18 inches (457 mm) o.c.
b. Space fasteners as required by portable roll-forming equipment manufacturer for specified UL classification for wind-uplift resistance.
2. Zinc-Tin Alloy-Coated Steel Roofing: For roofing with 3:12 slopes or less, paint underside of shop-coated, zinc-tin alloy-coated steel, before installation, with zinc-tin alloy-coated steel primer, applied at a dry film thickness of not less than 2.5 mils (0.06 mm). Comply with manufacturer's written instructions. This is in addition to the shop coating.

B. Underlayment Installation
1. Polyethylene Sheet: Install polyethylene sheet on roof sheathing under sheet metal roofing. Use adhesive for anchorage to minimize use of mechanical fasteners under sheet metal roofing. Apply at locations indicated on Drawings, in shingle fashion to shed water, with lapped and taped joints of not less than 2 inches (50 mm).
2. Felt Underlayment: Install felt underlayment on roof sheathing under sheet metal roofing. Use adhesive for temporary anchorage to minimize use of mechanical fasteners under sheet metal roofing. Apply at locations indicated, in shingle fashion to shed water, with lapped joints of not less than 2 inches (50 mm).
a. Apply from eave to ridge.
OR
Apply on roof not covered by self-adhering sheet underlayment. Lap edges of self-adhering sheet underlayment not less than 3 inches (75 mm), in shingle fashion to shed water.
3. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free, on roof sheathing under sheet metal roofing. Apply primer if required by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures. Apply over entire roof **OR** at locations indicated, **as directed**, in shingle fashion to shed water, with end laps of not less than 6 inches (150 mm) staggered 24 inches (600 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps with roller. Cover underlayment within 14 days.
a. Roof perimeter for a distance up from eaves of 24 inches (600 mm) **OR** 36 inches (900 mm), **as directed**, beyond interior wall line.

b. Valleys, from lowest to highest point, for a distance on each side of 18 inches (460 mm). Overlap ends of sheets not less than 6 inches (150 mm).
c. Rake edges for a distance of 18 inches (460 mm).
d. Hips and ridges for a distance on each side of 12 inches (300 mm).
e. Roof to wall intersections for a distance from wall of 18 inches (460 mm).
f. Around dormers, chimneys, skylights, and other penetrating elements for a distance from element of 18 inches (460 mm).

4. Install flashings to cover underlayment to comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim".
5. Apply slip sheet before installing sheet metal roofing.

C. Installation, General

1. General: Anchor sheet metal roofing and other components of the Work securely in place, with provisions for thermal and structural movement. Install fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for a complete roofing system and as recommended by fabricator for sheet metal roofing.
   a. Field cutting of sheet metal roofing by torch is not permitted.
   b. Provide metal closures at peaks, rake edges, rake walls, eaves, and each side of ridge and hip caps, **as directed**.
   c. Flash and seal sheet metal roofing with closure strips at eaves, rakes, and perimeter of all openings. Fasten with self-tapping screws.
   d. Locate and space fastenings in uniform vertical and horizontal alignment. Predrill panels for fasteners.
   e. Install ridge **OR** ridge and hip, **as directed**, caps as sheet metal roofing work proceeds.
   f. Locate roofing splices over, but not attached to, structural supports. Stagger roofing splices and end laps to avoid a four-panel lap splice condition. Install backing plates at roofing splices.
   g. Install sealant tape where indicated.
   h. Lap metal flashing over sheet metal roofing to allow moisture to run over and off the material.
   i. Do not use graphite pencils to mark metal surfaces.
2. Thermal Movement. Rigidly fasten metal roof panels to structure at only one location for each panel. Allow remainder of panel to move freely for thermal expansion and contraction.
   a. Point of Fixity: Fasten each panel along a single line of fixing located at eave **OR** ridge **OR** center of panel length **OR** locations indicated on Drawings, **as directed**.
   b. Avoid attaching accessories through roof panels in a manner that will inhibit thermal movement.
3. Fasteners: Use fasteners of sizes that will penetrate wood sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws **OR** metal decking not less than recommended by fastener manufacturer to achieve maximum pull-out resistance, **as directed**.
4. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying self-adhering sheet underlayment to each contact surface, or by other permanent separation as recommended by SMACNA.
   a. Coat back side of uncoated aluminum and stainless-steel sheet metal roofing with bituminous coating where roofing will contact wood, ferrous metal, or cementitious construction.
5. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
6. Fasciae: Align bottom of sheet metal roofing and fasten with blind rivets, bolts, or self-tapping screws. Flash and seal sheet metal roofing with closure strips where fasciae meet soffits, along lower panel edges, and at perimeter of all openings.

D. Custom-Fabricated Sheet Metal Roofing Installation

1. Fabricate and install work with lines and corners of exposed units true and accurate. Form exposed faces flat and free of buckles, excessive waves, and avoidable tool marks, considering temper and reflectivity of metal. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant. Fold back sheet metal to form a hem on concealed side of exposed edges unless otherwise indicated.
   a. Install cleats to hold sheet metal panels in position. Attach each cleat with two fasteners to prevent rotation.
   b. Fasten cleats not more than 12 inches (300 mm) o.c. Bend tabs over fastener head.
   c. Provide expansion-type cleats and clips for roof panels that exceed 30 feet (9.1 m) in length.
2. Seal joints as shown and as required for watertight construction. For roofing with 3:12 slopes or less, use cleats at transverse seams.
   a. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch (25 mm) into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F (4 deg C).
   b. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants".
3. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches (38 mm), except reduce pre-tinning where pre-tinned surface would show in completed Work.
   a. Do not solder metallic-coated steel **OR** aluminum **OR** titanium sheet.
   b. Do not pre-tin zinc-tin alloy-coated stainless steel **OR** zinc-tin alloy-coated copper.
   c. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.
   d. Stainless-Steel Roofing: Tin edges of uncoated sheets, using solder for stainless steel and acid flux. Promptly remove acid flux residue from metal after tinning and soldering. Comply with solder manufacturer's recommended methods for cleaning and neutralization.
   e. Copper Roofing: Tin edges of uncoated copper sheets, using solder for copper.
4. Rivets: Rivet joints in uncoated aluminum **OR** zinc, **as directed**, where indicated and where necessary for strength.
5. Flat-Seam Roofing: Attach flat-seam metal panels to substrate with cleats, starting at eave and working upward toward ridge. After panels are in place, mallet seams and solder.
   a. Attach roofing panels with cleats spaced not more than 24 inches (610 mm) o.c.. Lock and solder panels to base flashing.
   b. Attach edge flashing to face of roof edge with continuous cleat fastened to roof substrate at 12 inches (305 mm) o.c. Lock panels to edge flashing and solder **OR** apply sealant, **as directed**.
6. Standing-Seam Roofing: Attach standing-seam metal panels to substrate with cleats, double fastened at 12 inches (305 mm) o.c. Install panels reaching from eave to ridge before moving to adjacent panels. Before panels are interlocked, apply continuous bead of sealant to top of flange of lower panel. Lock standing seams by folding over twice so cleat and panel edges are completely engaged.
   a. Lock each panel to panel below with soldered **OR** sealed, **as directed**, transverse seam.
   b. Loose-lock panels at eave edges to continuous cleats and flanges at roof edge at gutters.
      OR
      Loose-lock panels at eave edges to continuous edge flashing exposed 24 inches (610 mm) from roof edge. Attach edge flashing to face of roof edge with continuous cleat fastened to roof substrate at 12 inches (305 mm) o.c. Lock panels to edge flashing.
   c. Leave seams upright **OR** Fold over seams, **as directed**, after locking at ridges and hips.
7. Batten-Seam Roofing: Attach batten-seam metal panels to substrate with cleats, starting at eave and working upward toward ridge. Hold cleats in place with battens and fold edges of cleats over to hold panels. After panels are in place and before batten cap is installed, apply continuous

bead of sealant to top of flanges of each panel. Install batten cap covering batten and panel edges and fold batten cap and panel together so batten cap and panel edges are completely engaged.

a. Hook each panel to panel below with soldered **OR** sealed, **as directed**, transverse seam.
b. Splay upturned edges of panels away from base of battens to provide expansion capability.
c. Close batten ends with metal closures. Fold together with panel edges and end of batten cap.
d. Loose-lock panels at eave edges to continuous cleats and flanges at roof edge at gutters.
OR
Loose-lock panels at eave edges to continuous edge flashing exposed 24 inches (610 mm) from roof edge. Attach edge flashing to face of roof edge with continuous cleat fastened to roof substrate at 12 inches (305 mm) o.c. Lock panels to edge flashing.

8. Horizontal-Seam (Bermuda-Type) Roofing: Attach horizontal-seam metal panels to substrate with cleats, starting at eave and working upward toward ridge. Attach cleats to battens, spaced at 8 inches (203 mm) o.c. Lock lower edge of each panel to upper edge of panel below, folding seam over to engage cleat and panel edges. After first fold, mallet seams against batten, leaving joint slightly angled to form drip.
   a. Hook end of each panel to adjacent panel with soldered **OR** sealed, **as directed**, cross seam.
   b. Hook panel at eave edge to continuous cleat.
   c. Join ridges and hips with a standing seam and leave seams upright **OR** fold over seams, **as directed**, after locking.
9. Field Painting: Paint exposed surfaces of zinc-tin alloy-coated steel with one coat of zinc-tin alloy-coated steel primer and one coat of zinc-tin alloy-coated steel finish coat as soon as possible after installation; apply each coat at a dry film thickness of not less than 2.5 mils (0.06 mm). Comply with manufacturer's written instructions.

E. On-Site, Roll-Formed Sheet Metal Roofing Installation
1. General: Install on-site, roll-formed sheet metal roofing fabricated from UL-certified equipment to comply with equipment manufacturer's written instructions for UL wind-uplift resistance class indicated. Provide sheet metal roofing of full length from eave to ridge unless otherwise restricted by on-site or shipping limitations.
2. Standing-Seam Sheet Metal Roofing: Fasten sheet metal roofing to supports with concealed clips at each standing-seam joint at location, at spacing, and with fasteners recommended by manufacturer of portable roll-forming equipment.
   a. Install clips to substrate with self-tapping fasteners.
   b. Install pressure plates at locations indicated in equipment manufacturer's written installation instructions.
   c. Before panels are joined, apply continuous bead of sealant to top of flange of lower panel.
   d. Snap-On Seam: Nest standing seams and fasten together by interlocking and completely engaging field-applied sealant.
   OR
   Seamed Joint: Crimp standing seams with manufacturer-approved motorized seamer tool so cleat, sheet metal roofing, and field-applied sealant are completely engaged.
3. Batten-Seam Sheet Metal Roofing: Fasten sheet metal roofing to supports with concealed clips at each batten-seam joint at location, at spacing, and with fasteners recommended by manufacturer of portable roll-forming equipment.
   a. Install clips to substrate with self-drilling fasteners.
   b. After panels are in place and before batten cap is installed, apply continuous bead of sealant to top of flange of each panel.
   c. Apply snap-on batten caps to sheet metal roofing seams, fully engaged to provide weathertight joints.
4. Seal joints as shown and as required for watertight construction. For roofing with 3:12 slopes or less, use cleats at transverse seams.

a. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch (25 mm) into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement either way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F (4 deg C).
b. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants".

F. Accessory Installation
1. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
a. Install components required for a complete sheet metal roofing assembly including trim, copings, seam covers, flashings, sealants, gaskets, fillers, metal closures, closure strips, and similar items.
b. Install accessories integral to sheet metal roofing that are specified in Division 07 Section "Sheet Metal Flashing And Trim" to comply with that Section's requirements.
2. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
a. Install flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers.
b. Install continuous strip of self-adhering underlayment at edge of continuous flashing overlapping self-adhering underlayment, where "continuous seal strip" is indicated in SMACNA's "Architectural Sheet Metal Manual," and where indicated on Drawings.
c. Install exposed flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
d. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (600 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, and filled with butyl sealant concealed within joints.
3. Pipe Flashing: Form flashing around pipe penetration and sheet metal roofing. Fasten and seal to sheet metal roofing as recommended by SMACNA.
4. Roof Curbs: Install curbs at locations indicated on Drawings. Install flashing around bases where they meet sheet metal roofing.
5. Stop-Type Snow Guards: Attach snow guards to sheet metal roofing with adhesive or adhesive tape, as recommended by manufacturer. Do not use fasteners that will penetrate sheet metal roofing.
a. Provide rows of snow guards, at locations indicated on Drawings, spaced apart, beginning up from roof edge at gutter, with each snow guard centered between sheet metal roofing ribs, **as directed**.
6. Bar-Type Snow Guards: Attach bar supports to vertical ribs of standing-seam sheet metal roofing with clamps or set screws. Do not use fasteners that will penetrate sheet metal roofing.
a. Provide rows of snow guards, at locations indicated on Drawings, spaced apart, beginning up from roof edge at gutter.

G. Erection Tolerances
1. Installation Tolerances: Shim and align sheet metal roofing within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

OR

Installation Tolerances: Shim and align sheet metal roofing within installed tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

H. Cleaning And Protection
1. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
2. Clean and neutralize flux materials. Clean off excess solder.
3. Clean off excess sealants.
4. Remove temporary protective coverings and strippable films as sheet metal roofing is installed unless otherwise indicated in manufacturer's written installation instructions. On completion of sheet metal roofing installation, clean finished surfaces as recommended by sheet metal roofing manufacturer. Maintain sheet metal roofing in a clean condition during construction.
5. Replace sheet metal roofing components that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07410a

SECTION 07460 - METAL WALL PANELS

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for metal wall panels. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Exposed-fastener, lap-seam metal wall panels.
b. Concealed-fastener, lap-seam metal wall panels.
c. Metal liner panels.
d. Metal soffit panels.

C. Definition
1. Metal Wall Panel Assembly: Metal wall panels, attachment system components, miscellaneous metal framing, thermal insulation, and accessories necessary for a complete weathertight wall system.

D. Performance Requirements
1. General Performance: Metal wall panel assemblies shall comply with performance requirements without failure due to defective manufacture, fabrication, installation, or other defects in construction.
2. Delegated Design: Design metal wall panel assembly, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
3. Air Infiltration: Air leakage through assembly of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) of wall area when tested according to ASTM E 283 at the following test-pressure difference:
a. Test-Pressure Difference: 1.57 lbf/sq. ft. (75 Pa).
4. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 331 at the following test-pressure difference:
a. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa) which is equivalent to a 50-mph (80-km/h) wind.
5. Water Penetration under Dynamic Pressure: No evidence of water leakage when tested according to AAMA 501.1 under dynamic pressure equal to 20 percent of inward-acting, wind-load design pressure of not less than 6.24 lbf/sq. ft. (300 Pa) (which is equivalent to a 50-mph (80-km/h) wind) and not more than 12 lbf/sq. ft. (575 Pa).
a. Water Leakage: As defined according to AAMA 501.1.
OR
Water Leakage: Uncontrolled water infiltrating the system or appearing on system's normally exposed interior surfaces from sources other than condensation. Water controlled by flashing and gutters that is drained back to the exterior and cannot damage adjacent materials or finishes is not water leakage.
6. Structural Performance: Provide metal wall panel assemblies capable of withstanding the effects the following loads and stresses within limits and under conditions indicated, based on testing according to ASTM E 1592:
a. Wind Loads: Determine loads based on the following minimum design wind pressures:
1) Uniform pressure of 20 lbf/sq. ft. (957 Pa) **OR** 30 lbf/sq. ft. (1436 Pa), **as directed**, acting inward or outward.
OR
Uniform pressure as indicated on Drawings.

b. Deflection Limits: Metal wall panel assemblies shall withstand wind loads with horizontal deflections no greater than 1/180 **OR** 1/240, **as directed**, of the span.

7. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

E. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Show fabrication and installation layouts of metal wall panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details. Distinguish between factory-, shop- and field-assembled work.
3. Samples: For each type of exposed finish required.
4. Delegated-Design Submittal: For metal wall panel assembly indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
5. Coordination Drawings: Exterior elevations drawn to scale and coordinating penetrations and wall-mounted items.
6. Product Test Reports.
7. Field quality-control reports.
8. Maintenance Data.
9. Warranties: Sample of special warranties.

F. Quality Assurance
1. Installer Qualifications: An employer of workers trained and approved by manufacturer.
2. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
3. Fire-Resistance Ratings: Where indicated, provide metal wall panels identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
4. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver components, sheets, metal wall panels, and other manufactured items so as not to be damaged or deformed. Package metal wall panels for protection during transportation and handling.
2. Unload, store, and erect metal wall panels in a manner to prevent bending, warping, twisting, and surface damage.
3. Stack metal wall panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal wall panels to ensure dryness, with positive slope for drainage of water. Do not store metal wall panels in contact with other materials that might cause staining, denting, or other surface damage.
4. Retain strippable protective covering on metal wall panel for period of metal wall panel installation.
5. Protect foam-plastic insulation as follows:
   a. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
   b. Protect against ignition at all times. Do not deliver foam-plastic insulation materials to Project site before installation time.
   c. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

H. Warranty

1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal wall panel assemblies that fail in materials or workmanship within specified warranty period.
   a. Warranty Period: Two years from date of Substantial Completion.
2. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal wall panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
   a. Finish Warranty Period:
      1) 20 years from date of Substantial Completion for fluoropolymer finish.
      2) 10 years from date of Substantial Completion for siliconized polyester.

1.2 PRODUCTS

A. Panel Materials
1. Metallic-Coated Steel Sheet: Restricted flatness steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
   a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality.
   b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40 (Class AZM150 coating designation, Grade 275); structural quality.
   c. Surface: Smooth, flat **OR** Embossed, **as directed**, finish.
   d. Exposed Coil-Coated Finish:
      1) 2-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      2) 3-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      3) 4-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat and clear coats. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      4) Mica Fluoropolymer: AAMA 621. 2-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      5) Metallic Fluoropolymer: AAMA 621. 3-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      6) FEVE Fluoropolymer: AAMA 621. 2-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      7) Siliconized-Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
      8) Plastisol: Epoxy primer and vinyl plastisol topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 3.8 mil (0.97 mm) for topcoat.
   e. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

2. Aluminum Sheet: Coil-coated sheet, ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.
   a. Surface: Smooth, flat **OR** Embossed, **as directed**, finish.
   b. Exposed Coil-Coated Finish:
      1) 2-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      2) 3-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      3) 4-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat and clear coats. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      4) Mica Fluoropolymer: AAMA 620. 2-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      5) Metallic Fluoropolymer: AAMA 620. 3-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      6) FEVE Fluoropolymer: AAMA 620. 2-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      7) Siliconized-Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
      8) Plastisol: Epoxy primer and vinyl plastisol topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 3.8 mil (0.97 mm) for topcoat.
   c. Exposed Anodized Finish:
      1) Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
      2) Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
   d. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).
3. Copper Sheet: ASTM B 370, cold-rolled copper sheet, H00 temper.
   a. Exposed Finish: Apply the following finish, as specified or indicated on Drawings.
      1) Natural finish.
      2) Brushed Satin: CDA M32-06x (Mechanical Finish: directionally textured, medium satin; Coating: clear organic, air drying, as specified below):
         a) Clear, Organic Coating: Clear, air-drying, acrylic lacquer specially developed for coating copper-alloy products, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
      3) Mirror Polished: CDA M22-06x (Mechanical Finish: buffed, specular; Coating: clear organic, air drying, as specified below):
         a) Clear, Organic Coating: Clear, air-drying, acrylic lacquer specially developed for coating copper-alloy products, applied by air spray in two coats per

manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).

4) Pre-patinated: ASTM B 882. Copper sheets artificially aged by chemical reaction to convert surface to inorganic crystalline structure with color range and durability of naturally-formed patina.

4. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304 **OR** 316, **as directed**, fully annealed.
   a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
   b. Polished Finish: Grind and polish surfaces to produce uniform finish, free of cross scratches.
      1) Run grain of directional finishes with long dimension of each piece.
      2) When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
      3) Directional Satin Finish: No. 4.
   c. Bright, Cold-Rolled, Unpolished Finish: No. 2B.
5. Panel Sealants:
   a. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
   b. Joint Sealant: ASTM C 920; elastomeric polyurethane, polysulfide, or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal wall panels and remain weathertight; and as recommended in writing by metal wall panel manufacturer.
   c. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

B. Field-Installed Thermal Insulation
1. Unfaced, Polyisocyanurate Board Insulation: ASTM C 591, Type II, compressive strength of 35 psi (241 kPa), with maximum flame-spread index of 75 and smoke-developed index of 450.
2. Faced, Polyisocyanurate Board Insulation: ASTM C 1289, Type I (foil facing), Class 1 or 2 **OR** Type II (asphalt felt or glass-fiber mat facing), Class 2 or 3, Grade 3, **as directed**, with maximum flame-spread index of 75 and smoke-developed index of 450, based on tests performed on unfaced core.
3. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.60-lb/cu. ft. (26-kg/cu. m), with maximum flame-spread index of 75 and smoke-developed index of 450.
4. Molded-Polystyrene Board Insulation: ASTM C 578, Type I, 0.9 lb/cu. ft. (15 kg/cu. m) **OR** Type II, 1.35 lb/cu. ft. (22 kg/cu. m), **as directed**, with maximum flame-spread index of 75 and smoke-developed index of 450.
5. Unfaced, Glass-Fiber Board Insulation: ASTM C 612, Type IA or Types IA and IB; with maximum flame-spread index of 25 and smoke-developed index of 50, and with a nominal density of 3 lb/cu. ft. (48 kg/cu. m).
6. Mineral-Fiber-Blanket Insulation: ASTM C 665, type indicated below; consisting of fibers manufactured from glass **OR** slag or rock wool, **as directed**.
   a. Type I (blankets without membrane covering), passing ASTM E 136 for combustion characteristics.
   b. Type II (blankets with nonreflective membrane covering), Category 1 (membrane is a vapor retarder), Class A (membrane-faced surface with a flame-spread index of 25 or less).
   c. Type III (blankets with reflective membrane covering), Category 1 (membrane is a vapor retarder), Class A (membrane-faced surface with a flame-spread index of 25 or less).
7. Metal Building Insulation: ASTM C 991, Type I; or NAIMA 202 **OR** ASTM C 991, Type II, **as directed**, glass-fiber-blanket insulation; 0.5-lb/cu. ft. (8-kg/cu. m) density; 2-inch- (50-mm-) wide, continuous, vapor-tight edge tabs; and with a flame-spread index of 25 or less.
   a. Vapor-Retarder Facing: ASTM C 1136, with permeance not greater than 0.02 perm (1.15 ng/Pa x s x sq. m) when tested according to ASTM E 96, Desiccant Method:
      1) Composition: Polypropylene faced, scrim reinforced, and kraft-paper backing **OR** Foil faced, scrim reinforced, and kraft-paper backing with vapor-retarder coating **OR** Polypropylene faced, scrim reinforced, and foil backing **OR** Vinyl faced, scrim reinforced, and foil backing **OR** Vinyl faced, scrim reinforced, and polyester backing, **as directed**.

b. Insulation Retainer Strips: 0.019-inch- (0.48-mm-) thick, formed galvanized steel or PVC retainer clips colored to match insulation facing.

C. Miscellaneous Metal Framing
1. Miscellaneous Metal Framing, General: ASTM C 645, cold-formed metallic-coated steel sheet, ASTM A 653/A 653M, G40 (Z120) hot-dip galvanized **OR** ASTM A 653/A 653M, G60 (Z180) hot-dip galvanized, **as directed**, or coating with equivalent corrosion resistance unless otherwise indicated.
2. Subgirts: Manufacturer's standard C- or Z-shaped sections, 0.064-inch (1.63-mm) nominal thickness.
3. Zee Clips: 0.079-inch (2.01-mm) nominal thickness.
4. Base or Sill Angles **OR** Channels, **as directed**: 0.079-inch (2.01-mm) nominal thickness.
5. Hat-Shaped, Rigid Furring Channels:
   a. Nominal Thickness: As indicated **OR** As required to meet performance requirements **OR** 0.025 inch (0.64 mm) **OR** 0.040 inch (1.02 mm), **as directed**.
   b. Depth: As indicated **OR** 7/8 inch (22 mm) **OR** 1-1/2 inches (38 mm), **as directed**.
6. Cold-Rolled Furring Channels: Minimum 1/2-inch- (13-mm-) wide flange.
   a. Nominal Thickness: As indicated **OR** As required to meet performance requirements **OR** 0.064 inch (1.63 mm), **as directed**.
   b. Depth: As indicated **OR** 3/4 inch (19 mm), **as directed**.
   c. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with 0.040-inch (1.02-mm) nominal thickness.
   d. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.57-mm-) diameter wire, or double strand of 0.048-inch- (1.22-mm-) diameter wire.
7. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (32 mm), wall attachment flange of 7/8 inch (22 mm), and depth required to fit insulation thickness indicated.
   a. Nominal Thickness: As indicated **OR** As required to meet performance requirements **OR** 0.025 inch (0.64 mm), **as directed**.
8. Fasteners for Miscellaneous Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten miscellaneous metal framing members to substrates.

D. Miscellaneous Materials
1. Panel Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of metal wall panels by means of plastic caps or factory-applied coating. Provide EPDM, PVC, or neoprene sealing washers.

E. Exposed-Fastener, Lap-Seam Metal Wall Panels
1. General: Provide factory-formed metal wall panels designed to be field assembled by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps. Include accessories required for weathertight installation.
2. Corrugated-Profile, Exposed-Fastener Metal Wall Panels: Formed with alternating curved ribs spaced at 2.67 inches (68 mm) o.c. across width of panel.
   a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
   b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.

1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm)**, as directed,** thick.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

d. Panel Coverage: 21.3 inches (541 mm) **OR** 29.3 inches (744 mm) **OR** 34.6 inches (881 mm) **OR** 37.3 inches (947 mm) **OR** 42.6 inches (1084 mm) **OR** 45.3 inches (1151 mm), **as directed**.

e. Panel Height: 0.5 inch (13 mm) **OR** 0.875 inch (22 mm), **as directed**.

3. Tapered-Rib-Profile, Exposed-Fastener Metal Wall Panels: Formed with raised, trapezoidal major ribs and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between major ribs.

a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

d. Major-Rib Spacing: 6 inches (152 mm) **OR** 8 inches (203 mm) **OR** 9 inches (229 mm) **OR** 12 inches (305 mm), **as directed**, o.c.

e. Panel Coverage: 24 inches (610 mm) **OR** 36 inches (914 mm), **as directed**.

f. Panel Height: 0.625 inch (16 mm) **OR** 0.75 inch (19 mm) **OR** 1.0 inch (25 mm) **OR** 1.25 inches (32 mm) **OR** 1.5 inches (38 mm), **as directed**.

4. Reverse-Rib-Profile, Exposed-Fastener Metal Wall Panels: Formed with recessed, trapezoidal major valleys and intermediate stiffening valleys symmetrically spaced **OR** flat pan, **as directed**, between major valleys.

a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.

1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

c. Major-Rib Spacing: 12 inches (305 mm) o.c.

d. Panel Coverage: 36 inches (914 mm).

e. Panel Height: 1.25 inches (32 mm).

5. Vee-Rib-Profile, Exposed-Fastener Metal Wall Panels: Formed with raised, V-shaped ribs and recesses that are approximately same size, evenly spaced across panel width, and with rib/recess sides angled at approximately 45 degrees.
a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm) **OR** 0.064-inch (1.63-mm), **as directed**, nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm) **OR** 0.064-inch (1.63-mm), **as directed**, nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm), **as directed**, thick.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

d. Rib Spacing: 5.3 inches (135 mm) **OR** 7.2 inches (183 mm) **OR** 12 inches (305 mm), **as directed**, o.c.

e. Panel Coverage: 30 inches (762 mm) **OR** 32 inches (813 mm) **OR** 36 inches (914 mm) **OR** 40 inches (1016 mm), **as directed**.

f. Panel Height: 1.375 inches (35 mm) **OR** 1.5 inches (38 mm) **OR** 1.75 inches (44 mm) **OR** 2.0 inches (51 mm) **OR** 3.0 inches (76 mm), **as directed**.

6. Box-Rib-Profile, Exposed-Fastener Metal Wall Panels: Formed with raised, box-shaped ribs, evenly spaced across panel width, and with rib/recess sides angled 60 degrees or more.
a. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.

1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

b. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

d. Rib Spacing: 2.67 inches (68 mm) **OR** 4.0 inches (102 mm) **OR** 5.3 inches (135 mm) **OR** 6.0 inches (152 mm), **as directed**, o.c.

e. Panel Coverage: 24 inches (610 mm) **OR** 28 inches (711 mm) **OR** 30 inches (762 mm) **OR** 32 inches (813 mm) **OR** 36 inches (914 mm), **as directed**.

f. Panel Height: 0.625 inch (16 mm) **OR** 1.0 inch (25 mm) **OR** 1.5 inches (38 mm) **OR** 2.0 inches (51 mm), **as directed**.

7. Deep-Box-Rib-Profile, Exposed-Fastener Metal Wall Panels: Formed with raised, box-shaped ribs, evenly spaced across panel width, and with rib/recess sides angled more than 60 degrees.

a. Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm) **OR** 0.064-inch (1.63-mm), **as directed**, nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

b. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm) **OR** 0.064-inch (1.63-mm), **as directed**, nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm), **as directed**, thick.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

d. Rib Spacing: 12 inches (305 mm) o.c.

e. Panel Coverage: 24 inches (610 mm).

f. Panel Height: 3.0 inches (76 mm) **OR** 4.0 inches (102 mm), **as directed**.

F. Concealed-Fastener, Lap-Seam Metal Wall Panels
1. General: Provide factory-formed metal wall panels designed to be field assembled by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners and factory-applied sealant in side laps. Include accessories required for weathertight installation.
2. Flush-Profile, Concealed-Fastener Metal Wall Panels: Formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between panel edges; with flush joint between panels.
   a. Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
   b. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
   c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm), **as directed**, thick.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
      2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
   d. Panel Coverage: 12 inches (305 mm), **as directed**.
   e. Panel Height: 1.0 inch (25 mm) **OR** 1.5 inches (38 mm), **as directed**.
3. Reveal-Joint, Concealed-Fastener Metal Wall Panels: Formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between panel edges; with narrow reveal joint between panels.
   a. Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
   b. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
   c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm), **as directed**, thick.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE

fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.

2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

d. Panel Coverage: 12 inches (305 mm).

e. Panel Height: 1.0 inch (25 mm) **OR** 1.5 inches (38 mm), **as directed**.

4. Wide-Reveal-Joint, Concealed-Fastener Metal Wall Panels: Formed with vertical panel edges and stepped profile between panel edges resulting in wide reveal joint between panels.

a. Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.

1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.

2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

b. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.

1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.

2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm), **as directed**, thick.

1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.

2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

d. Panel Coverage: 12 inches (305 mm).

e. Panel Height: 1.5 inches (38 mm).

5. V-Groove-Profile, Concealed-Fastener Metal Wall Panels: Formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between panel edges.

a. Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.

1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.

2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

b. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) nominal thickness.

1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.

2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

c. Panel Coverage: 6 inches (152 mm) **OR** 8 inches (203 mm) **OR** 12 inches (305 mm), **as directed**.

d. Panel Height: 0.625 inch (16 mm) **OR** 1.25 inches (32 mm), **as directed**.

6. Tapered-Rib-Profile, Concealed-Fastener Metal Wall Panels: Formed with raised, trapezoidal major ribs and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between major ribs.

a. Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

b. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) nominal thickness.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

c. Panel Coverage: 12 inches (305 mm) **OR** 14 inches (356 mm), **as directed**.

d. Panel Height: 1.0 inch (25 mm) **OR** 1.5 inches (38 mm), **as directed**.

7. Curved-Rib-Profile, Concealed-Fastener Metal Wall Panels: Formed with raised, curved-side major ribs and flat pan between major ribs; with reveal joint between panels.
   a. Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
   b. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As indicated by manufacturer's designations **OR** Match samplesAs selected from manufacturer's full range, **as directed**.
   c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm), **as directed**, thick.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
      2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
   d. Panel Coverage: 12 inches (305 mm).
   e. Panel Height: 0.875 inch (22 mm) **OR** 1.5 inches (38 mm), **as directed**.

8. Creased-Profile, Concealed-Fastener Metal Wall Panels: Formed with vertical panel edges and center-creased pan between panel edges; with flush joint between panels.
   a. Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
   b. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.

1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

d. Panel Coverage: 12 inches (305 mm).
e. Panel Height: 1.5 inches (38 mm).

9. Creased-Rib-Profile, Concealed-Fastener Metal Wall Panels: Formed with raised, center-creased, trapezoidal major ribs; with reveal joint between panels.
a. Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

b. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

d. Panel Coverage: 12 inches (305 mm).
e. Panel Height: 0.875 inch (22 mm) **OR** 1.5 inches (38 mm), **as directed**.

G. Metal Liner Panels
1. General: Provide factory-formed metal liner panels designed for interior side of metal wall panel assemblies and field assembled by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners and factory-applied sealant in side laps. Include accessories required for a complete installation.
2. Flush-Profile Metal Liner Panels: Solid **OR** Perforated, **as directed**, panels formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between panel edges; with flush joint between panels.
a. Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.

2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

b. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

c. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
   1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
   2) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

d. Panel Coverage: 12 inches (305 mm) **OR** 16 inches (406 mm) **OR** 24 inches (610 mm) **OR** 36 inches (914 mm), **as directed**.

e. Panel Height: 1.5 inches (38 mm) **OR** 2.0 inches (51 mm) **OR** 3.0 inches (76 mm), **as directed**.

f. Acoustical Performance: Where sound-absorption requirement is indicated, fabricate interior liner panels with 1/8-inch- (3-mm-) diameter holes uniformly spaced approximately 1000 holes/sq. ft. (10 750 holes/sq. m).
   1) NRC of not less than 0.65 **OR** 0.85 **OR** 1.00, **as directed**, when tested according to ASTM C 423.

H. Metal Soffit Panels
1. General: Provide factory-formed metal soffit panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners and factory-applied sealant in side laps. Include accessories required for weathertight installation.
2. Metal Soffit Panels: Match profile and material of metal wall panels.
   a. Finish: Match finish and color of metal wall panels **OR** As indicated on Drawings, **as directed**.
   b. Sealant: Factory applied within interlocking joint.
3. Flush-Profile Metal Soffit Panels: Solid **OR** Perforated, **as directed**, panels formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between panel edges; with flush joint between panels.
   a. Material: Same material, finish, and color as metal wall panels.
   b. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: Match finish and color of metal wall panels **OR** As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
   c. Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.

1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: Match finish and color of metal wall panels **OR** As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

d. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
2) Color: Match finish and color of metal wall panels **OR** As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

e. Material: Copper sheet, 16-oz./sq. ft. weight (0.55-mm thickness) **OR** 20-oz./sq. ft. weight (0.68-mm thickness), **as directed**.
1) Exterior Finish: Brushed satin (lacquered) **OR** Mirror polished, **as directed**.

f. Panel Coverage: 8 inches (203 mm) **OR** 12 inches (305 mm) **OR** 16 inches (406 mm) **OR** 20 inches (508 mm), **as directed**.

g. Panel Height: 0.875 inch (22 mm) **OR** 1.0 inch (25 mm) **OR** 1.5 inches (38 mm) **OR** 3.0 inches (76 mm), **as directed**.

h. Sealant: Factory applied within interlocking joint.

4. Reveal-Joint-Profile Metal Soffit Panels: Solid **OR** Perforated, **as directed**, panels formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between panel edges; with recessed reveal joint between panels.

a. Material: Same material, finish, and color as metal wall panels.

b. Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: Match finish and color of metal wall panels **OR** As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

c. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) nominal thickness.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
2) Color: Match finish and color of metal wall panels **OR** As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

d. Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
2) Color: Match finish and color of metal wall panels **OR** As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

e. Panel Coverage: 8 inches (203 mm) **OR** 12 inches (305 mm) **OR** 16 inches (406 mm) **OR** 20 inches (508 mm), **as directed**.

f. Panel Height: 0.75 inch (19 mm) **OR** 1.0 inch (25 mm) **OR** 1.5 inches (38 mm), **as directed**.

5. V-Groove-Profile Metal Soffit Panels: Solid **OR** Perforated, **as directed**, panels formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced **OR** flat pan, **as directed**, between panel edges; with V-groove joint between panels.
   a. Material: Same material, finish, and color as metal wall panels.
   b. Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: Match finish and color of metal wall panels **OR** As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
   c. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) nominal thickness.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
      2) Color: Match finish and color of metal wall panels **OR** As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
   d. Material: Aluminum sheet, 0.024 inch (0.65 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.
      1) Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**
      2) Color: Match finish and color of metal wall panels **OR** As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
   e. Panel Coverage: 6 inches (152 mm) **OR** 12 inches (305 mm) **OR** 14 inches (356 mm), **as directed**.
   f. Panel Height: 0.375 inch (10 mm) **OR** 0.44 inch (11 mm) **OR** 0.50 inch (13 mm) **OR** 0.625 inch (16 mm), **as directed**.

I. Accessories
   1. Wall Panel Accessories: Provide components required for a complete metal wall panel assembly including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal wall panels, unless otherwise indicated.
      a. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal wall panels.
      b. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
      c. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal wall panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
   2. Flashing and Trim: Formed from 0.018-inch (0.46-mm) minimum thickness, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal wall panels.

J. Fabrication
1. General: Fabricate and finish metal wall panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
2. Fabricate metal wall panels in a manner that eliminates condensation on interior side of panel and with joints between panels designed to form weathertight seals.
3. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
4. Fabricate metal wall panel joints with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, and that will minimize noise from movements within panel assembly.
5. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of item indicated.
   a. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
   b. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
   c. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
   d. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
   e. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
   f. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended by metal wall panel manufacturer.
      1) Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

K. General Finish Requirements
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
3. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

1.3 EXECUTION

A. Preparation
1. Miscellaneous Framing: Install subgirts, base angles, sills, furring, and other miscellaneous wall panel support members and anchorages according to ASTM C 754 and metal wall panel manufacturer's written recommendations.
   a. Soffit Framing: Wire-tie or clip furring channels to supports, as required to comply with requirements for assemblies indicated.

B. Thermal Insulation Installation
1. Board Insulation: Extend insulation in thickness indicated to cover entire wall. Comply with installation requirements in Division 07 Section "Building Insulation".

a. Erect insulation horizontally and hold in place with Z-shaped furring members spaced 24 inches (610 mm) o.c. Attach furring members to substrate with screws spaced 24 inches (610 mm) o.c.
b. Retain insulation in place by metal clips and straps or integral pockets within panels, spaced at intervals according to insulation manufacturer's instructions. Maintain cavity width between insulation and metal liner panel of dimension indicated.

2. Blanket Insulation: Install insulation concurrently with metal wall panel installation, in thickness indicated to cover entire wall, according to manufacturer's written instructions and as follows:
a. Set vapor-retarder-faced insulation with vapor-retarder facing building exterior **OR** building interior **OR** as indicated on Drawings, **as directed**. Do not obstruct ventilation spaces, except for firestopping.
b. Tape joints and ruptures in vapor retarder, and seal each continuous area of insulation to surrounding construction to ensure airtight installation.
c. Install insulation straight and true in one-piece lengths. Comply with the following installation method:
1) Over-Framing Installation: Extend insulation over and perpendicular to top flange of framing members.
d. Retainer Strips: Install retainer strips at each longitudinal insulation joint, straight and taut, nesting with framing to hold insulation in place.

C. Metal Wall Panel Installation
1. General: Install metal wall panels according to manufacturer's written instructions in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts and subgirts unless otherwise indicated. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement.
a. Commence metal wall panel installation and install minimum of 300 sq. ft. (27.8 sq. m.) in presence of factory-authorized representative.
b. Shim or otherwise plumb substrates receiving metal wall panels.
c. Flash and seal metal wall panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until weather barrier and flashings that will be concealed by metal wall panels are installed.
d. Install screw fasteners in predrilled holes.
e. Locate and space fastenings in uniform vertical and horizontal alignment.
f. Install flashing and trim as metal wall panel work proceeds.
g. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
h. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete and elsewhere as indicated or, if not indicated, as necessary for waterproofing.
i. Align bottom of metal wall panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
j. Provide weathertight escutcheons for pipe and conduit penetrating exterior walls.
2. Fasteners:
a. Steel Wall Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized steel fasteners for surfaces exposed to the interior.
b. Aluminum Wall Panels: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized steel fasteners for surfaces exposed to the interior.
c. Copper Wall Panels: Use copper, stainless-steel or hardware-bronze fasteners.
d. Stainless-Steel Wall Panels: Use stainless-steel fasteners.
3. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action as recommended by metal wall panel manufacturer.
4. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weathertight performance of metal wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal wall panel manufacturer.

a. Seal metal wall panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal wall panel manufacturer.
b. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants".

5. Lap-Seam Metal Wall Panels: Fasten metal wall panels to supports with fasteners at each lapped joint at location and spacing recommended by manufacturer.
   a. Lap ribbed or fluted sheets one full rib corrugation. Apply panels and associated items for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.
   b. Provide metal-backed washers under heads of exposed fasteners bearing on weather side of metal wall panels.
   c. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
   d. Install screw fasteners with power tools having controlled torque adjusted to compress washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.
   e. Provide sealant tape at lapped joints of metal wall panels and between panels and protruding equipment, vents, and accessories.
   f. Apply a continuous ribbon of sealant tape to weather-side surface of fastenings on end laps; on side laps of nesting-type panels; on side laps of corrugated nesting-type, ribbed, or fluted panels; and elsewhere as needed to make panels weathertight.
   g. At panel splices, nest panels with minimum 6-inch (152-mm) end lap, sealed with butyl-rubber sealant and fastened together by interlocking clamping plates.
6. Zee Clips: Provide Zee clips of size indicated or, if not indicated, as required to act as standoff from subgirts for thickness of insulation indicated. Attach to subgirts with fasteners.
7. Metal Liner Panels: Install panels on exterior side of girts with girts exposed to the interior **OR** interior side of girts with flush appearance on the inside **OR** girts as indicated on Drawings, **as directed**.
8. Fire-Rated Metal Wall Panel Assemblies: Install metal liner panels on exterior side of girts, fastening through faces of panels, with girts exposed to the interior. Install subgirts horizontally, fastened to legs of metal liner panels. Install substrate board as indicated in Division 06 Section "Sheathing", in number of layers required for fire rating, over subgirts, attached with board fasteners. Install second set of subgirts horizontally, fastened through substrate board into first set of subgirts. Install exterior metal wall panels, fastened to second set of subgirts.
   a. Comply with UL **OR** FMG, **as directed**, requirements for fire-rated construction.

D. Metal Soffit Panel Installation
1. In addition to complying with requirements of "Metal Wall Panel Installation, General" Article, install metal soffit panels to comply with the requirements of this article.
2. Metal Soffit Panels: Provide metal soffit panels full width of soffits. Install panels perpendicular to support framing.
   a. Flash and seal panels with weather closures where metal soffit panels meet walls and at perimeter of all openings.

E. Accessory Installation
1. General: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
   a. Install components required for a complete metal wall panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
2. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
   a. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form

hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.

b. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (605 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

F. Field Quality Control

1. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports, **as directed by the Owner**.
2. Water Penetration: Test areas of installed system indicated on Drawings for compliance with system performance requirements according to ASTM E 1105 at minimum differential pressure of 20 percent of inward-acting, wind-load design pressure as defined by SEI/ASCE 7, but not less than 6.24 lbf/sq. ft. (300 Pa).
3. Water-Spray Test: After completing the installation of 75-foot- (23-m-) by-2-story minimum area of metal wall panel assembly, test assembly for water penetration according to AAMA 501.2 in a 2-bay area directed by the Owner.
4. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect and test completed metal wall panel installation, including accessories.
5. Remove and replace metal wall panels where tests and inspections indicate that they do not comply with specified requirements.
6. Additional tests and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

G. Cleaning And Protection

1. Remove temporary protective coverings and strippable films, if any, as metal wall panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal wall panel installation, clean finished surfaces as recommended by metal wall panel manufacturer. Maintain in a clean condition during construction.
2. After metal wall panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
3. Replace metal wall panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07460

SECTION 07460a - INSULATED-CORE METAL WALL PANELS

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for insulated-core metal wall panels. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Foamed-insulation-core metal wall panels.
b. Laminated-insulation-core metal wall panels.
c. Honeycomb-core metal wall panels.

C. Definitions
1. Metal Wall Panel Assembly: Insulated-core metal wall panels, attachment system components, miscellaneous metal framing, and accessories necessary for a complete weathertight wall system.

D. Performance Requirements
1. General Performance: Metal wall panel assemblies shall comply with performance requirements without failure due to defective manufacture, fabrication, installation, or other defects in construction.
2. Delegated Design: Design metal wall panel assembly, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
3. Air Infiltration: Air leakage through assembly of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) of wall area when tested according to ASTM E 283 at the following test-pressure difference:
a. Test-Pressure Difference: 1.57 lbf/sq. ft. (75 Pa) which is equivalent to a 25-mph (40-km/h) wind.
4. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 331 at the following test-pressure difference:
a. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa) which is equivalent to a 50-mph (80-km/h) wind.
5. Water Penetration under Dynamic Pressure: No evidence of water leakage when tested according to AAMA 501.1 under dynamic pressure equal to 20 percent of inward-acting, wind-load design pressure of not less than 6.24 lbf/sq. ft. (299 Pa) and not more than 12 lbf/sq. ft. (575 Pa).
a. Water Leakage: As defined according to AAMA 501.1.
OR
Water Leakage: Uncontrolled water infiltrating the system or appearing on system's normally exposed interior surfaces from sources other than condensation. Water controlled by flashing and gutters that is drained back to the exterior and cannot damage adjacent materials or finishes is not water leakage.
6. Structural Performance: Metal wall panel assemblies shall withstand the effects the following loads and stresses within limits and under conditions indicated, based on testing according to ASTM E 330:
a. Wind Loads: Determine loads based on the following minimum design wind pressures:
1) Uniform pressure of 20 lbf/sq. ft. (958 Pa) **OR** 30 lbf/sq. ft. (1436 Pa), **as directed**, acting inward or outward.
OR
Uniform pressure as indicated on Drawings.

b. Deflection Limits: Metal wall panel assemblies shall withstand wind loads with horizontal deflections no greater than 1/180 **OR** 1/240, **as directed**, of the span.

7. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
8. Thermal Performance: Provide insulated metal wall panel assemblies with thermal-resistance value (R-value) indicated when tested according to ASTM C 518.

E. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Show fabrication and installation layouts of metal wall panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details. Distinguish between factory-, shop-, and field-assembled work.
3. Samples: For each type of exposed finish required.
4. Delegated-Design Submittal: For metal wall panel assembly indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
5. Coordination Drawings: Exterior elevations, drawn to scale, and coordinating penetrations and wall-mounted items.
6. Product Test Reports.
7. Field quality-control reports.
8. Maintenance Data.
9. Warranties: Sample of special warranties.

F. Quality Assurance
1. Installer Qualifications: An employer of workers trained and approved by manufacturer.
2. Fire-Test-Response Characteristics: Provide metal wall panels and system components with the following fire-test-response characteristics as determined by testing identical panels and system components per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.
   a. Fire-Resistance Characteristics: Provide materials and construction tested for fire resistance per ASTM E 119.
   b. Intermediate-Scale Multistory Fire Test: Tested mockup, representative of completed multistory wall assembly of which wall panel is a part, complies with NFPA 285 for test method and required fire-test-response characteristics of exterior non-load-bearing wall panel assemblies.
   c. Radiant Heat Exposure: No ignition when tested according to NFPA 268.
   d. Potential Heat: Acceptable level when tested according to NFPA 259.
   e. Surface-Burning Characteristics: Provide wall panels with flame-spread index of 25 or less and smoke-developed index of 450 or less, per ASTM E 84.
3. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver components, sheets, metal wall panels, and other manufactured items so as not to be damaged or deformed. Package metal wall panels for protection during transportation and handling.
2. Unload, store, and erect metal wall panels in a manner to prevent bending, warping, twisting, and surface damage.
3. Stack metal wall panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal wall panels to ensure dryness, with positive slope for

drainage of water. Do not store metal wall panels in contact with other materials that might cause staining, denting, or other surface damage.

4. Retain strippable protective covering on metal wall panels for period of metal wall panel installation.

H. Warranty

1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal wall panel assemblies that fail in materials or workmanship within specified warranty period.
   a. Warranty Period: Two years from date of Substantial Completion.
2. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal wall panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
   a. Finish Warranty Period:
      1) 20 years from date of Substantial Completion for fluoropolymer finish.
      2) 10 years from date of Substantial Completion for siliconized polyester.

1.2 PRODUCTS

A. Panel Materials

1. Metallic-Coated Steel Sheet: Restricted flatness steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
   a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality.
   b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40 (Class AZM150 coating designation, Grade 275); structural quality.
   c. Surface: Smooth, flat **OR** Embossed, **as directed**, finish.
   d. Exposed Coil-Coated Finish:
      1) Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      2) Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      3) Four-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat and clear coats. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      4) Mica Fluoropolymer: AAMA 621. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      5) Metallic Fluoropolymer: AAMA 621. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      6) FEVE Fluoropolymer: AAMA 621. Two-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

7) Siliconized-Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
8) Plastisol: Epoxy primer and vinyl plastisol topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 3.8 mil (0.097 mm) for topcoat.

e. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

2. Aluminum Sheet: Coil-coated sheet, ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.
   a. Surface: Smooth, flat **OR** Embossed, **as directed**, finish.
   b. Exposed Coil-Coated Finishes:
      1) Two-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      2) Three-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      3) Four-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat and clear coats. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      4) Mica Fluoropolymer: AAMA 620. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      5) Metallic Fluoropolymer: AAMA 620. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      6) FEVE Fluoropolymer: AAMA 620. Two-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      7) Siliconized-Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
      8) Plastisol: Epoxy primer and vinyl plastisol topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 3.8 mil (0.097 mm) for topcoat.
   c. Exposed Anodized Finish:
      1) Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
      2) Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
   d. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

3. Copper Sheet: ASTM B 370, cold-rolled copper sheet, H00 temper.
   a. Exposed Finish: Apply the following finish, as specified or indicated on Drawings.
      1) Natural finish.

2) Brushed Satin: CDA M32-06x (Mechanical Finish: directionally textured, medium satin; Coating: clear organic, air drying, as specified below):
   a) Clear, Organic Coating: Clear, air-drying, acrylic lacquer specially developed for coating copper-alloy products, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
3) Mirror Polished: CDA M22-06x (Mechanical Finish: buffed, specular; Coating: clear organic, air drying, as specified below):
   a) Clear, Organic Coating: Clear, air-drying, acrylic lacquer specially developed for coating copper-alloy products, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
4) Pre-patinated: ASTM B 882. Copper sheets artificially aged by chemical reaction to convert surface to inorganic crystalline structure with color range and durability of naturally-formed patina.

4. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304 **OR** 316, **as directed**, fully annealed.
   a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
   b. Polished Finish: Grind and polish surfaces to produce uniform finish, free of cross scratches.
      1) Run grain of directional finishes with long dimension of each piece.
      2) When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
      3) Directional Satin Finish: No. 4.
   c. Bright, Cold-Rolled, Unpolished Finish: No. 2B.
5. Panel Sealants:
   a. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
   b. Joint Sealant: ASTM C 920; elastomeric polyurethane, polysulfide, or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal wall panels and remain weathertight; and as recommended in writing by metal wall panel manufacturer.
   c. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

B. Insulation For Panel Cores
1. Polyisocyanurate Insulation: Closed cell, modified polyisocyanurate foam using a non-CFC blowing agent, foamed-in-place **OR** board, **as directed**, type, with maximum flame-spread index of 25 and smoke-developed index of 450.
   a. Closed-Cell Content: 90 percent when tested according to ASTM D 2856.
2. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.60-lb/cu. ft. (26-kg/cu. m) minimum density, unless otherwise indicated; with maximum flame-spread index of 25 and smoke-developed index of 450.
3. Molded-Polystyrene Board Insulation: ASTM C 578, Type I, 0.9 lb/cu. ft. (14 kg/cu. m) **OR** Type II, 1.35 lb/cu. ft. (22 kg/cu. m), Class 2 or 3, Grade 3, **as directed**, with maximum flame-spread index of 25 and smoke-developed index of 450.

C. Miscellaneous Metal Framing
1. Miscellaneous Metal Framing, General: ASTM C 645, cold-formed metallic-coated steel sheet, ASTM A 653/A 653M, G40 (Z120) hot-dip galvanized **OR** ASTM A 653/A 653M, G60 (Z180) hot-dip galvanized, **as directed**, or coating with equivalent corrosion resistance unless otherwise indicated.
2. Subgirts: Manufacturer's standard C- or Z-shaped sections, 0.064-inch (1.63-mm) nominal thickness.
3. Zee Clips: 0.079-inch (2.01-mm) nominal thickness.
4. Base or Sill Angles **OR** Channels, **as directed**: 0.079-inch (2.01-mm) nominal thickness.
5. Hat-Shaped, Rigid Furring Channels:

a. Nominal Thickness: As indicated **OR** As required to meet performance requirements **OR** 0.025 inch (0.64 mm) **OR** 0.040 inch (1.02 mm), **as directed**.
b. Depth: As indicated **OR** 7/8 inch (21 mm) **OR** 1-1/2 inches (38 mm), **as directed**.

6. Cold-Rolled Furring Channels: Minimum 1/2-inch- (13-mm-) wide flange.
   a. Nominal Thickness: As indicated **OR** As required to meet performance requirements **OR** 0.064 inch (1.63 mm), **as directed**.
   b. Depth: As indicated **OR** 3/4 inch (19 mm), **as directed**.
   c. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with 0.040-inch (1.02-mm) nominal thickness.
7. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.52-mm-) diameter wire, or double strand of 0.048-inch- (1.22-mm-) diameter wire.
8. Fasteners for Miscellaneous Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten miscellaneous metal framing members to substrates.

D. Miscellaneous Materials
1. Panel Fasteners: Self-tapping screws; bolts and nuts; self-locking rivets and bolts; end-welded studs; and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of metal wall panels by means of plastic caps or factory-applied coating. Provide EPDM, PVC, or neoprene sealing washers.
2. Backer Board: Hardboard complying with AHA A135.4, Class 1 tempered, 1/8 inch (3 mm) **OR** 1/4 inch (6 mm), **as directed**, thick unless otherwise indicated.

E. Foamed-Insulation-Core Metal Wall Panels
1. General: Provide factory-formed and -assembled metal wall panels fabricated from two metal facing sheets and insulation core foamed in place during fabrication, and with joints between panels designed to form weathertight seals. Include accessories required for weathertight installation.
   a. Panel Performance:
      1) Flatwise Tensile Strength: 30 psi (207 kPa) when tested according to ASTM C 297.
      2) Humid Aging: Volume increase not greater than 6.0 percent and no delamination or metal corrosion when tested for 7 days at 140 deg F (60 deg C) and 100 percent relative humidity according to ASTM D 2126.
      3) Heat Aging: Volume increase not greater than 2.0 percent and no delamination, surface blistering, or permanent bowing when tested for 7 days at 200 deg F (93 deg C) according to ASTM D 2126.
      4) Cold Aging: Volume decrease not more than 1.0 percent and no delamination, surface blistering, or permanent bowing when tested for 7 days at minus 20 deg F (29 deg C) according to ASTM D 2126.
      5) Fatigue: No evidence of delamination, core cracking, or permanent bowing when tested to a 20-lbf/sq. ft. (958-kPa) positive and negative wind load and with deflection of L/180 for 2 million cycles.
      6) Autoclave: No delamination when exposed to 2-psi (13.8-kPa) pressure at a temperature of 212 deg F (100 deg C) for 2-1/2 hours.
   b. Polyisocyanurate Insulation-Core Performance:
      1) Density: 2.0 to 2.6 lb/cu. ft. (32 to 42 kg/cu. m) when tested according to ASTM D 1622.
      2) Compressive Strength: Minimum 20 psi (138 kPa) when tested according to ASTM D 1621.
      3) Shear Strength: 26 psi (179 kPa) when tested according to ASTM C 273.
2. Exposed-Fastener, Foamed-Insulation-Core Metal Wall Panels: Formed with raised, trapezoidal major rib at panel edge and two intermediate stiffening ribs symmetrically spaced between major rib and panel edge; designed for lapping side edges of adjacent panels and mechanically attaching to supports using exposed fasteners in side laps.
   a. Facings: Fabricate panel with exterior and interior facings of same material and thickness.

1) Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
2) Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
3) Backer Board: On back side of exterior facing.
4) Exterior Facing Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
   a) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
5) Interior Facing Finish: Manufacturer's standard white polyester.

b. Snap-On Batten: Same material, finish, and color as exterior facings of wall panels.
c. Panel Coverage: 36 inches (914 mm) **OR** 40 inches (1016 mm), **as directed**, nominal.
d. Panel Thickness: 1.0 inch (25 mm) **OR** 1.5 inches (38 mm) **OR** 2.0 inches (51 mm) **OR** 2.5 inches (64 mm) **OR** 3.0 inches (76 mm) **OR** 4.0 inches (102 mm) **OR** 5.0 inches (127 mm), **as directed**.
e. Thermal-Resistance Value (R-Value): as directed by the Owner.

3. Concealed-Fastener, Foamed-Insulation-Core Metal Wall Panels: Formed with tongue-and-groove panel edges; designed for sequential installation by interlocking panel edges and mechanically attaching panels to supports using concealed clips or fasteners.
   a. Facings: Fabricate panel with exterior and interior facings of same material and thickness.
      1) Material: Zinc-coated (galvanized) steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
      2) Material: Aluminum-zinc alloy-coated steel sheet, 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, nominal thickness.
      3) Material: Stainless-steel sheet, 0.031 inch (0.79 mm) **OR** 0.038 inch (0.97 mm), **as directed**, thick with No. 4 **OR** 2B, **as directed**, finish.
      4) Backer Board: On back side of exterior facing.
      5) Exterior Facing Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol, **as directed**.
         a) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
      6) Interior Facing Finish: Manufacturer's standard siliconized polyester.
      7) Exterior Surface: Smooth, flat **OR** Striated **OR** Shallow ribs **OR** Shallow V grooves, **as directed**.
   b. Panel Coverage: 24 inches (610 mm) **OR** 30 inches (762 mm) **OR** 36 inches (914 mm) **OR** 39.37 inches (1000 mm) **OR** 42 inches (1067 mm), **as directed**, nominal.
   c. Panel Thickness: 2.0 inches (51 mm) **OR** 2.5 inches (64 mm) **OR** 3.0 inches (76 mm) **OR** 4.0 inches (102 mm) **OR** 5.0 inches (127 mm) **OR** 6.0 inches (152 mm), **as directed**.
   d. Thermal-Resistance Value (R-Value): as directed by the Owner.

F. Laminated-Insulation-Core Metal Wall Panels
   1. General: Provide factory-formed and -assembled metal wall panels fabricated from two metal facing sheets and core material laminated or otherwise securely bonded to facing sheets during fabrication without use of contact adhesives, and with joints between panels designed to form weathertight seals. Include accessories required for weathertight installation.
      a. Panel Performance:
         1) Flatwise Tensile Strength: 27 psi (186 kPa) when tested according to ASTM C 297.
         2) Humid Aging: Volume increase not greater than 6.0 percent and no delamination or metal corrosion when tested for 7 days at 140 deg F (60 deg C) and 100 percent relative humidity according to ASTM D 2126.
         3) Heat Aging: Volume increase not greater than 2.0 percent and no delamination, surface blistering, or permanent bowing when tested for 7 days at 200 deg F (93 deg C) according to ASTM D 2126.

4) Cold Aging: Volume decrease not more than 1.0 percent and no delamination, surface blistering, or permanent bowing when tested for 7 days at minus 20 deg F (29 deg C) according to ASTM D 2126.
5) Fatigue: No evidence of delamination, core cracking, or permanent bowing when tested to a 20-lbf/sq. ft. (958-kPa) positive and negative wind load and with deflection of L/180 for 2 million cycles.
6) Autoclave: No delamination when exposed to 2-psi (13.8-kPa) pressure at a temperature of 212 deg F (100 deg C) for 2-1/2 hours.

b. Polyisocyanurate Insulation-Core Performance:
1) Density: 1.8 to 2.3 lb/cu. ft. (29 to 37 kg/cu. m) when tested according to ASTM D 1622.
2) Compressive Strength: Minimum 20 psi (138 kPa) when tested according to ASTM D 1621.
3) Shear Strength: 24 psi (164 kPa) when tested according to ASTM C 273.

2. Wrapped-Edge, Laminated-Insulation-Core Metal Wall Panels: Formed with flush exterior panel facing wrapped over panel edges; designed for independent installation by mechanically attaching panels to supports using staggered, concealed side clips engaging panel edges **OR** through extended panel edges to supports using concealed fasteners, **as directed**; with sealant **OR** gasketed, **as directed**, joints.
a. Exterior Facing:
1) Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
2) Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
3) Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm) **OR** 0.063 inch (1.60 mm) **OR** 0.080 inch (2.03 mm), **as directed**, thick.
4) Surface: Smooth, flat **OR** Embossed, **as directed**.
5) Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
a) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

b. Interior Facing:
1) Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
2) Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
3) Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm), **as directed**, thick.
4) Finish: Manufacturer's standard primer or white polyester.

c. Core Material: Polyisocyanurate **OR** Extruded-polystyrene **OR** Expanded-polystyrene, **as directed**, board insulation.
1) Backer Board: 0.125-inch- (3-mm-) **OR** 0.250-inch- (6-mm-), **as directed**, thick hardboard behind exterior facing for increased impact resistance.

d. Clips: Manufacturer's standard one piece, formed from zinc-coated (galvanized) steel **OR** aluminum-zinc alloy-coated steel **OR** stainless steel, **as directed**.
e. Gaskets: Extruded, dry seal silicone.
f. Sealant: Manufacturer's standard silicone.
g. Panel Thickness: 1.0 inch (25 mm) **OR** 2.0 inches (51 mm) **OR** 3.0 inches (76 mm) **OR** 4.0 inches (102 mm) **OR** 5.0 inches (127 mm) **OR** 6.0 inches (152 mm), **as directed**.
h. Thermal-Resistance Value (R-Value): as directed by the Owner.

3. Shiplap-Edge, Laminated-Insulation-Core Metal Wall Panels: Formed with flush exterior panel facing and with shiplap edges; designed for sequential installation by mechanically attaching panels to supports using concealed clips and fasteners; with factory-applied sealant **OR** gaskets, **as directed**, in side laps.
   a. Exterior Facing:
      1) Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
      2) Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
      3) Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm) **OR** 0.063 inch (1.60 mm), **as directed**, thick.
      4) Surface: Smooth, flat **OR** Embossed, **as directed**.
      5) Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
         a) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
   b. Interior Facing:
      1) Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
      2) Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
      3) Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
      4) Finish: Manufacturer's standard primer or white polyester.
   c. Core Material: Polyisocyanurate **OR** Extruded-polystyrene **OR** Expanded-polystyrene, **as directed**, board insulation.
      1) Backer Board: 0.125-inch- (3-mm-) **OR** 0.250-inch- (6-mm-), **as directed**, thick hardboard behind exterior facing for increased impact resistance.
   d. Clips: Manufacturer's standard one piece, formed from zinc-coated (galvanized) steel **OR** aluminum-zinc alloy-coated steel **OR** stainless steel, **as directed**.
   e. Gaskets: Extruded, dry seal silicone.
   f. Sealant: Manufacturer's standard silicone.
   g. Panel Thickness: 1.0 inch (25 mm) **OR** 2.0 inches (51 mm) **OR** 3.0 inches (76 mm) **OR** 4.0 inches (102 mm) **OR** 5.0 inches (127 mm) **OR** 6.0 inches (152 mm), **as directed**.
   h. Thermal-Resistance Value (R-Value): as directed by the Owner.
4. Framed-Edge, Laminated-Insulation-Core Metal Wall Panels: Formed with flush exterior panel facing and integral, extruded edge members; designed for independent installation by mechanically attaching panels to supports through edge framing using concealed fasteners; with gasketed joints.
   a. Exterior Facing:
      1) Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
      2) Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0-71 mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
      3) Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm) **OR** 0.063 inch (1.60 mm) **OR** 0.080 inch (2.03 mm), **as directed**, thick.
      4) Surface: Smooth, flat **OR** Embossed, **as directed**.
      5) Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
         a) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

b. Interior Facing:
   1) Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
   2) Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
   3) Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm), **as directed**, thick.
   4) Finish: Manufacturer's standard primer or white polyester.

c. Core Material: Polyisocyanurate **OR** Extruded-polystyrene **OR** Expanded-polystyrene, **as directed**, board insulation.
   1) Backer Board: 0.125-inch- (3.18-mm-) **OR** 0.250-inch- (6-mm-), **as directed**, thick hardboard behind exterior facing for increased impact resistance.

d. Edge Members: Extruded aluminum, not less than 0.063-inch (1.60-mm) wall thickness.

e. Gaskets: Extruded, dry seal silicone.

f. Panel Thickness: 1.0 inch (25 mm) **OR** 2.0 inches (51 mm) **OR** 3.0 inches (76 mm) **OR** 4.0 inches (102 mm) **OR** 5.0 inches (127 mm) **OR** 6.0 inches (152 mm), **as directed**.

g. Thermal-Resistance Value (R-Value): as directed by the Owner.

G. Honeycomb-Core Metal Wall Panels

1. General: Provide factory-formed and -assembled metal wall panels fabricated from two metal facing sheets and honeycomb-core material laminated or otherwise securely bonded to facing sheets during fabrication without use of contact adhesives or pinch rollers, and with joints between panels designed to form weathertight seals. Include accessories required for weathertight installation.
   a. Panel Performance:
      1) Fatigue: No evidence of delamination, core cracking, or permanent bowing when tested to a 20-lbf/sq. ft. (958-kPa) positive and negative wind load and with deflection of L/180 for 2 million cycles.
      2) Autoclave: No delamination when exposed to 2-psi (13.8-kPa) pressure at a temperature of 212 deg F (100 deg C) for 2-1/2 hours.

2. Wrapped-Edge, Honeycomb-Core Metal Wall Panels: Formed with flush exterior panel facing wrapped over panel edges; designed for independent installation by mechanically attaching panels to supports using staggered, concealed side clips engaging panel edges **OR** through extended panel edges to supports using concealed fasteners, **as directed**; with sealant **OR** gasketed, **as directed**, joints.
   a. Facings: Fabricate panel with exterior and interior facings of same material and thickness.
      1) Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
      2) Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
      3) Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm) **OR** 0.063 inch (1.60 mm), **as directed**, thick.
      4) Exterior Facing Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
         a) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
      5) Interior Facing Finish: Manufacturer's standard primer or polyester.
   b. Kraft-Paper Honeycomb Core: Manufacturer's standard phenolic-resin impregnated paper, with not less than 15 percent resin content by weight and chemically treated for fire resistance; with maximum 1/2-inch (13-mm) cell size.
   c. Aluminum Honeycomb Core: Manufacturer's standard 0.003-inch- (0.08-mm-) thick, commercial grade aluminum with maximum 3/4-inch (19-mm) cell size.

d. Clips: Manufacturer's standard one piece, formed from zinc-coated (galvanized) steel **OR** aluminum-zinc alloy-coated steel **OR** stainless steel, **as directed**.
e. Gaskets: Extruded, dry seal silicone.
f. Sealant: Manufacturer's standard silicone.
g. Panel Thickness: 0.25 inch (6 mm) **OR** 1.0 inch (25 mm) **OR** 2.0 inches (51 mm) **OR** 3.0 inches (76 mm) **OR** 4.0 inches (102 mm), **as directed**.

3. Shiplap-Edge, Honeycomb-Core Metal Wall Panels: Formed with flush exterior panel facing and with shiplap edges; designed for sequential installation by mechanically attaching panels to supports using concealed clips and fasteners; with factory-applied sealant **OR** gaskets, **as directed**, in side laps.
   a. Facings: Fabricate panel with exterior and interior facings of same material and thickness.
      1) Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
      2) Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm), **as directed**, nominal thickness.
      3) Material: Aluminum sheet, 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm) **OR** 0.063 inch (1.60 mm), **as directed**, thick.
      4) Exterior Facing Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
         a) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
      5) Interior Facing Finish: Manufacturer's standard primer or polyester.
   b. Kraft-Paper Honeycomb Core: Manufacturer's standard phenolic-resin-impregnated paper, with not less than 15 percent resin content by weight and chemically treated for fire resistance; with maximum 1/2-inch (13-mm) cell size.
   c. Aluminum Honeycomb Core: Manufacturer's standard 0.003-inch- (0.08-mm-) thick, commercial grade aluminum with maximum 3/4-inch (19-mm) cell size.
   d. Clips: Manufacturer's standard one piece, formed from zinc-coated (galvanized) steel **OR** aluminum-zinc alloy-coated steel **OR** stainless steel, **as directed**.
   e. Gaskets: Extruded, dry seal silicone.
   f. Sealant: Manufacturer's standard silicone.
   g. Panel Thickness: 1.0 inch (25 mm) **OR** 1.25 inches (32 mm) **OR** 2.0 inches (51 mm), **as directed**.

4. Framed-Edge, Honeycomb-Core Metal Wall Panels: Formed with flush exterior panel facing and integral, extruded edge members; designed for independent installation by mechanically attaching panels to supports through edge framing using concealed fasteners; with gasketed joints.
   a. Facings: Fabricate panel with exterior and interior facings of same material and thickness.
      1) Material: Zinc-coated (galvanized) steel sheet, 0.028-inch (0.71-mm) nominal thickness.
      2) Material: Aluminum sheet, 0.040 inch (1.02 mm) **OR** 0.063 inch (1.60 mm), **as directed**, thick.
      3) Exterior Facing Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Siliconized polyester **OR** Plastisol **OR** Clear anodized **OR** Color anodized, **as directed**.
         a) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
      4) Interior Facing Finish: Manufacturer's standard primer or polyester.
   b. Kraft-Paper Honeycomb Core: Manufacturer's standard phenolic-resin-impregnated paper, with not less than 15 percent resin content by weight and chemically treated for fire resistance; with maximum 1/2-inch (13-mm) cell size.
   c. Aluminum Honeycomb Core: Manufacturer's standard 0.003-inch- (0.08-mm-) thick, commercial grade aluminum with maximum 3/4-inch (19-mm) cell size.

d. Edge Members: Extruded aluminum, not less than 0.063-inch (1.6-mm) wall thickness.
e. Gaskets: Extruded, dry seal silicone.
f. Panel Thickness: 1.0 inch (25 mm) **OR** 2.0 inches (51 mm) **OR** 3.0 inches (76 mm), **as directed**.

H. Accessories
1. Wall Panel Accessories: Provide components required for a complete metal wall panel assembly including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal wall panels unless otherwise indicated.
a. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal wall panels.
b. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
c. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal wall panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
2. Flashing and Trim: Formed from 0.018-inch- (0.46-mm-) minimum thickness, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal wall panels.

I. Fabrication
1. General: Fabricate and finish metal wall panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
2. Fabricate metal wall panels in a manner that eliminates condensation on interior side of panel and with joints between panels designed to form weathertight seals.
3. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
4. Fabricate metal wall panel joints with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will minimize noise from movements within panel assembly.
5. Honeycomb-Core Metal Wall Panels: Fabricate panels using manufacturer's standard thermosetting structural adhesive in a lamination process that bonds panel under minimum 10-psi (69-kPa) pressure. Use of contact adhesives with pinch-roll process is not acceptable.
a. Panel Bow Tolerance: Not more than 0.5 percent of panel width or length.
6. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of item indicated.
a. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
b. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
c. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
d. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
e. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.

f. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended by metal wall panel manufacturer.
   1) Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

J. General Finish Requirements
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
3. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

1.3 EXECUTION

A. Preparation
1. Miscellaneous Framing: Install subgirts, base angles, sills, furring, and other miscellaneous wall panel support members and anchorages according to ASTM C 754 and metal wall panel manufacturer's written recommendations.

B. Metal Wall Panel Installation, General
1. General: Install metal wall panels according to manufacturer's written instructions in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts and subgirts unless otherwise indicated. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement.
   a. Commence metal wall panel installation and install minimum of 300 sq. ft. (27.9 sq. m.) in presence of factory-authorized representative.
   b. Shim or otherwise plumb substrates receiving metal wall panels.
   c. Flash and seal metal wall panels with weather closures at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until weather barrier and flashings that will be concealed by metal wall panels are installed.
   d. Install screw fasteners in predrilled holes.
   e. Locate and space fastenings in uniform vertical and horizontal alignment.
   f. Install flashing and trim as metal wall panel work proceeds.
   g. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
   h. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, and elsewhere as indicated or, if not indicated, as necessary for waterproofing.
   i. Align bottom of metal wall panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
   j. Provide weathertight escutcheons for pipe and conduit penetrating exterior walls.
2. Fasteners:
   a. Steel Wall Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized steel fasteners for surfaces exposed to the interior.
   b. Aluminum Wall Panels: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized steel fasteners for surfaces exposed to the interior.
   c. Copper Wall Panels: Use copper, stainless-steel, or hardware-bronze fasteners.
   d. Stainless-Steel Wall Panels: Use stainless-steel fasteners.
3. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action as recommended by metal wall panel manufacturer.

4. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weathertight performance of metal wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal wall panel manufacturer.
   a. Seal metal wall panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal wall panel manufacturer.
   b. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants".

C. Insulated-Core Metal Wall Panel Installation
1. General: Apply continuous ribbon of sealant to panel joint on concealed side of insulated-core metal wall panels as vapor seal; apply sealant to panel joint on exposed side of panels for weather seal.
   a. Fasten insulated-core metal wall panels to supports with fasteners at each lapped joint at location and spacing and with fasteners recommended by manufacturer.
   b. Lap ribbed or fluted sheets one full rib corrugation. Apply panels and associated items for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.
   c. Provide metal-backed washers under heads of exposed fasteners on weather side of insulated metal wall panels.
   d. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
   e. Provide sealant tape at lapped joints of insulated metal wall panels and between panels and protruding equipment, vents, and accessories.
   f. Apply a continuous ribbon of sealant tape to panel side laps and elsewhere as needed to make panels weathertight.
   g. Apply snap-on battens to exposed-fastener, insulated-core metal wall panel seams to conceal fasteners.
2. Foamed-Insulation-Core Metal Wall Panels: Fasten metal wall panels to supports with concealed clips at each joint at location and spacing and with fasteners recommended by manufacturer. Fully engage tongue and groove of adjacent panels.
   a. Install clips to supports with self-tapping fasteners.
3. Laminated-Insulation-Core Metal Wall Panels:
   a. Wrapped-Edge Panels: Mechanically attach wall panels to supports using staggered, concealed side clips engaging wrapped panel edges. Install clips to supports with self-tapping fasteners. Seal joints with backer rod and sealant **OR** manufacturer's standard gaskets, **as directed**.
   b. Wrapped-Edge Panels: Mechanically attach wall panels through extended edge of panels to supports using self-tapping fasteners. Seal joints with backer rod and sealant **OR** manufacturer's standard gaskets, **as directed**.
   c. Shiplap-Edge Panels: Mechanically attach wall panels to supports using staggered, concealed side clips engaging tongue-and-groove panel edges. Install clips to supports with self-tapping fasteners.
      1) Horizontal Joints: Maintain reveal joint of consistent width **OR** Seal joints with backer rod and sealant **OR** Seal joints with manufacturer's standard gaskets, **as directed**.
      2) Vertical Joints: Maintain reveal joint of consistent width **OR** Seal joints with backer rod and sealant **OR** Seal joints with manufacturer's standard gaskets, **as directed**.
   d. Framed-Edge Panels: Mechanically attach wall panels through integral, extruded edge members to supports using self-tapping fasteners. Seal joints with manufacturer's standard gaskets.
4. Honeycomb-Core Metal Wall Panels:
   a. Wrapped-Edge Panels: Mechanically attach wall panels to supports using staggered, concealed side clips engaging wrapped panel edges. Install clips to supports with self-tapping fasteners. Seal joints with backer rod and sealant **OR** manufacturer's standard gaskets, **as directed**.

b. Wrapped-Edge Panels: Mechanically attach wall panels through extended edge of panels to supports using self-tapping fasteners. Seal joints with backer rod and sealant **OR** manufacturer's standard gaskets, **as directed**.

c. Shiplap-Edge Panels: Mechanically attach wall panels to supports using staggered, concealed side clips engaging tongue-and-groove panel edges. Install clips to supports with self-tapping fasteners.

1) Horizontal Joints: Maintain reveal joint of consistent width **OR** Seal joints with backer rod and sealant **OR** Seal joints with manufacturer's standard gaskets, **as directed**.

2) Vertical Joints: Maintain reveal joint of consistent width **OR** Seal joints with backer rod and sealant **OR** Seal joints with manufacturer's standard gaskets, **as directed**.

d. Framed-Edge Panels: Mechanically attach wall panels through integral, extruded edge members to supports using self-tapping fasteners. Seal joints with manufacturer's standard gaskets.

D. Accessory Installation

1. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.

a. Install components required for a complete metal wall panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.

2. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

a. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.

b. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (605 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

E. Field Quality Control

1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

2. Water Penetration: Test areas of installed system indicated on Drawings for compliance with system performance requirements according to ASTM E 1105 at minimum differential pressure of 20 percent of inward-acting, wind-load design pressure as defined by SEI/ASCE 7, but not less than 6.24 lbf/sq. ft. (299 Pa).

3. Water-Spray Test: After completing the installation of 75-foot- (23-m-) by-2-story minimum area of metal wall panel assembly, test assembly for water penetration according to AAMA 501.2 in a 2-bay area directed by the Owner.

4. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect and test completed metal wall panel installation, including accessories.

5. Remove and replace metal wall panels where tests and inspections indicate that they do not comply with specified requirements.

6. Additional tests and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

F. Cleaning And Protection

1. Remove temporary protective coverings and strippable films, if any, as metal wall panels are installed unless otherwise indicated in manufacturer's written installation instructions. On

completion of metal wall panel installation, clean finished surfaces as recommended by metal wall panel manufacturer. Maintain in a clean condition during construction.

2. After metal wall panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
3. Replace metal wall panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07460a

SECTION 07460b - METAL PLATE WALL PANELS

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for metal plate wall panels. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes metal plate wall panels.

C. Definition
1. Metal Plate Wall Panel Assembly: Metal plate wall panels, attachment system components, miscellaneous metal framing, and accessories necessary for a complete weathertight wall system.

D. Performance Requirements
1. General Performance: Metal plate wall panel assemblies shall comply with performance requirements without failure due to defective manufacture, fabrication, installation, or other defects in construction.
2. Delegated Design: Design metal plate wall panel assembly, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
3. Air Infiltration: Air leakage through assembly of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) of wall area when tested according to ASTM E 283 at the following test-pressure difference:
   a. Test-Pressure Difference: 1.57 lbf/sq. ft. (75 Pa) which is equivalent to a 25-mph (40-km/h) wind.
4. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 331 at the following test-pressure difference:
   a. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa) which is equivalent to a 50-mph (80-km/h) wind.
5. Water Penetration under Dynamic Pressure: No evidence of water leakage when tested according to AAMA 501.1 under dynamic pressure equal to 20 percent of inward-acting, wind-load design pressure of not less than 6.24 lbf/sq. ft. (300 Pa) {which is equivalent to a 50-mph (80-km/h) wind} and not more than 12 lbf/sq. ft. (575 Pa).
   a. Water Leakage: As defined according to AAMA 501.1.
      OR
      Water Leakage: Uncontrolled water infiltrating the system or appearing on system's normally exposed interior surfaces from sources other than condensation. Water controlled by flashing and gutters that is drained back to the exterior and cannot damage adjacent materials or finishes is not water leakage.
6. Structural Performance: Provide metal plate wall panel assemblies capable of withstanding the effects of the following loads and stresses within limits and under conditions indicated, based on testing according to ASTM E 330:
   a. Wind Loads: Determine loads based on the following minimum design wind pressures:
      1) Uniform pressure of 20 lbf/sq. ft. (957 Pa) **OR** 30 lbf/sq. ft. (1436 Pa), **as directed**, acting inward or outward.
         OR
         Uniform pressure as indicated on Drawings.
   b. Deflection Limits: Metal plate wall panel assemblies shall withstand wind loads with horizontal deflections no greater than 1/180 **OR** 1/240, **as directed**, of the span.

7. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

E. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Show fabrication and installation layouts of metal plate wall panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details. Distinguish among factory-, shop-, and field-assembled work.
3. Samples: For each type of exposed finish required.
4. Delegated-Design Submittal: For metal plate wall panel assembly indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
5. Coordination Drawings: Exterior elevations, drawn to scale and coordinating penetrations and wall-mounted items.
6. Product Test Reports.
7. Field quality-control reports.
8. Maintenance Data.
9. Warranties: Sample of special warranties.

F. Quality Assurance
1. Installer Qualifications: An employer of workers trained and approved by manufacturer.
2. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
3. Fire-Resistance Ratings: Where indicated, provide metal plate wall panels identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
4. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver components, metal plate wall panels, and other manufactured items so as not to be damaged or deformed. Package panels for protection during transportation and handling.
2. Unload, store, and erect metal plate wall panels in a manner to prevent bending, warping, twisting, and surface damage.
3. Stack metal plate wall panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store panels to ensure dryness, with positive slope for drainage of water. Do not store panels in contact with other materials that might cause staining, denting, or other surface damage.
4. Retain strippable protective covering on metal plate wall panel for period of installation.
5. Protect foam-plastic insulation as follows:
   a. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
   b. Protect against ignition at all times. Do not deliver foam-plastic insulation materials to Project site before installation time.
   c. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

H. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal plate wall panel assemblies that fail in materials or workmanship within specified warranty period.
   a. Warranty Period: Two years from date of Substantial Completion.

2. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal plate wall panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
   a. Finish Warranty Period:
      1) 20 years from date of Substantial Completion for fluoropolymer finish.
      2) 10 years from date of Substantial Completion for siliconized polyester.

1.2 PRODUCTS

A. Panel Materials
1. Aluminum Plate: ASTM B 209 (ASTM B 209M). Alloy and temper as recommended by manufacturer for application.
2. Copper Plate: ASTM B 152/B 152M, solid copper alloy.
3. Panel Sealant: ASTM C 920; elastomeric polyurethane, polysulfide, or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal plate wall panels and remain weathertight; and as recommended in writing by panel manufacturer.

B. Miscellaneous Metal Framing
1. Miscellaneous Metal Framing, General: ASTM C 645, cold-formed metallic-coated steel sheet, ASTM A 653/A 653M, G40 (Z120) hot-dip galvanized **OR** ASTM A 653/A 653M, G60 (Z180) hot-dip galvanized, **as directed**, or coating with equivalent corrosion resistance unless otherwise indicated.
2. Subgirts: Manufacturer's standard C- or Z-shaped sections, 0.064-inch (1.63-mm) nominal thickness.
3. Zee Clips: 0.079-inch (2.01-mm) nominal thickness.
4. Base or Sill Angles **OR** Channels, **as directed**: 0.079-inch (2.01-mm) nominal thickness.
5. Hat-Shaped, Rigid Furring Channels:
   a. Nominal Thickness: As indicated **OR** As required to meet performance requirements **OR** 0.025 inch (0.64 mm) **OR** 0.040 inch (1.02 mm), **as directed**.
   b. Depth: As indicated **OR** 7/8 inch (22 mm) **OR** 1-1/2 inches (38 mm), **as directed**.
6. Cold-Rolled Furring Channels: Minimum 1/2-inch- (13-mm-) wide flange.
   a. Nominal Thickness: As indicated **OR** As required to meet performance requirements **OR** 0.064 inch (1.63 mm), **as directed**.
   b. Depth: As indicated **OR** 3/4 inch (19 mm), **as directed**.
   c. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with nominal thickness of 0.040 inch (1.02 mm).
   d. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.57-mm-) diameter wire, or double strand of 0.048-inch- (1.22-mm-) diameter wire.
7. Fasteners for Miscellaneous Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten miscellaneous metal framing members to substrates.

C. Miscellaneous Materials
1. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), alloy and temper recommended by manufacturer for type of use and finish indicated.
2. Panel Fasteners: Self-tapping screws; bolts and nuts; self-locking rivets and bolts; end-welded studs; and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of metal wall panels by means of plastic caps or factory-applied coating. Provide EPDM, PVC, or neoprene sealing washers.

D. Metal Plate Wall Panels
1. Metal Plate Wall Panels: Provide factory-formed, metal plate wall panels fabricated from single sheets of metal formed into profile for installation method indicated. Include attachment system components, panel stiffeners, and accessories required for weathertight system.

a. Material: Tension-leveled, smooth aluminum sheet, ASTM B 209 (ASTM B 209M), 0.120 inch (3.05 mm) **OR** 0.125 inch (3.18 mm) **OR** 0.1875 inch (4.76 mm) **OR** 0.190 inch (4.82 mm), **as directed**, thick.
b. Panel Depth: 2 inches (51 mm) **OR** As indicated on Drawings, **as directed**.
c. Exterior Finish: Two-coat fluoropolymer **OR** Three-coat fluoropolymer **OR** Four-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Clear anodized **OR** Color anodized, **as directed**.
1) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.

2. Attachment System Components: Formed from extruded aluminum.
a. Provide internal drainage system that allows individual panels to be installed and removed without disturbing adjacent panels.
b. Include manufacturer's standard subgirts, perimeter extrusions, tracks, and drainage channels, panel stiffeners, panel clips and anchor channels, **as applicable**.
c. Alignment Pins: Stainless steel.

E. Accessories
1. Metal Plate Wall Panel Accessories: Provide components required for a complete metal plate wall panel assembly including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of panels unless otherwise indicated.
2. Flashing and Trim: Same material, finish, and color as adjacent metal plate wall panels, minimum 0.030 inch (0.76 mm) thick unless otherwise indicated.

F. Fabrication
1. General: Fabricate and finish metal plate wall panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
2. Fabricate metal plate wall panels in a manner that eliminates condensation on interior side of panel and with joints between panels designed to form weathertight seals.
3. Metal Plate Wall Panels: Fabricate panels with panel stiffeners as required to comply with deflection limits. Weld and grind panel corners smooth. Fabricate panels to the following dimensional tolerances:
a. Length and Width: Plus or minus 0.032 inch (0.81 mm) up to 48 inches (1219 mm); 0.064 inch (1.63 mm) more than 48 inches (1219 mm).
b. Diagonal: Plus or minus 0.1875 inch (4.76 mm).
c. Panel Bow: Not more than 0.2 percent of panel width or length up to 0.1875 inch (4.76 mm) maximum.
d. Thickness: Plus or minus 0.008 inch (0.2 mm).
e. Squareness: 0.1875-inch (4.76-mm) difference between diagonal measurements.
f. Camber: 0.032 inch (0.81 mm).
4. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
a. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
b. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
c. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
d. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.

e. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.

f. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended by metal plate wall panel manufacturer.

1) Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal plate wall panel manufacturer for application, but not less than thickness of metal being secured.

G. General Finish Requirements

1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
3. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

H. Aluminum Finishes

1. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
3. Four-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat and clear coats. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
4. Mica Fluoropolymer: AAMA 2605. 2-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
5. Metallic Fluoropolymer: AAMA 2605. 3-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
6. FEVE Fluoropolymer: AAMA 2605. 2-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
7. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
8. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
9. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

I. Copper-Alloy Finishes

1. Exposed Finish: Mill.
2. Exposed Finish: Finish designations prefixed by CDA comply with the system established by the Copper Development Association for designating copper-alloy finish systems.

a. Brushed Satin: CDA M32-06x (Mechanical Finish: directionally textured, medium satin; Coating: clear organic, air drying, as specified below):

1) Clear, Organic Coating: Clear, air-drying, acrylic lacquer specially developed for coating copper-alloy products, applied by air spray in 2 coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).

b. Mirror Polished: CDA M22-06x (Mechanical Finish: buffed, specular; Coating: clear organic, air drying, as specified below):

1) Clear, Organic Coating: Clear, air-drying, acrylic lacquer specially developed for coating copper-alloy products, applied by air spray in 2 coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).

1.3 EXECUTION

A. Preparation

1. Miscellaneous Framing: Install subgirts, base angles, sills, furring, and other miscellaneous metal plate wall panel support members and anchorage according to ASTM C 754 and panel manufacturer's written instructions.

B. Metal Plate Wall Panel Installation

1. General: Install metal plate wall panels according to manufacturer's written instructions in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts and subgirts unless otherwise indicated. Anchor panels and other components of the Work securely in place, with provisions for thermal and structural movement.
   a. Commence metal plate wall panel installation and install minimum of 300 sq. ft. (27.8 sq. m) in presence of factory-authorized representative.
   b. Shim or otherwise plumb substrates receiving metal plate wall panels.
   c. Flash and seal metal plate wall panels with weather closures at perimeter of all openings. Do not begin installation until weather barrier and flashings that will be concealed by panels are installed.
   d. Install flashing and trim as metal plate wall panel work proceeds.
   e. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, and elsewhere as indicated or, if not indicated, as necessary for waterproofing.
   f. Provide weathertight escutcheons for pipe and conduit penetrating exterior walls.
2. Fasteners:
   a. Aluminum Plate Wall Panels: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior and aluminum or galvanized-steel fasteners for surfaces exposed to the interior.
   b. Copper Plate Wall Panels: Use copper, stainless-steel, or hardware-bronze fasteners.
3. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action as recommended by metal plate wall panel manufacturer.
4. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weathertight performance of metal wall plate panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by panel manufacturer.
   a. Seal metal plate wall panel end laps with double beads of sealant, full width of panel. Seal side joints where recommended by panel manufacturer.
   b. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants".
5. Attachment System, General: Install attachment system required to support metal plate wall panels and to provide a complete weathertight wall system, including subgirts, perimeter extrusions, tracks, drainage channels, panel clips, and anchor channels.
   a. Include attachment to supports, panel-to-panel joinery, panel-to-dissimilar-material joinery, and panel-system joint seals.
6. Flange-Attachment Installation: Attach metal plate wall panels, formed with extended perimeter flanges, to supports at locations, spacings, and with fasteners recommended by manufacturer.

a. Seal horizontal and vertical joints between adjacent panels with sealant backing and sealant. Install sealant backing and sealant according to requirements specified in Division 07 Section "Joint Sealants".
b. Seal horizontal and vertical joints between adjacent panels with manufacturer's standard gaskets.

7. Clip Installation: Attach panel clips to supports at locations, spacings, and with fasteners recommended by manufacturer. Attach flanges of metal plate wall panels to panel clips with fasteners **OR** by welding, **as directed**, as recommended by manufacturer.
   a. Seal horizontal and vertical joints between adjacent metal plate wall panels with sealant backing and sealant. Install sealant backing and sealant according to requirements specified in Division 07 Section "Joint Sealants".
   b. Seal horizontal and vertical joints between adjacent metal plate wall panels with manufacturer's standard gaskets.
8. Subgirt-and-Spline Installation: Provide manufacturer's standard subgirts and splines that provide support and complete secondary drainage system, draining to the exterior at horizontal joints. Install support system at locations, spacings, and with fasteners recommended by manufacturer. Attach metal plate wall panels by interlocking perimeter extrusions attached to panels with subgirts and splines. Fully engage integral subgirt-and-spline gaskets and leave horizontal and vertical joints with open reveal. Terminate edge of panels flush with perimeter extrusions.
   a. Install metal plate wall panels to allow individual panels to be installed and removed without disturbing adjacent panels.
   b. Do not apply sealants to joints unless otherwise indicated on Drawings.
9. Track-Support Installation: Provide manufacturer's standard horizontal tracks and vertical tracks **OR** drain channels, **as directed**, that provide support and complete secondary drainage system, draining to the exterior at horizontal joints through drain tube. Install support system at locations, spacings, and with fasteners recommended by manufacturer. Attach metal plate wall panels to tracks by interlocking panel edges with manufacturer's standard "T" clips.
   a. Install metal plate wall panels to allow individual panels to be installed and removed without disturbing adjacent panels.
   b. Seal horizontal and vertical joints between adjacent metal plate wall panels with sealant backing and sealant. Install sealant backing and sealant according to requirements specified in Division 07 Section "Joint Sealants".
10. Rail-Support Installation: Provide manufacturer's standard interlocking rails that provide support and complete secondary drainage system, draining to the exterior at horizontal joints. Install rails at locations, spacings, and with fasteners recommended by manufacturer. Attach metal plate wall panels by overlapping and interlocking support rails with perimeter rails attached to panels. Apply sealant, foam sealant, and tape sealant at locations recommended by manufacturer. Leave horizontal and vertical joints with open reveal.
    a. Install metal plate wall panels to allow individual panels to be installed and removed without disturbing adjacent panels.
    b. Install backer plates before installing support rails.
    c. Do not apply sealants to joints unless otherwise indicated on Drawings.
11. Rainscreen-Principle Installation: Provide manufacturer's standard pressure-equalized, rainscreen-principle system with vertical channel that provides support and complete secondary drainage system, draining at base of wall. Notch vertical channel to receive support pins. Install vertical channels supported by channel brackets or adjuster angles and at locations, spacings, and with fasteners recommended by manufacturer. Attach metal plate wall panels by engaging horizontal support pins into notches in vertical channels and into flanges of panels. Leave horizontal and vertical joints with open reveal.
    a. Install metal plate wall panels to allow individual panels to be installed and removed without disturbing adjacent panels.
    b. Do not apply sealants to joints unless otherwise indicated on Drawings.

C. Accessory Installation

1. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
   a. Install components required for a complete metal plate wall panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
2. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
   a. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
   b. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (610 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

D. Erection Tolerances
1. Installation Tolerances: Shim and align metal plate wall panel units within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m), nonaccumulative, on level, plumb, and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

E. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Water Penetration: Test areas of installed system indicated on Drawings for compliance with system performance requirements according to ASTM E 1105 at minimum differential pressure of 20 percent of inward-acting, wind-load design pressure as defined by SEI/ASCE 7, but not less than 6.24 lbf/sq. ft. (300 Pa).
3. Water-Spray Test: After completing the installation of 75-foot- (23-m-) by-2-story minimum area of metal plate wall panel assembly, test assembly for water penetration according to AAMA 501.2 in a 2-bay area directed by the Owner.
4. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust completed metal plate wall panel installation, including accessories.
5. Metal plate wall panels will be considered defective if they do not pass tests and inspections.
6. Additional tests and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
7. Prepare test and inspection reports.

F. Cleaning
1. Remove temporary protective coverings and strippable films, if any, as metal plate wall panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of metal plate wall panel installation, clean finished surfaces as recommended by panel manufacturer. Maintain in a clean condition during construction.
2. After metal plate wall panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
3. Replace metal plate wall panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07460b

SECTION 07460c - COMPOSITE WALL PANELS

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for composite wall panels. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes metal-faced composite wall panels.

C. Definition
1. Metal-Faced Composite Wall Panel Assembly: Metal-faced composite wall panels, attachment system components, miscellaneous metal framing, and accessories necessary for a complete weathertight wall system.

D. Performance Requirements
1. General Performance: Metal-faced composite wall panel assemblies shall comply with performance requirements without failure due to defective manufacture, fabrication, installation, or other defects in construction.
2. Delegated Design: Design metal-faced composite wall panel assembly, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
3. Air Infiltration: Air leakage through assembly of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) of wall area when tested according to ASTM E 283 at the following test-pressure difference:
   a. Test-Pressure Difference: 1.57 lbf/sq. ft. (75 Pa) which is equivalent to a 25-mph (40-km/h) wind.
4. Water Penetration Under Static Pressure: No water penetration when tested according to ASTM E 331 at the following test-pressure difference:
   a. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa) which is equivalent to a 50-mph (80-km/h) wind.
5. Structural Performance: Provide metal-faced composite wall panel assemblies capable of withstanding the effects of the following loads and stresses within limits and under conditions indicated, based on testing according to ASTM E 330:
   a. Wind Loads: Determine loads based on the following minimum design wind pressures:
      1) Uniform pressure of 20 lbf/sq. ft. (957 Pa) **OR** 30 lbf/sq. ft. (1436 Pa), **as directed**, acting inward or outward.
         OR
         Uniform pressure as indicated on Drawings.
   b. Deflection Limits: Metal-faced composite wall panel assemblies shall withstand wind loads with horizontal deflections no greater than 1/175 of the span at the perimeter and 1/60 of the span anywhere in the panel.
6. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

E. Submittals
1. Product Data: For each type of product indicated.

2. Shop Drawings: Show fabrication and installation layouts of metal-faced composite wall panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details. Distinguish among factory-, shop-, and field-assembled work.
3. Samples: For each type of exposed finish required.
4. Delegated-Design Submittal: For metal-faced composite wall panel assembly indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
5. Coordination Drawings: Exterior elevations, drawn to scale, on which the following items are shown and coordinated with each other.
6. Product Test Reports.
7. Field quality-control reports.
8. Maintenance Data.
9. Warranties: Samples of special warranties.

F. Quality Assurance
1. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
2. Fire-Resistance Ratings: Where indicated, provide metal-faced composite wall panels identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
3. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver components, sheets, metal-faced composite wall panels, and other manufactured items so as not to be damaged or deformed. Package metal-faced composite wall panels for protection during transportation and handling.
2. Unload, store, and erect metal-faced composite wall panels in a manner to prevent bending, warping, twisting, and surface damage.
3. Store metal-faced composite wall panels vertically, covered with suitable weathertight and ventilated covering. Store metal-faced composite wall panels to ensure dryness, with positive slope for drainage of water. Do not store metal-faced composite wall panels in contact with other materials that might cause staining, denting, or other surface damage. Do not allow storage space to exceed 120 deg F (49 deg C).
4. Retain strippable protective covering on metal-faced composite wall panel for period of panel installation.

H. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal-faced composite wall panel assemblies that fail in materials or workmanship within specified warranty period.
   a. Warranty Period: Two years from date of Substantial Completion.
2. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal-faced composite wall panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
   a. Finish Warranty Period:
      1) 20 years from date of Substantial Completion for fluoropolymer finish.
      2) 10 years from date of Substantial Completion for siliconized polyester.

1.2 PRODUCTS

A. Panel Materials
1. Aluminum Sheet: Coil-coated sheet, ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.

a. Surface: Smooth, flat **OR** Embossed, **as directed**, finish.
b. Exposed Coil-Coated Finishes:
   1) Two-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   2) Three-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   3) Four-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat and clear coats. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   4) Mica Fluoropolymer: AAMA 620. 2-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   5) Metallic Fluoropolymer: AAMA 620. 3-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   6) FEVE Fluoropolymer: AAMA 620. 2-coat fluoropolymer finish containing 100 percent FEVE resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
c. Exposed Anodized Finishes:
   1) Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
   2) Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
d. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

2. Copper Sheet: ASTM B 370, cold-rolled copper sheet, H00 temper.
   a. Exposed Finish: Apply the following finish, as specified or indicated on Drawings.
      1) Natural.
      2) Brushed Satin: CDA M32-06x (Mechanical Finish: directionally textured, medium satin; Coating: clear organic, air drying, as specified below):
         a) Clear, Organic Coating: Clear, air-drying, acrylic lacquer specially developed for coating copper-alloy products, applied by air spray in 2 coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
      3) Mirror Polished: CDA M22-06x (Mechanical Finish: buffed, specular; Coating: clear organic, air drying, as specified below):
         a) Clear, Organic Coating: Clear, air-drying, acrylic lacquer specially developed for coating copper-alloy products, applied by air spray in 2 coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
      4) Pre-patinated: ASTM B 882. Copper sheets artificially aged by chemical reaction to convert surface to inorganic crystalline structure with color range and durability of naturally formed patina.

3. Panel Sealants:
   a. Joint Sealant: ASTM C 920; elastomeric polyurethane, polysulfide, or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal-faced composite wall panels and remain weathertight; and as recommended in writing by panel manufacturer.

B. Miscellaneous Metal Framing
   1. Miscellaneous Metal Framing, General: ASTM C 645, cold-formed metallic-coated steel sheet, ASTM A 653/A 653M, G40 (Z120) hot-dip galvanized **OR** ASTM A 653/A 653M, G60 (Z180) hot-dip galvanized, **as directed**, or coating with equivalent corrosion resistance unless otherwise indicated.
   2. Subgirts: Manufacturer's standard C- or Z-shaped sections 0.064-inch (1.63-mm) nominal thickness.
   3. Zee Clips: 0.079-inch (2.01-mm) nominal thickness.
   4. Base or Sill Angles **OR** Channels, **as directed**: 0.079-inch (2.01-mm) nominal thickness.
   5. Hat-Shaped, Rigid Furring Channels:
      a. Nominal Thickness: As indicated **OR** As required to meet performance requirements **OR** 0.025 inch (0.64 mm) **OR** 0.040 inch (1.02 mm), **as directed**.
      b. Depth: As indicated **OR** 7/8 inch (22 mm) **OR** 1-1/2 inches (38 mm), **as directed**.
   6. Cold-Rolled Furring Channels: Minimum 1/2-inch- (13-mm-) wide flange.
      a. Nominal Thickness: As indicated **OR** As required to meet performance requirements **OR** 0.064 inch (1.63 mm), **as directed**.
      b. Depth: As indicated **OR** 3/4 inch (19 mm), **as directed**.
      c. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with nominal thickness of 0.040 inch (1.02 mm).
      d. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.57-mm-) diameter wire, or double strand of 0.048-inch- (1.22-mm-) diameter wire.
   7. Fasteners for Miscellaneous Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten miscellaneous metal framing members to substrates.

C. Miscellaneous Materials
   1. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), alloy and temper recommended by manufacturer for type of use and finish indicated.
   2. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of metal-faced composite wall panels by means of plastic caps or factory-applied coating. Provide EPDM, PVC, or neoprene sealing washers.

D. Metal-Faced Composite Wall Panels
   1. General: Provide factory-formed and -assembled, metal-faced composite wall panels fabricated from two metal facings bonded, using no glues or adhesives, to solid, extruded thermoplastic core; formed into profile for installation method indicated. Include attachment system components and accessories required for weathertight system.
      a. Fire-Retardant Core: Noncombustible, with the following surface-burning characteristics as determined by testing identical products per ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
         1) Flame-Spread Index: 25 or less.
         2) Smoke-Developed Index: 450 or less.
   2. Aluminum-Faced Composite Wall Panels: Formed with 0.020-inch- (0.50-mm-) thick, coil-coated **OR** anodized, **as directed**, aluminum sheet facings.
      a. Panel Thickness: 0.118 inch (3 mm) **OR** 0.157 inch (4 mm) **OR** 0.197 inch (5 mm) **OR** 0.236 inch (6 mm) **OR** As indicated on Drawings, **as directed**.
      b. Core: Standard **OR** Fire retardant, **as directed**.
      c. Exterior Finish: 2-coat fluoropolymer **OR** 3-coat fluoropolymer **OR** 4-coat fluoropolymer **OR** Mica fluoropolymer **OR** Metallic fluoropolymer **OR** FEVE fluoropolymer **OR** Clear anodized **OR** Color anodized, **as directed**.
         1) Color: As indicated by manufacturer's designations **OR** Match samples **OR** As selected from manufacturer's full range, **as directed**.
   3. Copper-Faced Composite Wall Panels: Formed with 16-oz./sq. ft. (0.55-mm-thick) copper sheet facings.

a. Panel Thickness: 0.118 inch (3 mm) **OR** 0.157 inch (4 mm) **OR** 0.197 inch (5 mm) **OR** 0.236 inch (6 mm) **OR** As indicated on Drawings, **as directed**.
b. Core: Standard **OR** Fire retardant, **as directed**.
c. Exterior Finish: Mill **OR** Acrylic finish for maintaining an "aged" finish **OR** Acrylic finish for maintaining a "penny-bright" finish **OR** Pre-patinated, **as directed**.

4. Attachment System Components: Formed from extruded aluminum **OR** material compatible with panel facing, **as directed**.
   a. Include manufacturer's standard perimeter extrusions with integral weather stripping**,** panel stiffeners, panel clips, and anchor channels, **as applicable**.

E. Accessories
1. Wall Panel Accessories: Provide components required for a complete metal-faced composite wall panel assembly including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal-faced composite wall panels unless otherwise indicated.
2. Flashing and Trim: Formed from 0.018-inch- (0.46-mm-) minimum thickness, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal-faced composite wall panels.

F. Fabrication
1. General: Fabricate and finish metal-faced composite wall panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
2. Fabricate metal-faced composite wall panels in a manner that eliminates condensation on interior side of panel and with joints between panels designed to form weathertight seals.
3. Metal-Faced Composite Wall Panels: Factory form panels in a continuous process with no glues or adhesives **OR** batch process by laminating each sheet using glues or adhesives, **as directed**, between dissimilar materials. Trim and square edges of sheets with no displacement of face sheets or protrusion of core material.
   a. Form panel lines, breaks, and angles to be sharp and true, with surfaces free from warp and buckle.
   b. Fabricate panels with sharply cut edges, with no displacement of face sheets or protrusion of core material.
   c. Fabricate panels with panel stiffeners, as required to comply with deflection limits, attached to back of panels with structural silicone sealant or bond tape.
   d. Dimensional Tolerances:
      1) Panel Bow: 0.8 percent maximum of panel length or width.
      2) Squareness: 0.25 inch (5 mm) maximum.
4. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
   a. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
   b. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
   c. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
   d. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
   e. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.

f. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended by metal-faced composite wall panel manufacturer.
   1) Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal-faced composite wall panel manufacturer for application, but not less than thickness of metal being secured.

G. General Finish Requirements
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
3. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

1.3 EXECUTION

A. Preparation
1. Miscellaneous Framing: Install subgirts, base angles, sills, furring, and other miscellaneous wall panel support members and anchorage according to ASTM C 754 and metal-faced composite wall panel manufacturer's written instructions.

B. Metal-Faced Composite Wall Panel Installation
1. General: Install metal-faced composite wall panels according to manufacturer's written instructions in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts and subgirts unless otherwise indicated. Anchor panels and other components of the Work securely in place, with provisions for thermal and structural movement.
   a. Commence metal-faced composite wall panel installation and install minimum of 300 sq. ft. (27.8 sq. m) in presence of factory-authorized representative.
   b. Shim or otherwise plumb substrates receiving metal-faced composite wall panels.
   c. Flash and seal metal-faced composite wall panels at perimeter of all openings. Do not begin installation until weather barrier and flashings that will be concealed by panels are installed.
   d. Install flashing and trim as metal-faced composite wall panel work proceeds.
   e. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, and elsewhere as indicated or, if not indicated, as necessary for waterproofing.
2. Provide weathertight escutcheons for pipe and conduit penetrating exterior walls.
3. Fasteners:
   a. Aluminum Wall Panels: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior and aluminum or galvanized-steel fasteners for surfaces exposed to the interior.
   b. Copper Wall Panels: Use copper, stainless-steel, or hardware-bronze fasteners.
4. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action as recommended by metal-faced composite wall panel manufacturer.
5. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weathertight performance of metal-faced composite wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by panel manufacturer.
   a. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants".

6. Attachment System Installation, General: Install attachment system required to support metal-faced composite wall panels and to provide a complete weathertight wall system, including subgirts, perimeter extrusions, tracks, drainage channels, panel clips, and anchor channels.
   a. Include attachment to supports, panel-to-panel joinery, panel-to-dissimilar-material joinery, and panel-system joint seals.
   b. Do not begin installation until weather barrier and flashings that will be concealed by composite panels are installed.
7. Clip Installation: Attach panel clips to supports at each metal-faced composite wall panel joint at locations, spacings, and with fasteners recommended by manufacturer. Attach routed-and-returned flanges of wall panels to panel clips with manufacturer's standard fasteners.
   a. Seal horizontal and vertical joints between adjacent panels with sealant backing and sealant. Install sealant backing and sealant according to requirements specified in Division 07 Section "Joint Sealants".
8. Track-Support Installation: Provide manufacturer's standard horizontal and vertical tracks that provide support and complete secondary drainage system, draining to the exterior at horizontal joints. Install support system at locations, spacings, and with fasteners recommended by manufacturer. Attach panels to wall by interlocking tracks with perimeter extrusions attached to wall panels. Fully engage integral gaskets and leave horizontal and vertical joints with open reveal.
   a. Attach routed-and-returned flanges of wall panels to perimeter extrusions with manufacturer's standard fasteners.
      OR
      Attach flush wall panels to perimeter extrusions by engaging panel edges and by attaching with manufacturer's standard structural silicone adhesive.
   b. Install wall panels to allow individual panels to "free float" and be installed and removed without disturbing adjacent panels.
   c. Do not apply sealants to joints unless otherwise indicated on Drawings.
9. Subgirt-and-Spline Installation: Provide manufacturer's standard subgirts and splines that provide support and complete secondary drainage system, draining to the exterior at horizontal joints. Install support system at locations, spacings, and with fasteners recommended by manufacturer. Attach wall panels by interlocking perimeter extrusions attached to routed-and-returned flanges of wall panels with subgirts and splines. Fully engage integral subgirt-and-spline gaskets and leave horizontal and vertical joints with open reveal.
   a. Install wall panels to allow individual panels to "free float" and be installed and removed without disturbing adjacent panels.
   b. Do not apply sealants to joints unless otherwise indicated on Drawings.
10. Rainscreen-Principle Installation: Provide manufacturer's standard pressure-equalized, rainscreen-principle system with vertical channel that provides support and complete secondary drainage system, draining at base of wall. Notch vertical channel to receive support pins. Install vertical channels supported by channel brackets or adjuster angles and at locations, spacings, and with fasteners recommended by manufacturer. Attach wall panels by engaging horizontal support pins into notches in vertical channels and into flanges of wall panels. Leave horizontal and vertical joints with open reveal.
    a. Install wall panels to allow individual panels to "free float" and be installed and removed without disturbing adjacent panels.
    b. Do not apply sealants to joints unless otherwise indicated on Drawings.

C. Accessory Installation
1. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
   a. Install components required for a complete metal-faced composite wall panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
2. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners

where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

a. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.

b. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (610 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

D. Erection Tolerances

1. Installation Tolerances: Shim and align metal-faced composite wall panel units within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m), nonaccumulative, on level, plumb, and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

E. Field Quality Control

1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Water Penetration: Test areas of installed system indicated on Drawings for compliance with system performance requirements according to ASTM E 1105 at minimum differential pressure of 20 percent of inward-acting, wind-load design pressure as defined by SEI/ASCE 7, but not less than 6.24 lbf/sq. ft. (300 Pa).
3. Water-Spray Test: After completing the installation of 75-foot- (23-m-) by-2-story minimum area of metal-faced composite wall panel assembly, test assembly for water penetration according to AAMA 501.2 in a 2-bay area directed by the Owner.
4. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust completed metal-faced composite wall panel installation, including accessories.
5. Metal-faced composite wall panels will be considered defective if they do not pass tests and inspections.
6. Additional tests and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
7. Prepare test and inspection reports.

F. Cleaning

1. Remove temporary protective coverings and strippable films, if any, as metal-faced composite wall panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of metal-faced composite wall panel installation, clean finished surfaces as recommended by panel manufacturer. Maintain in a clean condition during construction.
2. After metal-faced composite wall panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
3. Replace metal-faced composite wall panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07460c

SECTION 07460d - SIDING

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for siding. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Aluminum, Fiber-cement, and Vinyl siding.
b. Aluminum, Fiber-cement, and Vinyl soffit.

C. Submittals
1. Product Data: For each type of product indicated.
a. For vinyl siding, include VSI's official certification logo printed on product data.
2. Samples: For siding and soffit including related accessories.
3. Qualification Data: For qualified vinyl siding Installer.
4. Product certificates.
5. Product test reports.
6. Research/evaluation reports
7. Maintenance data.
8. Warranty: Sample of special warranty.

D. Quality Assurance
1. Labeling: Provide fiber-cement siding that is tested and labeled according to ASTM C 1186 by a qualified testing agency acceptable to authorities having jurisdiction.
2. Vinyl Siding Installer Qualifications: A qualified installer who employs a VSI-Certified Installer on Project.
3. Vinyl Siding Certification Program: Provide vinyl siding products that are listed in VSI's list of certified products.
4. Source Limitations: Obtain each type, color, texture, and pattern of siding and soffit, including related accessories, from single source from single manufacturer.
5. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
1. Store materials in a dry, well-ventilated, weathertight place.

F. Warranty
1. Special Warranty: Standard form in which manufacturer agrees to repair or replace siding and/or soffit that fail(s) in materials or workmanship within 10 **OR** 25 **OR** 50, **as directed**, years from date of Substantial Completion.

1.2 PRODUCTS

A. Aluminum Siding
1. General: Formed and coated aluminum siding complying with AAMA 1402.
2. Horizontal Pattern: 8-inch (203-mm) exposure in plain, single-board **OR** beaded-edge, single-board **OR** plain, double-board, 4-inch (102-mm), **as directed**, style.
3. Horizontal Pattern: 10-inch (254-mm) exposure in plain, **OR** Dutch-lap, **as directed**, double, 5-inch (127-mm) board style.

4. Vertical Pattern: 12-inch (300-mm) exposure in board-and-batten, single-board style.
5. Vertical Pattern: 16-inch (400-mm) exposure in V-grooved, triple, 5-1/3-inch (135-mm) board style.
6. Texture: Smooth **OR** Wood grain, **as directed**.
7. Nominal Thickness: 0.019 inch (0.5 mm) **OR** 0.024 inch (0.6 mm), **as directed**.
8. Insulation: Manufacturer's standard integral insulation panels.
9. Finish: Manufacturer's standard three-coat PVDF **OR** primer and baked-on acrylic **OR** primer and baked-on polyester, **as directed**.
    a. Colors: As selected by the Owner from manufacturer's full range of industry colors.

B. Fiber-Cement Siding
1. General: ASTM C 1186, Type A, Grade II, fiber-cement board, noncombustible when tested according to ASTM E 136; with a flame-spread index of 25 or less when tested according to ASTM E 84.
    a. Horizontal Pattern: Boards 5-1/4 inches (133 mm) **OR** 6-1/4 to 6-1/2 inches (159 to 165 mm) **OR** 7-1/4 to 7-1/2 inches (184 to 190 mm) **OR** 8-1/4 to 8-1/2 inches (210 to 216 mm) **OR** 9-1/4 to 9-1/2 inches (235 to 241 mm), **as directed**, wide in plain **OR** beaded-edge, **as directed**, style.
        1) Texture: Smooth **OR** Rough sawn **OR** Wood grain, **as directed**.
    b. Vertical Pattern: 48-inch- (1200-mm-) wide sheets with wood-grain texture and grooves 8 inches (203 mm) **OR** 12 inches (300 mm), **as directed**, o.c.
    c. Shingle Pattern: 48-inch- (1200-mm-) wide, straight-edge notched **OR** staggered-edge notched, **as directed**, sheets with wood-grain texture.
    d. Panel Texture: 48-inch- (1200-mm-) wide sheets with smooth **OR** stucco **OR** wood-grain, **as directed**, texture.
    e. Factory Priming: Manufacturer's standard acrylic primer.

C. Vinyl Siding
1. General: Integrally colored vinyl siding complying with ASTM D 3679.
2. Horizontal Pattern: 6-1/2- or 7-inch (165- or 178-mm) exposure in beaded-edge, single-board style.
3. Horizontal Pattern: 8-inch (203-mm) exposure in plain, single-board **OR** double board, 4-inch (102-mm) **OR** triple board, 2-2/3-inch (68-mm), **as directed**, style.
4. Horizontal Pattern: 8-inch (203-mm) exposure in Dutch-lap, double, 4-inch (102-mm) board style.
5. Horizontal Pattern: 9-inch (229-mm) exposure in plain, double board, 4-1/2-inch (114-mm) **OR** triple board, 3-inch (76-mm), **as directed**, style.
6. Horizontal Pattern: 9-inch (229-mm) exposure in Dutch-lap, double, 4-1/2-inch (114-mm) board style.
7. Horizontal Pattern: 10-inch (254-mm) exposure in plain, **OR** Dutch-lap, **as directed**, double, 5-inch (127-mm) board style.
8. Vertical Pattern: 6-inch (152-mm) exposure in V-grooved, single-board style.
9. Vertical Pattern: 8-inch (203-mm) exposure in beaded-edge, double, 4-inch (102-mm) board style.
10. Vertical Pattern: 10-inch (254-mm) exposure in V-grooved, double, 5-inch (127-mm) board style.
11. Vertical Pattern: 12-inch (300-mm) exposure in V-grooved, double board, 6-inch (152-mm) **OR** triple board, 4-inch (102-mm), **as directed**, style.
12. Shingle Pattern: 48-inch- (1200-mm-) wide, straight-edge notched **OR** staggered-edge notched **OR** half-round edge **OR** octagon edge, **as directed**, sheets with wood-grain texture.
13. Texture: Smooth **OR** Wood grain, **as directed**.
14. Nominal Thickness: 0.040 inch (1.0 mm) **OR** 0.044 inch (1.1 mm), **as directed**.
15. Minimum Profile Depth (Butt Thickness): 1/2 inch (13 mm) **OR** 5/8 inch (16 mm) **OR** 3/4 inch (19 mm), **as directed**.
16. Nailing Hem: Double thickness.
17. Finish: Wood-grain print with clear protective coating containing not less than 70 percent PVDF.
    a. Colors: As selected by the Owner from manufacturer's full range of industry colors.

D. Aluminum Soffit
   1. General: Formed and coated aluminum soffit complying with AAMA 1402.
   2. Pattern: 6-inch (152-mm) exposure in V-grooved, single-board style.
   3. Pattern: 10-inch (254-mm) exposure in V-grooved, double, 5-inch (127-mm) board style.
   4. Pattern: 12-inch (300-mm) exposure in V-grooved, double, 6-inch (152-mm) board style.
   5. Pattern: 16-inch (400-mm) exposure in V-grooved, triple board, 5-1/3-inch (135-mm) **OR** quadruple board, 4-inch (102-mm), **as directed**, style.
   6. Texture: Smooth **OR** Wood grain, **as directed**.
   7. Ventilation: Provide perforated **OR** unperforated, **as directed**, soffit unless otherwise indicated.
   8. Nominal Thickness: 0.019 inch (0.5 mm) **OR** 0.024 inch (0.6 mm), **as directed**.
   9. Finish: Manufacturer's standard three-coat PVDF **OR** primer and baked-on acrylic **OR** primer and baked-on polyester, **as directed**.
      a. Colors: As selected by the Owner from manufacturer's full range of industry colors **OR** Match adjacent siding, **as directed**.

E. Fiber-Cement Soffit
   1. General: ASTM C 1186, Type A, Grade II, fiber-cement board, noncombustible when tested according to ASTM E 136; with a flame-spread index of 25 or less when tested according to ASTM E 84.
   2. Pattern: 12-inch- (300-mm-) **OR** 16-inch- (400-mm-) **OR** 24-inch- (600-mm-), **as directed**, wide sheets with smooth **OR** wood-grain, **as directed**, texture.
   3. Ventilation: Provide perforated **OR** unperforated, **as directed**, soffit unless otherwise indicated.
   4. Factory Priming: Manufacturer's standard acrylic primer.

F. Vinyl Soffit
   1. General: Integrally colored vinyl soffit complying with ASTM D 4477.
   2. Pattern: 6-inch (152-mm) exposure in V-grooved, single-board **OR** beaded-edge, triple board, 2-inch (51-mm), **as directed**, style.
   3. Pattern: 8-inch (203-mm) exposure in V-grooved, double, 4-inch (102-mm) board style.
   4. Pattern: 10-inch (254-mm) exposure in V-grooved, double, 5-inch (127-mm) board style.
   5. Pattern: 12-inch (300-mm) exposure in V-grooved, double board, 6-inch (152-mm) **OR** triple board, 4-inch (102-mm), **as directed**, style.
   6. Texture: Smooth **OR** Wood grain, **as directed**.
   7. Ventilation: Provide perforated **OR** unperforated, **as directed**, soffit unless otherwise indicated.
   8. Nominal Thickness: 0.035 inch (0.9 mm) **OR** 0.040 inch (1.0 mm) **OR** 0.044 inch (1.1 mm), **as directed**.
   9. Minimum Profile Depth: 1/2 inch (13 mm) **OR** 5/8 inch (16 mm) **OR** 3/4 inch (19 mm), **as directed**.
   10. Colors: As selected by the Owner from manufacturer's full range of industry colors **OR** Match adjacent siding, **as directed**.

G. Accessories
   1. Siding Accessories, General: Provide starter strips, edge trim, outside and inside corner caps, and other items as recommended by siding manufacturer for building configuration.
      a. Provide accessories made from same material as **OR** matching color and texture of, **as directed**, adjacent siding unless otherwise indicated.
   2. Aluminum Accessories: Where aluminum accessories are indicated, provide accessories complying with AAMA 1402.
      a. Texture: Smooth **OR** Wood grain, **as directed**.
      b. Nominal Thickness: 0.019 inch (0.5 mm) **OR** 0.024 inch (0.6 mm), **as directed**.
      c. Finish: Manufacturer's standard three-coat PVDF **OR** primer and baked-on acrylic **OR** primer and baked-on polyester, **as directed**.
   3. Vinyl Accessories: Integrally colored vinyl accessories complying with ASTM D 3679 except for wind-load resistance.
      a. Texture: Smooth **OR** Wood grain, **as directed**.

4. Decorative Accessories: Provide the following aluminum **OR** fiber-cement **OR** vinyl, **as directed**, decorative accessories as indicated:
   a. Corner posts with fluted faces, **as directed**.
   b. Door and window casings with fluted faces, **as directed**, and corner rosettes, **as directed**.
   c. Entrance and window head pediments.
   d. Pilasters with fluted faces, **as directed**.
   e. Shutters with paneled **OR** louvered, **as directed**, faces.
   f. Louvers.
   g. Lattice.
   h. Fasciae.
   i. Moldings and trim.
5. Colors for Decorative Accessories: As selected by the Owner from manufacturer's full range of industry colors **OR** Match adjacent siding, **as directed**.
6. Flashing: Provide aluminum **OR** stainless-steel, **as directed**, flashing complying with Division 07 Section "Sheet Metal Flashing And Trim" at window and door heads and where indicated.
   a. Finish for Aluminum Flashing: Same as aluminum siding **OR** Siliconized polyester coating, same color as siding **OR** High-performance organic finish, same color as siding **OR** Factory-prime coating, **as directed**.
7. Fasteners:
   a. For fastening to wood, use siding nails **OR** ribbed bugle-head screws, **as directed**, of sufficient length to penetrate a minimum of 1 inch (25 mm) into substrate.
   b. For fastening to metal, use ribbed bugle-head screws of sufficient length to penetrate a minimum of 1/4 inch (6 mm), or three screw-threads, into substrate.
   c. For fastening aluminum, use aluminum fasteners. Where fasteners will be exposed to view, use prefinished aluminum fasteners in color to match item being fastened.
   d. For fastening fiber cement, use hot-dip galvanized **OR** stainless-steel, **as directed**, fasteners.
   e. For fastening vinyl, use aluminum **OR** hot-dip galvanized **OR** stainless-steel, **as directed**, fasteners. Where fasteners will be exposed to view, use prefinished aluminum fasteners in color to match item being fastened.
8. Insect Screening for Soffit Vents: Aluminum, 18-by-16 (1.4-by-1.6-mm) mesh **OR** PVC-coated, glass-fiber fabric, 18-by-14 or 18-by-16 (1.4-by-1.8- or 1.4-by-1.6-mm) mesh **OR** Stainless steel, 18-by-18 (1.4-by-1.4-mm) mesh, **as directed**.
9. Continuous Soffit Vents: Aluminum, hat-channel shape, with stamped louvers **OR** perforations, **as directed**; 2 inches (51 mm) wide and not less than 96 inches (2438 mm) long.
   a. Net-Free Area: 4 sq. in./linear ft. (280 sq. cm/m) **OR** 6 sq. in./linear ft. (420 sq. cm/m) **OR** 8 sq. in./linear ft. (560 sq. cm/m), **as directed**.
   b. Finish: Mill finish **OR** White paint **OR** Brown paint, **as directed**.
10. Round Soffit Vents: Stamped aluminum louvered vents, 2 inches (51 mm) **OR** 2-1/2 inches (64 mm) **OR** 3 inches (76 mm) **OR** 4 inches (102 mm), **as directed**, in diameter, made to be inserted into round holes cut into soffit.
    a. Finish: Mill finish **OR** White paint **OR** Brown paint, **as directed**.

1.3 EXECUTION

A. Preparation
   1. Clean substrates of projections and substances detrimental to application.

B. Installation
   1. General: Comply with siding and soffit manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.
      a. Do not install damaged components.
      b. Center nails in elongated nailing slots without binding siding to allow for thermal movement.

2. Install aluminum siding and soffit and related accessories according to AAMA 1402.
   a. Install fasteners no more than 24 inches (600 mm) o.c.
3. Install fiber-cement siding and soffit and related accessories.
   a. Install fasteners no more than 24 inches (600 mm) o.c.
4. Install vinyl siding and soffit and related accessories according to ASTM D 4756.
   a. Install fasteners for horizontal vinyl siding no more than 16 inches (400 mm) o.c.
   b. Install fasteners for vertical vinyl siding no more than 12 inches (300 mm) o.c.
5. Install joint sealants as specified in Division 07 Section "Joint Sealants" and to produce a weathertight installation.
6. Where aluminum siding will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape or installing nonconductive spacers as recommended by manufacturer for this purpose.

C. Adjusting And Cleaning
1. Remove damaged, improperly installed, or otherwise defective materials and replace with new materials complying with specified requirements.
2. Clean finished surfaces according to manufacturer's written instructions and maintain in a clean condition during construction.

END OF SECTION 07460d

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Task	Specification	Specification Description
07462	01352	No Specification Required
07462	07460d	Siding
07510	06110a	Miscellaneous Carpentry
07510	07212	Built-Up Asphalt Roofing
07510	07212a	Built-Up Coal-Tar Roofing
07510	07212b	EPDM Membrane Roofing
07510	07212d	APP-Modified Bituminous Membrane Roofing

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SECTION 07533 - POLYVINYL-CHLORIDE (PVC) ROOFING

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for polyvinyl-chloride (PVC) roofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Adhered PVC membrane roofing system.
   b. Mechanically fastened PVC membrane roofing system.
   c. Loosely laid and ballasted PVC membrane roofing system.
   d. Vapor retarder.
   e. Roof insulation.
2. Section includes the installation of acoustical roof deck rib insulation strips furnished under Division 05 Section "Steel Deck".

C. Definitions
1. Roofing Terminology: See ASTM D 1079 and glossary in NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.

D. Performance Requirements
1. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.
2. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.
3. Roofing System Design: Provide membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.
4. FM Approvals Listing, **as directed**: Provide membrane roofing, base flashings, and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a membrane roofing system, and that are listed in FM Approvals' "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals markings.
   a. Fire/Windstorm Classification: Class 1A-60 **OR** Class 1A-75 **OR** Class 1A-90 **OR** Class 1A-105 **OR** Class 1A-120 **OR** Class 1A-135 **OR** Class 1A-150 **OR** Class 1A-165, **as directed**.
   b. Hail Resistance: MH **OR** SH, **as directed**.
5. Energy Performance: Provide roofing system with initial Solar Reflectance Index not less than 78 **OR** 29, **as directed**, when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.
6. Energy Performance: Provide roofing system that is listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low **OR** steep, **as directed**,-slope roof products.
7. Energy Performance(for roofs that must comply with California Energy Commission's CEC-Title 24): Provide roofing system with initial solar reflectance not less than 0.70 and emissivity not less than 0.75 when tested according to CRRC-1.

E. Submittals
1. Product Data: For each type of product indicated.

2. LEED Submittals:
   a. Product Data for Credit SS 7.2: For roof materials, indicating that roof materials comply with Solar Reflectance Index requirement.
   b. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
3. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.
4. Samples: For each product included in the roofing system.
5. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
   a. Submit evidence of compliance with performance requirements.
6. Research/evaluation reports.
7. Field quality-control reports.
8. Maintenance data.
9. Warranties: Sample of special warranties.

F. Quality Assurance
1. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
2. Source Limitations: Obtain components for membrane roofing system from same manufacturer as membrane roofing or approved by membrane roofing manufacturer.
3. Exterior Fire-Test Exposure: ASTM E 108, Class A **OR** Class B **OR** Class C, **as directed**; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.
4. Fire-Resistance Ratings: Where indicated, provide fire-resistance-rated roof assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
5. Preinstallation Roofing Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
2. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
   a. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
3. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
4. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

H. Project Conditions
1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

I. Warranty
1. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail

in materials or workmanship within 10 **OR** 15, **as directed**, years from date of Substantial Completion.

1.2 PRODUCTS

A. PVC Membrane Roofing
1. PVC Sheet: ASTM D 4434, Type II, Grade I, glass fiber reinforced, felt backed.
a. Thickness: 48 mils (1.2 mm), minimum **OR** 60 mils (1.5 mm), nominal **OR** 72 mils (1.8 mm) **OR** 80 mils (2.0 mm) **OR** 96 mils (2.4 mm), **as directed**.
b. Exposed Face Color: Gray.
OR
PVC Sheet: ASTM D 4434, Type III, fabric reinforced and fabric backed, **as directed**.
a. Thickness: 45 mils (1.1 mm), minimum **OR** 48 mils (1.2 mm) **OR** 50 mils (1.27 mm) **OR** 60 mils (1.5 mm), nominal **OR** 72 mils (1.8 mm) **OR** 80 mils (2.0 mm) **OR** 100 mils (2.5 mm), **as directed**.
b. Exposed Face Color: White **OR** Gray, **as directed**.
OR
PVC Sheet: ASTM D 4434, Type IV, fabric reinforced and fabric backed, **as directed**.
a. Thickness: 36 mils (0.9 mm), minimum **OR** 40 mils (1.0 mm), nominal **OR** 50 mils (1.27 mm) **OR** 60 mils (1.5 mm), nominal **OR** 72 mils (1.8 mm) **OR** 80 mils (2.0 mm) **OR** 100 mils (2.5 mm), **as directed**.
b. Exposed Face Color: White **OR** Gray, **as directed**.

B. Auxiliary Membrane Roofing Materials
1. General: Auxiliary membrane roofing materials recommended by roofing system manufacturer for intended use, and compatible with membrane roofing.
a. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
b. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
1) Plastic Foam Adhesives: 50 g/L.
2) Gypsum Board and Panel Adhesives: 50 g/L.
3) Multipurpose Construction Adhesives: 70 g/L.
4) Fiberglass Adhesives: 80 g/L.
5) Contact Adhesive: 80 g/L.
6) Other Adhesives: 250 g/L.
7) PVC Welding Compounds: 510 g/L.
8) Adhesive Primer for Plastic: 650 g/L
9) Single-Ply Roof Membrane Sealants: 450 g/L.
10) Nonmembrane Roof Sealants: 300 g/L.
11) Sealant Primers for Nonporous Substrates: 250 g/L.
12) Sealant Primers for Porous Substrates: 775 g/L.
2. Sheet Flashing: Manufacturer's standard sheet flashing of same material, type, reinforcement, thickness, and color as PVC sheet membrane.
3. Bonding Adhesive: Manufacturer's standard, water based, **as directed**.
4. Slip Sheet: Manufacturer's standard, of thickness required for application.
5. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.
6. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch (25 mm wide by 1.3 mm) thick, prepunched.
7. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening membrane to substrate, and acceptable to membrane roofing system manufacturer.

8. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

C. Substrate Boards
1. Substrate Board: ASTM C 1396/C 1396M, Type X gypsum board, 5/8 inch (16 mm) thick.
OR
Substrate Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** Type X, 5/8 inch (16 mm), **as directed**, thick.
OR
Substrate Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.
OR
Substrate Board: ASTM C 728, perlite board, 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick, seal coated.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

D. Vapor Retarder
1. Polyethylene Film: ASTM D 4397, 6 mils (0.15 mm) thick, minimum, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).
a. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
OR
Adhesive: Manufacturer's standard lap adhesive, FM Approvals approved for vapor-retarder application.
2. Laminated Sheet: Kraft paper, two layers, laminated with asphalt and edge reinforced with woven fiberglass yarn with maximum permeance rating of 0.50 perm (29 ng/Pa x s x sq. m) and with manufacturer's standard adhesive, **as directed**.
3. Glass-Fiber Felts: ASTM D 2178, Type IV, asphalt impregnated.

E. Roof Insulation
1. General: Preformed roof insulation boards manufactured or approved by PVC membrane roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Approvals-approved roof insulation, **as directed**.
2. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.6-lb/cu. ft. (26-kg/cu. m) **OR** Type X, 1.3-lb/cu. ft. (21-kg/cu. m), **as directed**, minimum density, square edged.
3. Molded-Polystyrene Board Insulation: ASTM C 578, Type II, 1.35-lb/cu. ft. (22-kg/cu. m) **OR** Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) **OR** Type IX, 1.8-lb/cu. ft. (29-kg/cu. m), **as directed**, minimum density.
4. Composite Molded-Polystyrene Board Insulation: ASTM C 578, Type II, 1.35-lb/cu. ft. (22-kg/cu. m) **OR** Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) **OR** Type IX, 1.8-lb/cu. ft. (29-kg/cu. m), **as directed**, minimum density, with factory-applied facings, as follows:
a. Facer: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, asphalt coated, 1/2 inch (13 mm) thick.
OR
Facer: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.
5. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2 **OR** Type II, Class I, Grade 3, **as directed**, felt or glass-fiber mat facer on both major surfaces.
6. Composite Polyisocyanurate Board Insulation: ASTM C 1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber mat facer on the other.
a. Type IV, cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch (13 mm) thick.
b. Type V, OSB facer, 7/16 inch (11 mm) thick.
c. Type VII, glass mat faced gypsum board facer, 1/4 inch (6 mm) thick.

7. Perlite Board Insulation: ASTM C 728, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.
8. Cellulosic-Fiber Board Insulation: ASTM C 208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.
9. Cellular-Glass Board Insulation: ASTM C 552, Type IV, rigid, cellular-glass thermal board insulation faced with manufacturer's standard kraft-paper sheets.
10. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches (1:48), **as directed**, unless otherwise indicated.
11. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

F. Insulation Accessories
1. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards, **as directed**, to substrate, and acceptable to roofing system manufacturer.
3. Modified Asphaltic Insulation Adhesive: Insulation manufacturer's recommended modified asphalt, asbestos-free, cold-applied adhesive formulated to attach roof insulation to substrate or to another insulation layer.
4. Bead-Applied Insulation Adhesive: Insulation manufacturer's recommended bead-applied, low-rise, one- or multicomponent urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
5. Full-Spread Applied Insulation Adhesive: Insulation manufacturer's recommended spray-applied, low-rise, two-component urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
6. Cover Board: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, 1/2 inch (13 mm) thick.
   OR
   Cover Board: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.
   OR
   Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick, factory primed, **as directed**.
   OR
   Cover Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.
7. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric, water permeable and resistant to UV degradation, type and weight as recommended by roofing system manufacturer for application.

G. Asphalt Materials
1. Roofing Asphalt: ASTM D 312, Type III or Type IV **OR** ASTM D 6152, SEBS modified, **as directed**.
2. Asphalt Primer: ASTM D 41.

H. Aggregate Ballast (for loosely laid and aggregate-ballasted installations)
1. Aggregate Ballast: Provide aggregate ballast that will withstand weather exposure without significant deterioration and will not contribute to membrane degradation, of the following type and size:
   a. Aggregate Type: Smooth, washed, riverbed gravel or other acceptable smooth-faced stone **OR** Crushed gravel or crushed stone, **as directed**.
   b. Size: ASTM D 448, Size 4, ranging in size from 3/4 to 1-1/2 inches (19 to 38 mm).
      OR

Size: ASTM D 448, Size 2, ranging in size from 1-1/2 to 2-1/2 inches (38 to 63 mm).
OR
Size: ASTM D 448, Size 3, ranging in size from 1 to 2 inches (25 to 50 mm).

I. Roof Pavers
1. Lightweight Roof Pavers: Interlocking, lightweight concrete units, specially factory cast for use as roof ballast; grooved back, with four-way drainage capability; beveled, doweled, or otherwise profiled; and as follows:
   a. Size: 8 by 16 inches (200 by 400 mm) **OR** 12 by 12 inches (300 by 300 mm) **OR** 12 by 16-1/2 inches (300 by 420 mm) **OR** 12 by 18 inches (300 by 450 mm), **as directed**.
   b. Weight: At least 10 lb/sq. ft. (50 kg/sq. m) but not exceeding 18 lb/sq. ft. (90 kg/sq. m).
   c. Compressive Strength: 2500 psi (17 MPa) **OR** 5000 psi (34 MPa), **as directed**, minimum.
   d. Colors and Textures: As selected from manufacturer's full range.
2. Heavyweight Roof Pavers: Heavyweight, hydraulically pressed, concrete units, square edged **OR** with top edges beveled 3/16 inch (5 mm), **as directed**, factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C 67; and as follows:
   a. Size: 12 by 12 inches (300 by 300 mm) **OR** 18 by 18 inches (450 by 450 mm) **OR** 24 by 24 inches (600 by 600 mm), **as directed**. Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch (1.6 mm) in length, height, and thickness.
   b. Weight: 18 lb/sq. ft. (90 kg/sq. m) **OR** 22 lb/sq. ft. (110 kg/sq. m), **as directed**.
   c. Compressive Strength: 7500 psi (52 MPa) **OR** 6500 psi (45 MPa), **as directed**, minimum.
   d. Colors and Textures: As selected from manufacturer's full range.

J. Walkways
1. Flexible Walkways: Factory-formed, nonporous, heavy-duty, solid-rubber, slip-resisting, surface-textured walkway pads **OR** rolls, **as directed**, approximately 3/16 inch (5 mm) thick, and acceptable to membrane roofing system manufacturer.
2. Walkway Roof Pavers: Heavyweight, hydraulically pressed, concrete units, square edged **OR** with top edges beveled 3/16 inch (5 mm), **as directed**, factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C 67; and as follows:
   a. Size: 12 by 12 inches (300 by 300 mm) **OR** 18 by 18 inches (450 by 450 mm) **OR** 24 by 24 inches (600 by 600 mm), **as directed**. Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch (1.6 mm) in length, height, and thickness.
   b. Weight: 18 lb/sq. ft. (90 kg/sq. m) **OR** 22 lb/sq. ft. (110 kg/sq. m), **as directed**.
   c. Compressive Strength: 7500 psi (52 MPa) **OR** 6500 psi (45 MPa), **as directed**, minimum.
   d. Colors and Textures: As selected from manufacturer's full range.

1.3 EXECUTION

A. Preparation
1. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
2. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
3. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.
4. Install acoustical roof deck rib insulation strips, specified in Division 05 Section "Steel Deck", according to acoustical roof deck manufacturer's written instructions, immediately before installation of overlying construction and to remain dry.

B. Substrate Board
   1. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
      a. Fasten substrate board to top flanges of steel deck according to recommendations in FM Approvals' "RoofNav" and FM Global Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.
         OR
         Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to membrane roofing system manufacturers' written instructions.

C. Vapor-Retarder Installation
   1. Polyethylene Film: Loosely lay polyethylene-film vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.
      a. Continuously seal side and end laps with tape **OR** adhesive, **as directed**.
   2. Laminate Sheet: Install laminate-sheet vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively. Bond vapor retarder to substrate as follows:
      a. Apply adhesive at rate recommended by vapor-retarder manufacturer. Seal laps with adhesive.
         OR
         Apply ribbons of hot roofing asphalt at spacing, temperature, and rate recommended by vapor-retarder manufacturer. Seal laps with hot roofing asphalt.
   3. Built-up Vapor Retarder: Install two glass-fiber felt plies lapping each felt 19 inches (483 mm) over preceding felt. Embed each felt in a solid mopping of hot roofing asphalt. Glaze-coat completed surface with hot roofing asphalt. Apply hot roofing asphalt within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
   4. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into membrane roofing system.

D. Insulation Installation
   1. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
   2. Comply with membrane roofing system and insulation manufacturer's written instructions for installing roof insulation.
   3. Install tapered insulation under area of roofing to conform to slopes indicated.
   4. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches (68 mm) or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.
      a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
   5. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
   6. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
      a. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
   7. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
      a. Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.
      b. Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.

c. Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
d. Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

8. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
   a. Fasten insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
      OR
      Fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.
9. Mechanically Fastened and Adhered Insulation: Install each layer of insulation and secure first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
   a. Fasten first layer of insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
      OR
      Fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
   b. Set each subsequent layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
      OR
      Set each subsequent layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
      OR
      Set each subsequent layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
10. Loosely Laid Insulation: Loosely lay insulation units over substrate.
11. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction. Loosely butt cover boards together and fasten to roof deck, **as directed**.
    a. Fasten cover boards according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
       OR
       Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.
12. Install slip sheet over insulation **OR** cover board, **as directed**, and immediately beneath membrane roofing.

E. Adhered Membrane Roofing Installation
1. Adhere membrane roofing over area to receive roofing and install according to membrane roofing system manufacturer's written instructions.
   a. Install sheet according to ASTM D 5036.
2. Start installation of membrane roofing in presence of membrane roofing system manufacturer's technical personnel.
3. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
4. Bonding Adhesive: Apply to substrate and underside of membrane roofing at rate required by manufacturer and allow to partially dry before installing membrane roofing. Do not apply to splice area of membrane roofing.
5. In addition to adhering, mechanically fasten membrane roofing securely at terminations, penetrations, and perimeter of roofing.
6. Apply membrane roofing with side laps shingled with slope of roof deck where possible.
7. Seams: Clean seam areas, overlap membrane roofing, and hot-air weld side and end laps of membrane roofing and sheet flashings according to manufacturer's written instructions to ensure a watertight seam installation.

a. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet membrane.
b. Verify field strength of seams a minimum of twice daily and repair seam sample areas.
c. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.

8. Spread sealant bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.
9. Install membrane roofing and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition and to not void warranty for existing membrane roofing system.

F. Mechanically Fastened Membrane Roofing Installation
1. Mechanically fasten membrane roofing over area to receive roofing and install according to roofing system manufacturer's written instructions.
a. Install sheet according to ASTM D 5082.
b. For in-splice attachment, install membranes roofing with long dimension perpendicular to steel roof deck flutes.
2. Start installation of membrane roofing in presence of roofing system manufacturer's technical personnel.
3. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
4. Mechanically fasten or adhere membrane roofing securely at terminations, penetrations, and perimeter of roofing.
5. Apply membrane roofing with side laps shingled with slope of roof deck where possible.
6. In-Seam Attachment: Secure one edge of PVC sheet using fastening plates or metal battens centered within membrane seam and mechanically fasten PVC sheet to roof deck.
7. Seams: Clean seam areas, overlap membrane roofing, and hot-air weld side and end laps of membrane roofing and sheet flashings according to manufacturer's written instructions to ensure a watertight seam installation.
a. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet membrane.
b. Verify field strength of seams a minimum of twice daily and repair seam sample areas.
c. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
8. Spread sealant bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.
9. Install membrane roofing and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition and to not void warranty for existing membrane roofing system.

G. Loosely Laid And Ballasted Membrane Roofing Installation
1. Loosely lay membrane roofing over area to receive roofing and install according to roofing system manufacturer's written instructions.
a. Comply with requirements in SPRI RP-4 for System 1 **OR** System 2 **OR** System 3, **as directed**.
2. Start installation of membrane roofing in presence of roofing system manufacturer's technical personnel.
3. Accurately align membrane roofing, without stretching, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
4. Mechanically fasten or adhere perimeter of membrane roofing according to requirements in SPRI RP-4.
OR
Mechanically fasten **OR** adhere, **as directed**, membrane roofing at corners, perimeters, and transitions according to requirements in SPRI RP-4.
a. At corners and perimeters, omit aggregate ballast leaving membrane roofing exposed.
OR
At corners and perimeters, adhere a second layer of membrane roofing.
5. Apply membrane roofing with side laps shingled with slope of deck where possible.

6. Seams: Clean seam areas, overlap membrane roofing, and hot-air weld side and end laps of membrane roofing and sheet flashings according to manufacturer's written instructions to ensure a watertight seam installation.
   a. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet membrane.
   b. Verify field strength of seams a minimum of twice daily and repair seam sample areas.
   c. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
7. Spread sealant bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.
8. Install membrane roofing and auxiliary materials to tie in to existing roofing.
9. Install protection mat over membrane roofing, overlapping a minimum of 6 inches (150 mm). Install an additional protection mat layer at projections, pipes, vents, and drains, overlapping a minimum of 12 inches (300 mm).
10. Aggregate Ballast: Apply uniformly over membrane roofing at the rate required by membrane roofing system manufacturer, but not less than the following, spreading with care to minimize possibility of damage to membrane roofing system. Lay ballast as membrane roofing is installed, leaving membrane roofing ballasted at the end of the workday.
    a. Ballast Weight: Size 4 aggregate, 10 lb/sq. ft. (50 kg/sq. m).
       OR
       Ballast Weight: Size 2 aggregate, 13 lb/sq. ft. (65 kg/sq. m), at corners and perimeter; Size 4 aggregate, 10 lb/sq. ft. (50 kg/sq. m), elsewhere.
       OR
       Ballast Weight: Size 2 aggregate, 13 lb/sq. ft. (65 kg/sq. m).
11. Roof-Paver Ballast: Install lightweight **OR** heavyweight, **as directed**, roof-paver ballast according to manufacturer's written instructions.
    OR
    Roof-Paver and Aggregate Ballast: Install heavyweight roof pavers according to manufacturer's written instructions on roof corners and perimeter.
    a. Install Size 4 aggregate ballast elsewhere on roofing at a minimum rate of 10 lb/sq. ft. (50 kg/sq. m).
       OR
       Install Size 2 aggregate ballast elsewhere on roofing at a minimum rate of 13 lb/sq. ft. (65 kg/sq. m).

H. Base Flashing Installation
1. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.
2. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply to seam area of flashing.
3. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
4. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.
5. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars, **as directed**.

I. Walkway Installation
1. Flexible Walkways: Install walkway products in locations indicated. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.
2. Roof-Paver Walkways: Install walkway roof pavers according to manufacturer's written instructions in locations indicated, to form walkways. Leave 3 inches (75 mm) of space between adjacent roof pavers.

J. Field Quality Control

1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.
3. Repair or remove and replace components of membrane roofing system where inspections indicate that they do not comply with specified requirements.
4. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

K. Protecting And Cleaning

1. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Owner.
2. Correct deficiencies in or remove membrane roofing system that does not comply with requirements; repair substrates; and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
3. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07533

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SECTION 07533a - THERMOPLASTIC POLYOLEFIN (TPO) ROOFING

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for thermoplastic polyolefin (TPO) roofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Adhered TPO membrane roofing system.
   b. Mechanically fastened TPO membrane roofing system.
   c. Loosely laid and ballasted TPO membrane roofing system.
   d. Vapor retarder.
   e. Roof insulation.
2. Section includes the installation of acoustical roof deck rib insulation strips furnished under Division 05 Section "Steel Deck".

C. Definitions
1. TPO: Thermoplastic polyolefin.
2. Roofing Terminology: See ASTM D 1079 and glossary in NRCA's "The NRCA Roofing and Waterproofing Manual" for definitions of terms related to roofing work in this Section.

D. Performance Requirements
1. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.
2. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.
3. Roofing System Design: Provide membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.
4. FM Approvals Listing, **as directed**: Provide membrane roofing, base flashings, and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a membrane roofing system, and that are listed in FM Approvals' "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals markings.
   a. Fire/Windstorm Classification: Class 1A-60 **OR** Class 1A-75 **OR** Class 1A-90 **OR** Class 1A-105 **OR** Class 1A-120 **OR** Class 1A-135 **OR** Class 1A-150 **OR** Class 1A-165, **as directed**.
   b. Hail Resistance: MH **OR** SH, **as directed**.
5. Energy Performance: Provide roofing system with initial Solar Reflectance Index not less than 78 **OR** 29, **as directed**, when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.
6. Energy Performance: Provide roofing system that is listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low **OR** steep, **as directed**,-slope roof products.
7. Energy Performance (for roofs that must comply with California Energy Commission's CEC-Title 24): Provide roofing system with initial solar reflectance not less than 0.70 and emissivity not less than 0.75 when tested according to CRRC-1.

E. Submittals

1. Product Data: For each type of product indicated.
2. LEED Submittals:
   a. Product Data for Credit SS 7.2: For roof materials, indicating that roof materials comply with Solar Reflectance Index requirement.
   b. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
3. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.
4. Samples: For each product included in the roofing system.
5. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
   a. Submit evidence of compliance with performance requirements.
6. Research/evaluation reports.
7. Field quality-control reports.
8. Maintenance data.
9. Warranties: Sample of special warranties.

F. Quality Assurance
1. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
2. Source Limitations: Obtain components for membrane roofing system from same manufacturer as membrane roofing or approved by membrane roofing manufacturer.
3. Exterior Fire-Test Exposure: ASTM E 108, Class A **OR** Class B **OR** Class C, **as directed**; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.
4. Fire-Resistance Ratings: Where indicated, provide fire-resistance-rated roof assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
5. Preinstallation Roofing Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
2. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
   a. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
3. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
4. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

H. Project Conditions
1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

I. Warranty
1. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail

in materials or workmanship within 10 **OR** 15, **as directed**, years from date of Substantial Completion.

1.2 PRODUCTS

A. TPO Membrane Roofing
1. Fabric-Reinforced Thermoplastic Polyolefin Sheet: ASTM D 6878, internally fabric or scrim reinforced, uniform, flexible fabric backed, **as directed**, TPO sheet.
a. Thickness: 45 mils (1.1 mm) **OR** 60 mils (1.5 mm), **as directed**, nominal.
b. Exposed Face Color: Black **OR** Gray **OR** Tan **OR** White, **as directed**.

B. Auxiliary Membrane Roofing Materials
1. General: Auxiliary membrane roofing materials recommended by roofing system manufacturer for intended use, and compatible with membrane roofing.
a. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
b. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
1) Plastic Foam Adhesives: 50 g/L.
2) Gypsum Board and Panel Adhesives: 50 g/L.
3) Multipurpose Construction Adhesives: 70 g/L.
4) Fiberglass Adhesives: 80 g/L.
5) Contact Adhesive: 80 g/L.
6) Other Adhesives: 250 g/L.
7) Single-Ply Roof Membrane Sealants: 450 g/L.
8) Nonmembrane Roof Sealants: 300 g/L.
9) Sealant Primers for Nonporous Substrates: 250 g/L.
10) Sealant Primers for Porous Substrates: 775 g/L.
2. Sheet Flashing: Manufacturer's standard unreinforced thermoplastic polyolefin sheet flashing, 55 mils (1.4 mm) thick, minimum, of same color as sheet membrane.
3. Bonding Adhesive: Manufacturer's standard, water based, **as directed**.
4. Slip Sheet: Manufacturer's standard, of thickness required for application.
5. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.
6. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick (25 mm wide by 1.3 mm thick), prepunched.
7. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening membrane to substrate, and acceptable to membrane roofing system manufacturer.
8. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

C. Substrate Boards
1. Substrate Board: ASTM C 1396/C 1396M, Type X gypsum board, 5/8 inch (16 mm) thick.
OR
Substrate Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** Type X, 5/8 inch (16 mm), **as directed**, thick.
OR
Substrate Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.
OR

Substrate Board: ASTM C 728, perlite board, 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick, seal coated.

2. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

D. Vapor Retarder
1. Polyethylene Film: ASTM D 4397, 6 mils (0.15 mm) thick, minimum, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).
   a. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
      OR
      Adhesive: Manufacturer's standard lap adhesive, FM Approvals approved for vapor-retarder application.
2. Laminated Sheet: Kraft paper, two layers, laminated with asphalt and edge reinforced with woven fiberglass yarn with maximum permeance rating of 0.50 perm (29 ng/Pa x s x sq. m) and with manufacturer's standard adhesive, **as directed**.
3. Glass-Fiber Felts: ASTM D 2178, Type IV, asphalt impregnated.

E. Roof Insulation
1. General: Preformed roof insulation boards manufactured or approved by TPO membrane roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Approvals-approved roof insulation, **as directed**.
2. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.6-lb/cu. ft. (26-kg/cu. m) **OR** Type X, 1.3-lb/cu. ft. (21-kg/cu. m), **as directed**, minimum density, square edged.
3. Molded-Polystyrene Board Insulation: ASTM C 578, Type II, 1.35-lb/cu. ft. (22-kg/cu. m) **OR** Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) **OR** Type IX, 1.8-lb/cu. ft. (29-kg/cu. m), **as directed**, minimum density.
4. Composite Molded-Polystyrene Board Insulation: ASTM C 578, Type II, 1.35-lb/cu. ft. (22-kg/cu. m) **OR** Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) **OR** Type IX, 1.8-lb/cu. ft. (29-kg/cu. m), **as directed**, minimum density, with factory-applied facings, as follows:
   a. Facer: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, asphalt coated, 1/2 inch (13 mm) thick.
      OR
      Facer: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.
5. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2 **OR** Type II, Class I, Grade 3, **as directed**, felt or glass-fiber mat facer on both major surfaces.
6. Composite Polyisocyanurate Board Insulation: ASTM C 1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber mat facer on the other.
   a. Type IV, cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch (13 mm) thick.
   b. Type V, OSB facer, 7/16 inch (11 mm) thick.
   c. Type VII, glass mat faced gypsum board facer, 1/4 inch (6 mm) thick.
7. Perlite Board Insulation: ASTM C 728, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.
8. Cellulosic-Fiber Board Insulation: ASTM C 208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.
9. Cellular-Glass Board Insulation: ASTM C 552, Type IV, rigid, cellular-glass thermal board insulation faced with manufacturer's standard kraft-paper sheets.
10. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches (1:48) unless otherwise indicated.
11. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

F. Insulation Accessories

1. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing.
2. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards, **as directed**, to substrate, and acceptable to roofing system manufacturer.
3. Modified Asphaltic Insulation Adhesive: Insulation manufacturer's recommended modified asphalt, asbestos-free, cold-applied adhesive formulated to attach roof insulation to substrate or to another insulation layer.
4. Bead-Applied Insulation Adhesive: Insulation manufacturer's recommended bead-applied, low-rise, one- or multicomponent urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
5. Full-Spread Applied Insulation Adhesive: Insulation manufacturer's recommended spray-applied, low-rise, two-component urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
6. Cover Board: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, 1/2 inch (13 mm) thick.
   OR
   Cover Board: DOC PS 2, Exposure 1, OSB, 7/16 inch (11 mm) thick.
   OR
   Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick, factory primed, **as directed**.
   OR
   Cover Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), **as directed**, thick.
7. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric, water permeable and resistant to UV degradation, type and weight as recommended by roofing system manufacturer for application.

G. Asphalt Materials
1. Roofing Asphalt: ASTM D 312, Type III or Type IV **OR** ASTM D 6152, SEBS modified, **as directed**.
2. Asphalt Primer: ASTM D 41.

H. Aggregate Ballast (for loosely laid and aggregate-ballasted installations)
1. Aggregate Ballast: Provide aggregate ballast that will withstand weather exposure without significant deterioration and will not contribute to membrane degradation, of the following type and size:
   a. Aggregate Type: Smooth, washed, riverbed gravel or other acceptable smooth-faced stone **OR** Crushed gravel or crushed stone, **as directed**.
   b. Size: ASTM D 448, Size 4, ranging in size from 3/4 to 1-1/2 inches (19 to 38 mm).
      OR
      Size: ASTM D 448, Size 2, ranging in size from 1-1/2 to 2-1/2 inches (38 to 63 mm).
      OR
      Size: ASTM D 448, Size 3, ranging in size from 1 to 2 inches (25 to 50 mm).

I. Roof Pavers
1. Lightweight Roof Pavers: Interlocking, lightweight concrete units, specially factory cast for use as roof ballast; grooved back, with four-way drainage capability; beveled, doweled, or otherwise profiled; and as follows:
   a. Size: 8 by 16 inches (200 by 400 mm) **OR** 12 by 12 inches (300 by 300 mm) **OR** 12 by 16-1/2 inches (300 by 420 mm) **OR** 12 by 18 inches (300 by 450 mm), **as directed**.
   b. Weight: At least 10 lb/sq. ft. (50 kg/sq. m) but not exceeding 18 lb/sq. ft. (90 kg/sq. m).
   c. Compressive Strength: 2500 psi (17 MPa) **OR** 5000 psi (34 MPa), **as directed**, minimum.
   d. Colors and Textures: As selected from manufacturer's full range.

2. Heavyweight Roof Pavers: Heavyweight, hydraulically pressed, concrete units, square edged **OR** with top edges beveled 3/16 inch (5 mm), **as directed**, factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C 67; and as follows:
   a. Size: 12 by 12 inches (300 by 300 mm) **OR** 18 by 18 inches (450 by 450 mm) **OR** 24 by 24 inches (600 by 600 mm), **as directed**. Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch (1.6 mm) in length, height, and thickness.
   b. Weight: 18 lb/sq. ft. (90 kg/sq. m) **OR** 22 lb/sq. ft. (110 kg/sq. m), **as directed**.
   c. Compressive Strength: 7500 psi (52 MPa) **OR** 6500 psi (45 MPa), **as directed**, minimum.
   d. Colors and Textures: As selected from manufacturer's full range.

J. Walkways
1. Flexible Walkways: Factory-formed, nonporous, heavy-duty, solid-rubber, slip-resisting, surface-textured walkway pads **OR** rolls, **as directed**, approximately 3/16 inch (5 mm) thick, and acceptable to membrane roofing system manufacturer.
2. Walkway Roof Pavers: Heavyweight, hydraulically pressed, concrete units, square edged **OR** with top edges beveled 3/16 inch (5 mm), **as directed**, factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C 67; and as follows:
   a. Size: 12 by 12 inches (300 by 300 mm) **OR** 18 by 18 inches (450 by 450 mm) **OR** 24 by 24 inches (600 by 600 mm), **as directed**. Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch (1.6 mm) in length, height, and thickness.
   b. Weight: 18 lb/sq. ft. (90 kg/sq. m) **OR** 22 lb/sq. ft. (110 kg/sq. m), **as directed**.
   c. Compressive Strength: 7500 psi (52 MPa) **OR** 6500 psi (45 MPa), **as directed**, minimum.
   d. Colors and Textures: As selected from manufacturer's full range.

1.3 EXECUTION

A. Preparation
1. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
2. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
3. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.
4. Install acoustical roof deck rib insulation strips, specified in Division 05 Section "Steel Deck", according to acoustical roof deck manufacturer's written instructions, immediately before installation of overlying construction and to remain dry.

B. Substrate Board
1. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
   a. Fasten substrate board to top flanges of steel deck according to recommendations in FM Approvals' "RoofNav" and FM Global Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.
      OR
      Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to membrane roofing system manufacturers' written instructions.

C. Vapor-Retarder Installation

1. Polyethylene Film: Loosely lay polyethylene-film vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.
   a. Continuously seal side and end laps with tape **OR** adhesive, **as directed**.
2. Laminate Sheet: Install laminate-sheet vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively. Bond vapor retarder to substrate as follows:
   a. Apply adhesive at rate recommended by vapor-retarder manufacturer. Seal laps with adhesive.
      OR
      Apply ribbons of hot roofing asphalt at spacing, temperature, and rate recommended by vapor-retarder manufacturer. Seal laps with hot roofing asphalt.
3. Built-up Vapor Retarder: Install two glass-fiber felt plies lapping each felt 19 inches (483 mm) over preceding felt. Embed each felt in a solid mopping of hot roofing asphalt. Glaze-coat completed surface with hot roofing asphalt. Apply hot roofing asphalt within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
4. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into membrane roofing system.

D. Insulation Installation
1. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
2. Comply with membrane roofing system and insulation manufacturer's written instructions for installing roof insulation.
3. Install tapered insulation under area of roofing to conform to slopes indicated.
4. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches (68 mm) or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.
   a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
5. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
6. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
   a. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
7. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
   a. Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.
   b. Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
   c. Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
   d. Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
8. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
   a. Fasten insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
      OR
      Fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.

9. Mechanically Fastened and Adhered Insulation: Install each layer of insulation and secure first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
   a. Fasten first layer of insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
      OR
      Fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
   b. Set each subsequent layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
      OR
      Set each subsequent layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
      OR
      Set each subsequent layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
10. Loosely Laid Insulation: Loosely lay insulation units over substrate.
11. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction. Loosely butt cover boards together and fasten to roof deck, **as directed**.
   a. Fasten cover boards according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
      OR
      Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.
12. Install slip sheet over insulation **OR** cover board, **as directed**, and immediately beneath membrane roofing.

E. Adhered Membrane Roofing Installation
1. Adhere membrane roofing over area to receive roofing and install according to membrane roofing system manufacturer's written instructions.
2. Start installation of membrane roofing in presence of membrane roofing system manufacturer's technical personnel.
3. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
4. Bonding Adhesive: Apply to substrate and underside of membrane roofing at rate required by manufacturer and allow to partially dry before installing membrane roofing. Do not apply to splice area of membrane roofing.
5. In addition to adhering, mechanically fasten membrane roofing securely at terminations, penetrations, and perimeter of roofing.
6. Apply membrane roofing with side laps shingled with slope of roof deck where possible.
7. Seams: Clean seam areas, overlap membrane roofing, and hot-air weld side and end laps of membrane roofing and sheet flashings according to manufacturer's written instructions to ensure a watertight seam installation.
   a. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet membrane.
   b. Verify field strength of seams a minimum of twice daily and repair seam sample areas.
   c. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
8. Spread sealant bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.
9. Install membrane roofing and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition and to not void warranty for existing membrane roofing system, **as directed**.

F. Mechanically Fastened Membrane Roofing Installation

1. Mechanically fasten membrane roofing over area to receive roofing and install according to roofing system manufacturer's written instructions.
   a. For in-splice attachment, install membranes roofing with long dimension perpendicular to steel roof deck flutes.
2. Start installation of membrane roofing in presence of roofing system manufacturer's technical personnel.
3. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
4. Mechanically fasten or adhere membrane roofing securely at terminations, penetrations, and perimeter of roofing.
5. Apply membrane roofing with side laps shingled with slope of roof deck where possible.
6. In-Seam Attachment: Secure one edge of TPO sheet using fastening plates or metal battens centered within membrane seam and mechanically fasten TPO sheet to roof deck.
7. Seams: Clean seam areas, overlap membrane roofing, and hot-air weld side and end laps of membrane roofing and sheet flashings according to manufacturer's written instructions to ensure a watertight seam installation.
   a. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet membrane.
   b. Verify field strength of seams a minimum of twice daily and repair seam sample areas.
   c. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
8. Spread sealant bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.
9. Install membrane roofing and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition and to not void warranty for existing membrane roofing system.

G. Loosely Laid And Ballasted Membrane Roofing Installation
1. Loosely lay membrane roofing over area to receive roofing and install according to roofing system manufacturer's written instructions.
   a. Comply with requirements in SPRI RP-4 for System 1 **OR** System 2 **OR** System 3, **as directed**.
2. Start installation of membrane roofing in presence of roofing system manufacturer's technical personnel.
3. Accurately align membrane roofing, without stretching, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
4. Mechanically fasten or adhere perimeter of membrane roofing according to requirements in SPRI RP-4.
   OR
   Mechanically fasten **OR** adhere, **as directed**, membrane roofing at corners, perimeters, and transitions according to requirements in SPRI RP-4.
   a. At corners and perimeters, omit aggregate ballast leaving membrane roofing exposed.
      OR
      At corners and perimeters, adhere a second layer of membrane roofing.
5. Apply membrane roofing with side laps shingled with slope of deck where possible.
6. Seams: Clean seam areas, overlap membrane roofing, and hot-air weld side and end laps of membrane roofing and sheet flashings according to manufacturer's written instructions to ensure a watertight seam installation.
   a. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet membrane.
   b. Verify field strength of seams a minimum of twice daily and repair seam sample areas.
   c. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
7. Spread sealant bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.
8. Install membrane roofing and auxiliary materials to tie in to existing roofing.
9. Install protection mat over membrane roofing, overlapping a minimum of 6 inches (150 mm). Install an additional protection mat layer at projections, pipes, vents, and drains, overlapping a minimum of 12 inches (300 mm).

10. Aggregate Ballast: Apply uniformly over membrane roofing at the rate required by membrane roofing system manufacturer, but not less than the following, spreading with care to minimize possibility of damage to membrane roofing system. Lay ballast as membrane roofing is installed, leaving membrane roofing ballasted at the end of the workday.
    a. Ballast Weight: Size 4 aggregate, 10 lb/sq. ft. (50 kg/sq. m).
       OR
       Ballast Weight: Size 2 aggregate, 13 lb/sq. ft. (65 kg/sq. m), at corners and perimeter; Size 4 aggregate, 10 lb/sq. ft. (50 kg/sq. m), elsewhere.
       OR
       Ballast Weight: Size 2 aggregate, 13 lb/sq. ft. (65 kg/sq. m).
11. Roof-Paver Ballast: Install lightweight **OR** heavyweight, **as directed**, roof-paver ballast according to manufacturer's written instructions.
    OR
    Roof-Paver and Aggregate Ballast: Install heavyweight roof pavers according to manufacturer's written instructions on roof corners and perimeter.
    a. Install Size 4 aggregate ballast elsewhere on roofing at a minimum rate of 10 lb/sq. ft. (50 kg/sq. m).
       OR
       Install Size 2 aggregate ballast elsewhere on roofing at a minimum rate of 13 lb/sq. ft. (65 kg/sq. m).

H. Base Flashing Installation
1. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.
2. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply to seam area of flashing.
3. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
4. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.
5. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars, **as directed**.

I. Walkway Installation
1. Flexible Walkways: Install walkway products in locations indicated. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.
2. Roof-Paver Walkways: Install walkway roof pavers according to manufacturer's written instructions in locations indicated, to form walkways. Leave 3 inches (75 mm) of space between adjacent roof pavers.

J. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.
3. Repair or remove and replace components of membrane roofing system where inspections indicate that they do not comply with specified requirements.
4. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

K. Protecting And Cleaning
1. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Owner.

2. Correct deficiencies in or remove membrane roofing system that does not comply with requirements; repair substrates; and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
3. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07533a

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Task	Specification	Specification Description
07533	01352	No Specification Required
07533	07212c	CSPE Membrane Roofing

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SECTION 07544 - COATED FOAMED ROOFING

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for coated foamed roofing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Spray-applied, polyurethane foam insulation.
   b. Elastomeric roof coatings.
   c. Mineral granules.
   d. Aggregate.
   e. Walkways.

C. Performance Requirements
1. Watertightness: Provide coated foamed roofing that is watertight and will not permit the passage of water.
2. Material Compatibility: Provide polyurethane foam, elastomeric coatings, and miscellaneous roofing materials that are compatible with one another and able to bond to substrate under conditions of service and application required, as demonstrated by coated foamed roofing manufacturer based on testing and field experience.
3. Roofing System Design: Provide a coated foamed roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to SEI/ASCE 7.
4. FMG Listing: Provide roofing system and component materials that comply with requirements in FMG 4450 for steel roof decks and FMG 4470 for roof covers as part of a foamed roofing system and that are listed in FMG's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FMG markings.
   a. Fire/Windstorm Classification: Class 1A-60 **OR** 75 **OR** 90 **OR** 105 **OR** 120, **as directed**.
   b. Hail-Resistance Classification: MH **OR** SH, **as directed**.
5. Energy Performance: Provide roofing system with Solar Reflectance Index not less than 78 **OR** 29, **as directed**, when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency.

D. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:
   a. Product Test Reports for Credit SS 7.2: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirement.
3. Samples: For each exposed product and for each color and texture specified.
4. Research/evaluation reports.
5. Maintenance data.
6. Warranty: Sample of special warranty.
7. Warranty: Sample of special warranty.

E. Quality Assurance
1. Installer Qualifications: A qualified installer who is approved, authorized, or licensed by roof coating manufacturer for installation of manufacturer's product over polyurethane foam.

a. Engage an installer who participates in and who has fulfilled requirements of the SPFA Accreditation Program for company accreditation and individual applicator accreditation for personnel assigned to work on Project.

2. Source Limitations: Obtain polyurethane foam materials from single source or producer and coating products from single, coated foamed roofing manufacturer.
3. Fire-Test-Response Characteristics: Provide coated foamed roofing systems with the fire-test-response characteristics indicated, as determined by testing identical systems per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
   a. Surface-Burning Characteristics: Maximum flame-spread and smoke-developed indexes of 75 and 450, respectively; ASTM E 84.
   b. Exterior Fire-Test Exposure: ASTM E 108; Class A.
   c. Fire-Resistance Ratings: ASTM E 119, determined for coated polyurethane foam roofing as part of a roof assembly.
4. Comply with recommendations in NRCA's "Quality Control Guidelines for the Application of Spray Polyurethane Foam Roofing."
5. Comply with recommendations in SPFA AY 104, "Spray Polyurethane Foam Systems for New and Remedial Roofing."
6. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Deliver materials to Project site in original containers with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, shelf life, and directions for storing and mixing with other components.
2. Store materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by manufacturer. Protect stored materials from direct sunlight.
3. Remove and replace material that cannot be applied within its stated shelf life.

G. Warranty
1. Special Warranty: Coated foamed roofing manufacturer's standard form in which manufacturer agrees to repair or replace coated foamed roofing that does not comply with requirements or that does not remain watertight within five **OR** 10, **as directed**, years from date of Substantial Completion.

1.2 PRODUCTS

A. Polyurethane Foam
1. Polyurethane Foam: Rigid cellular polyurethane, spray applied, produced by the catalyzed chemical reaction of polyisocyanates with polyhydroxyls, with stabilizers, fire retardants, and blowing agents added; and complying with ASTM C 1029, Type III, as certified by a qualified independent testing agency.
   a. In-Place Density: 2.8 to 3.0 lb/cu. ft. (44.9 to 48.1 kg/cu. m); ASTM D 1622.
   b. Surface-Burning Characteristic: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
      1) Flame-Spread Index: 75 or less.

B. Urethane Coatings
1. Urethane Coatings: Liquid urethane elastomeric coating system, specifically formulated for coating spray polyurethane roofing, of the following composition, coat type, and topcoat color and complying with specified performance and physical requirements.
   a. Base-Coat Composition and Type: One-component **OR** Two-component, **as directed**, aromatic urethane.

b. Topcoat Composition and Type: One-component **OR** Two-component, **as directed**, aromatic **OR** aliphatic, **as directed**, urethane.
c. Topcoat Color: White **OR** Gray **OR** Tan **OR** Copper **OR** Black, **as directed**.
d. Topcoat Color at Walkways: White **OR** Gray **OR** Tan **OR** Copper **OR** Black, **as directed**.
e. Tensile Strength: 400 psi (2.8 MPa) per ASTM D 412.
f. Elongation: 300 percent at 75 deg F (24 deg C) per ASTM D 412.
g. Permanent Set at Break: 30 percent maximum per ASTM D 412.
h. Tear Resistance: 100 lbf/inch (17.5 kN/m) per ASTM D 1004.
i. Water Absorption: 3 percent maximum by weight, 168 hours at 75 deg F (24 deg C) per ASTM D 471.
j. Permeance:
1) Minimum 0.7 perms (40.2 ng/Pa x s x sq. m) at 20 mils (0.5 mm) thick per ASTM E 96.
OR
Minimum 5.0 perms (286 ng/Pa x s x sq. m) at 20 mils (0.5 mm) thick per ASTM E 96.

C. Silicone Coatings
1. Silicone Coatings: Liquid silicone elastomeric coating system, complying with ASTM D 6694 and specifically formulated for coating spray polyurethane roofing.
a. Base-Coat and Topcoat Composition: One-component **OR** Two-component, **as directed**, silicone.
b. Topcoat Color: White **OR** Gray,**as directed** .
c. Topcoat Color at Walkways: White **OR** Gray, **as directed**.
d. Permeance: Minimum 5.0 perms (286 ng/Pa x s x sq. m) at 20 mils (0.5 mm) thick per ASTM E 96.

D. Acrylic Coatings
1. Acrylic Coatings: Liquid acrylic elastomeric emulsion coating system, complying with ASTM D 6083 and specifically formulated for coating spray polyurethane roofing.
a. Topcoat Color: White **OR** Gray **OR** Buff, **as directed**.
b. Topcoat Color at Walkways: White **OR** Gray **OR** Buff, **as directed**.
c. Permeance: Minimum 5.0 perms (286 ng/Pa x s x sq. m) at 20 mils (0.5 mm) thick per ASTM E 96.

E. Substrate Board
1. Thermal Barrier:
a. Glass-mat, water-resistant gypsum board, ASTM C 1177/C 1177M, 1/4 inch (6 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm), Type X, **as directed**.
b. ASTM C 36/C 36M, 5/8-inch (16-mm) gypsum board base, Type X.
2. Recovery Board and Fasteners: As recommended by polyurethane foam manufacturer, and meeting the requirements of Division 07 Section "Membrane Reroofing Preparation".
3. Thermal-Barrier Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FMG 4470, and designed and sized for fastening thermal barrier to substrate.

F. Auxiliary Materials
1. Primer: Polyurethane foam manufacturer's standard factory-formulated primer.
2. Vapor Retarder: Fluid applied **OR** Bituminous membrane **OR** As recommended by coated foamed roofing manufacturer, **as directed**.
3. Mineral Granules: Ceramic-coated roofing granules, No. 11 screen size with 100 percent passing No. 8 (2.36-mm) sieve and 98 percent of mass retained by No. 40 (0.42-mm) sieve.
a. Color: Buff white **OR** Gray **OR** Green **OR** Red, **as directed**.
4. Aggregate: Coarse mineral aggregate, 3/4 inch (19 mm) maximum, ASTM D 1863, No. 7 or No. 67 gradation.

5. Reinforcement: Flexible polyester or fiberglass mat of weight, type, and composition recommended by roof coating manufacturer for embedment in liquid coating.
6. Walkway Pads: Factory formed of nonwoven PVC strands, porous, UV stabilized, of 5/16-inch (8-mm) nominal thickness, and approved by roof coating manufacturer. Provide pad sizes indicated.
   a. Color: Yellow **OR** Gray **OR** Blue **OR** Orange **OR** Green, **as directed**.
7. Sealant: ASTM C 920, Class 25, Use NT, Grade NS, Type M, multicomponent urethane **OR** Type S, one-component, neutral- or acid-curing silicone, **as directed**, and as recommended by coated foamed roofing manufacturer for substrate and joint conditions and for compatibility with roofing materials.
8. Sheet Flashing and Accessories: Types recommended by coated foamed roofing manufacturer, provided at locations indicated and as recommended by coated foamed roofing manufacturer.

1.3 EXECUTION

A. Substrate Board
   1. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
      a. Fasten thermal barrier to top flanges of steel deck according to recommendations in FMG's "Approval Guide" for specified Windstorm Resistance Classification.
      b. Fasten thermal barrier to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to coated foamed roofing manufacturer's written instructions.
      c. Install recovery board according to coated foamed roofing manufacturer's written instructions and the requirements of Division 07 Section "Membrane Reroofing Preparation". Fasten through existing roofing to roof structure as indicated. Space fasteners for wind-uplift conditions at Project site **OR** as indicated, **as directed**.

B. Surface Preparation
   1. Clean and prepare substrate according to coated foamed roofing manufacturer's written instructions. Provide clean, dust-free, dew-free, and dry substrate for coated foamed roofing application.
   2. Remove grease, oil, form-release agents, curing compounds, and other contaminants from substrate.
   3. Prepare substrate for recovering according toDivision 07 Section "Membrane Reroofing Preparation" and to coated foamed roofing manufacturer's written instructions.
   4. Cover and mask adjoining surfaces not receiving coated foamed roofing to prevent overspray or spillage affecting other construction. Close off roof drains, removing roof-drain plugs when no work is being done or when rain is forecast.
      a. Remove masking after polyurethane foam application and remask adjoining substrates before coating.
   5. Prime substrate if recommended by coated foamed roofing manufacturer.
   6. Fill, cover, or tape joints and cracks in substrate that exceed a width of 1/4 inch (6 mm). Remove dust and dirt from joints and cracks before applying polyurethane foam.
   7. Install vapor retarder according to coated foamed roofing manufacturer's written instructions.

C. Polyurethane Foam Application
   1. General: Mix and apply polyurethane foam according to ASTM D 5469 and coated foamed roofing manufacturer's written instructions.
      a. Fill irregularities and areas of ponding.
      b. Apply the required full thickness of polyurethane foam in any specific area on same day.
      c. Apply only the area of polyurethane foam that can be covered on same day with required base coating.
      d. Apply polyurethane foam to avoid overspray beyond immediate area of work.

2. Apply polyurethane foam in lift thicknesses not less than 1/2 inch (13 mm) and not more than 1-1/2 inches (38 mm).
3. Uniformly apply total thickness of polyurethane foam indicated, but not less than 1 inch (25 mm), to a surface tolerance of plus 1/4 inch (6 mm) and no minus.
4. Apply polyurethane foam to roof penetrations, terminations, and vertical surfaces as indicated. Unless otherwise indicated, extend polyurethane foam at least 4 inches (100 mm) above elevation of adjacent roof field.
5. Surface Finish: Provide finished surface of polyurethane foam within the following range of surface textures as defined by ASTM D 5469:
   a. Texture: Smooth to orange peel **OR** coarse orange peel **OR** rippling verge of popcorn, **as directed**.
6. Remove and replace polyurethane foam not complying with minimum surface-texture limitations. Remove defective thickness and prepare and reapply polyurethane foam with acceptable, uniform results.

D. Coating Application
1. Allow polyurethane foam substrate to cure for a minimum of two hours and remove dust, dirt, water, and other contaminants before applying coating.
2. Apply coating system to polyurethane foam, in two or more coats and according to roof coating manufacturer's written instructions, by spray, roller, or other suitable application method.
3. Apply base coat and one or more topcoats to obtain a uniform, seamless membrane free of blisters and pinholes. Apply each coat at right angles to preceding coat, using contrasting colors for successive coats.
   a. Apply base coat on same day as polyurethane foam is applied and allow it to cure.
   b. Apply topcoat(s) after removing dust, dirt, water, and other contaminants from base coat.
   c. Urethane Coating: Apply base coat and topcoat to a minimum dry film thickness recommend by coated foamed roofing manufacturer **OR** of 25 mils (0.64 mm) **OR** of 30 mils (0.76 mm) **OR** of 35 mils (0.89 mm), **as directed**.
   d. Silicone Coating: Apply base coat and topcoat to a minimum dry film thickness recommend by coated foamed roofing manufacturer **OR** of 20 mils (0.50 mm) **OR** of 22 mils (0.56 mm) **OR** of 26 mils (0.66 mm) **OR** of 30 mils (0.76 mm), **as directed**.
   e. Acrylic Coating: Apply base coat and topcoat to a minimum dry film thickness recommend by coated foamed roofing manufacturer **OR** of 25 mils (0.64 mm) **OR** of 28 mils (0.71 mm) **OR** of 32 mils (0.81 mm), **as directed**.
4. Apply coating system at wall terminations and vertical surfaces to extend beyond polyurethane foam by 4 inches (100 mm), minimum.
5. Mineral Granules: Apply mineral granules over wet topcoat using pressure equipment at the rate of 0.5 lb/sq. ft. (2.45 kg/sq. m). Remove excess granules after topcoat has cured.
6. Sealant: Apply sealant to perimeter and other terminations where indicated or required by coated foamed roofing manufacturer.
7. Walkways: Install roof walkways in pattern and locations indicated. Mask off completed roof coating adjacent to walkways and apply one or two additional topcoats to achieve a minimum dry film thickness recommended by coated foamed roofing manufacturer. Spread mineral granules uniformly at a rate of 0.5 lb/sq. ft. (2.45 kg/sq. m) into final wet coating. Remove masking and excess granules after topcoat has cured.
8. Walkways: Install roof walkways in pattern and locations indicated. Mask off completed roof coating adjacent to walkways and apply one additional topcoat to achieve a minimum dry film thickness recommended by coated foamed roofing manufacturer. Lay reinforcing fabric into wet coating and apply another topcoat, completely filling fabric. Spread mineral granules uniformly at a rate of 0.5 lb/sq. ft. (2.45 kg/sq. m) into final wet coating. Remove masking and excess granules after topcoat has cured.
9. Walkways: Install walkway pads in pattern and locations indicated. Adhere walkway pads to substrate with compatible adhesive according to coated foamed roofing manufacturer's written instructions.
10. Aggregate: Apply aggregate uniformly over coated polyurethane foam at coated foamed roofing manufacturer's recommended rate, but not less than 6 lb/sq. ft. (29 kg/sq. m) and a minimum

thickness of 3/4 inch (19 mm). Spread with care to prevent puncturing coating and to minimize damage to substrate foam.

E. Field Quality Control
1. Correct deficiencies in, or remove, foam or coatings that do not comply with requirements; fill and repair substrates and reapply materials.
2. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with requirements.
3. Refill cores, repair slits, and recoat test areas.

F. Repair And Recoating
1. Repair and recoat coated foamed roofing according to ASTM D 6705 and coated foamed roofing manufacturer's written instructions.

G. Curing, Protecting, And Cleaning
1. Cure coatings according to coated foamed roofing manufacturer's written instructions, taking care to prevent contamination and damage during application stages and curing. Do not permit traffic on uncured coatings.
2. Protect coated foamed roofing from damage and wear during remainder of construction period.
3. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07544

SECTION 07620 - SHEET METAL FLASHING AND TRIM

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for sheet metal flashing and trim. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Manufactured Products:
1) Manufactured through-wall flashing and counterflashing.
2) Manufactured reglets and counterflashing.
b. Formed Products:
1) Formed roof drainage sheet metal fabrications.
2) Formed low-slope roof sheet metal fabrications.
3) Formed steep-slope roof sheet metal fabrications.
4) Formed wall sheet metal fabrications.
5) Formed equipment support flashing.
6) Formed overhead-piping safety pans.

C. Performance Requirements
1. General: Sheet metal flashing and trim assemblies as indicated shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
2. Fabricate and install roof edge flashing and copings capable of resisting the following forces according to recommendations in FMG Loss Prevention Data Sheet 1-49:
a. Wind Zone 1: For velocity pressures of 10 to 20 lbf/sq. ft. (0.48 to 0.96 kPa): 40-lbf/sq. ft. (1.92-kPa) perimeter uplift force, 60-lbf/sq. ft. (2.87-kPa) corner uplift force, and 20-lbf/sq. ft. (0.96-kPa) outward force.
b. Wind Zone 1: For velocity pressures of 21 to 30 lbf/sq. ft. (1.00 to 1.44 kPa): 60-lbf/sq. ft. (2.87-kPa) perimeter uplift force, 90-lbf/sq. ft. (4.31-kPa) corner uplift force, and 30-lbf/sq. ft. (1.44-kPa) outward force.
c. Wind Zone 2: For velocity pressures of 31 to 45 lbf/sq. ft. (1.48 to 2.15 kPa): 90-lbf/sq. ft. (4.31-kPa) perimeter uplift force, 120-lbf/sq. ft. (5.74-kPa) corner uplift force, and 45-lbf/sq. ft. (2.15-kPa) outward force.
d. Wind Zone 3: For velocity pressures of 46 to 104 lbf/sq. ft. (2.20 to 4.98 kPa): 208-lbf/sq. ft. (9.96-kPa) perimeter uplift force, 312-lbf/sq. ft. (14.94-kPa) corner uplift force, and 104-lbf/sq. ft. (4.98-kPa) outward force.
3. Thermal Movements: Provide sheet metal flashing and trim that allows for thermal movements from ambient and surface temperature changes.
a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

D. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Show installation layouts of sheet metal flashing and trim, including plans, elevations, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work.

a. Include details for forming, joining, supporting, and securing sheet metal flashing and trim, including pattern of seams, termination points, fixed points, expansion joints, expansion-joint covers, edge conditions, special conditions, and connections to adjoining work.

3. Samples: For each exposed product and for each finish specified.
4. Maintenance data.
5. Warranty: Sample of special warranty.

E. Quality Assurance
1. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" unless more stringent requirements are specified or shown on Drawings.
2. Copper Sheet Metal Standard: Comply with CDA's "Copper in Architecture Handbook." Conform to dimensions and profiles shown unless more stringent requirements are indicated.
3. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
a. Build mockup of typical roof eave, including built-in gutter, fascia, fascia trim, and apron flashing, approximately 10 feet (3.0 m) long, including supporting construction cleats, seams, attachments, underlayment, and accessories.
4. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
2. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to the extent necessary for the period of sheet metal flashing and trim installation.

G. Warranty
1. Special Warranty on Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within 20 **OR** 10, **as directed**, years from date of Substantial Completion.

1.2 PRODUCTS

A. Sheet Metals
1. General: Protect mechanical and other finishes on exposed surfaces from damage by applying a strippable, temporary protective film before shipping.
2. Copper Sheet: ASTM B 370, cold-rolled copper sheet, H00 or H01 temper.
a. Non-Patinated Exposed Finish: Mill.
b. Non-Patinated, Exposed, Lacquered Finish: Finish designations for copper alloys comply with the system defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products."
1) Brushed Satin (Lacquered): M32-06x (Mechanical Finish: directionally textured, medium satin; with clear organic coating); coating of "Incralac," waterborne **OR** solvent-borne, **as directed**, methyl methacrylate copolymer lacquer with UV inhibitor, applied by air spray in two coats per manufacturer's written instructions to a total thickness of 1 mil (0.025 mm).
2) Mirror Polished (Lacquered): M22-06x (Mechanical Finish: buffed, specular; with clear organic coating); coating of "Incralac," waterborne **OR** solvent-borne, **as directed**, air-drying, methyl methacrylate copolymer lacquer with UV inhibitor, applied by air spray in two coats per manufacturer's written instructions to a total thickness of 1 mil (0.025 mm).
c. Pre-Patinated Copper-Sheet Finish: Dark brown **OR** Verdigris, **as directed**, pre-patinated according to ASTM B 882.

3. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required.
   a. As-Milled Finish: Mill **OR** One-side bright mill **OR** Standard one-side bright **OR** Standard two-side bright, **as directed**, finish.
   b. Alclad Finish: Metallurgically bonded surfacing to both sides, forming a composite aluminum sheet with reflective luster.
   c. Surface: Smooth, flat **OR** Embossed, **as directed**.
   d. Factory Prime Coating: Where painting after installation is indicated, pretreat with white or light-colored, factory-applied, baked-on epoxy primer coat; minimum dry film thickness of 0.2 mil (0.005 mm).
   e. Clear Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.
   f. Color Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
      1) Color: Champagne **OR** Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black, **as directed**.
      2) Color Range: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
   g. Exposed Coil-Coated Finishes:
      1) Two-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat.
      2) Three-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
      3) Four-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat and clear coats.
      4) Mica Fluoropolymer: AAMA 620. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat.
      5) Metallic Fluoropolymer: AAMA 620. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
      6) FEVE Fluoropolymer: AAMA 620. Two-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether resin in color coat.
      7) Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
      8) Plastisol: Epoxy primer and vinyl plastisol topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 3.8 mils (0.97 mm) for topcoat.
   h. Color: As selected from manufacturer's full range.
   i. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).
4. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304, dead soft, fully annealed.
   a. Finish: 2D (dull, cold rolled) **OR** 2B (bright, cold rolled) **OR** 3 (coarse, polished directional satin) **OR** 4 (polished directional satin), **as directed**.
   b. Surface: Smooth, flat **OR** Embossed, **as directed**.
5. Zinc-Tin Alloy-Coated Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304, dead-soft, fully annealed stainless-steel sheet of minimum uncoated thickness indicated; coated on both sides with a zinc-tin alloy (50 percent zinc, 50 percent tin), with factory-applied gray preweathering.
6. Zinc-Tin Alloy-Coated Copper Sheet: ASTM B 370, cold-rolled copper sheet, H00 temper, of minimum uncoated weight (thickness) indicated; coated on both sides with a zinc-tin alloy (50 percent zinc, 50 percent tin).
7. Metallic-Coated Steel Sheet: Restricted flatness steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality.
b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40 (Class AZM150 coating designation, Grade 275); structural quality.
c. Surface: Smooth, flat **OR** Embossed, **as directed**, and mill phosphatized for field painting **OR** and with manufacturer's standard clear acrylic coating on both sides, **as directed**.
d. Exposed Coil-Coated Finish:
1) Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat.
2) Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
3) Four-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat and clear coats.
4) Mica Fluoropolymer: AAMA 621. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat.
5) Metallic Fluoropolymer: AAMA 621. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
6) FEVE Fluoropolymer: AAMA 621. Two-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether resin in color coat.
7) Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.
8) Plastisol: Epoxy primer and vinyl plastisol topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 3.8 mils (0.97 mm) for topcoat.
e. Color: As selected from manufacturer's full range.
f. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

8. Zinc Sheet: Zinc, 99 percent pure, alloyed with a maximum of 1 percent copper and titanium; with manufacturer's standard factory-applied, flexible, protective back coating.
a. Finish: Bright rolled **OR** Preweathered gray **OR** Preweathered black, **as directed**.

B. Underlayment Materials
1. Polyethylene Sheet: 6-mil- (0.15-mm-) thick polyethylene sheet complying with ASTM D 4397.
2. Felt: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
3. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils (0.76 to 1.0 mm) thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
a. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F (116 deg C).
b. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F (29 deg C).
4. Slip Sheet: Building paper, 3-lb/100 sq. ft. (0.16-kg/sq. m) minimum, rosin sized.

C. Miscellaneous Materials
1. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.
2. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
a. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.

1) Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating.
2) Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
3) Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.

b. Fasteners for Copper **OR** Zinc-Tin Alloy-Coated Copper, **as directed**, Sheet: Copper, hardware bronze or Series 300 stainless steel.
c. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
d. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.
e. Fasteners for Zinc-Tin Alloy-Coated Stainless-Steel Sheet: Series 300 stainless steel.
f. Fasteners for Zinc-Coated (Galvanized) **OR** Aluminum-Zinc Alloy-Coated, **as directed**, Steel Sheet: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329 or Series 300 stainless steel.
g. Fasteners for Zinc Sheet: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329 or Series 300 stainless steel.

3. Solder:
a. For Copper: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead.
b. For Stainless Steel: ASTM B 32, Grade Sn60, with an acid flux of type recommended by stainless-steel sheet manufacturer.
c. For Zinc-Tin Alloy-Coated Stainless Steel **OR** Copper, **as directed**: ASTM B 32, 100 percent tin.
d. For Zinc-Coated (Galvanized) Steel: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead or Grade Sn60, 60 percent tin and 40 percent lead.
e. For Zinc: ASTM B 32, 40 percent tin and 60 percent lead with low antimony, as recommended by manufacturer.

4. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
5. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane **OR** polysulfide **OR** silicone, **as directed**, polymer sealant; low modulus; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
6. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
7. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.
8. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.
9. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

D. Manufactured Sheet Metal Flashing And Trim
1. Through-Wall Ribbed Sheet Metal Flashing: Manufacture through-wall sheet metal flashing for embedment in masonry with ribs at 3-inch (75-mm) intervals along length of flashing to provide an integral mortar bond. Manufacture through-wall flashing with snaplock receiver on exterior face to receive counterflashing **OR** interlocking counterflashing on exterior face, of same metal as reglet, **as directed**.
a. Copper: 10 oz. (0.34 mm thick) minimum for fully concealed flashing; 16 oz. (0.55 mm thick) elsewhere.
b. Stainless Steel: 0.016 inch (0.40 mm) thick.
2. Reglets: Units of type, material, and profile indicated, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with factory-mitered and -welded corners and junctions **OR** with interlocking counterflashing on exterior face, of same metal as reglet, **as directed**.
a. Material: Stainless steel, 0.019 inch (0.48 mm) thick **OR** Copper, 16 oz./sq. ft. (0.55 mm thick) **OR** Aluminum, 0.024 inch (0.61 mm) thick **OR** Galvanized steel, 0.022 inch (0.56 mm) thick, **as directed**.

b. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
c. Stucco Type: Provide with upturned fastening flange and extension leg of length to match thickness of applied finish materials.
d. Concrete Type: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
e. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
f. Accessories:
1) Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where Drawings show reglet without metal counterflashing.
2) Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.
g. Finish: Mill **OR** With manufacturer's standard color coating, **as directed**.

E. Fabrication, General
1. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, geometry, metal thickness, and other characteristics of item indicated. Fabricate items at the shop to greatest extent possible.
a. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
b. Obtain field measurements for accurate fit before shop fabrication.
c. Form sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
d. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces exposed to view.
2. Fabrication Tolerances:
a. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.
OR
Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."
3. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant.
4. Expansion Provisions: Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with butyl sealant concealed within joints.
5. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
6. Fabricate cleats and attachment devices of sizes as recommended by SMACNA's "Architectural Sheet Metal Manual" and by FMG Loss Prevention Data Sheet 1-49, **as directed**, for application, but not less than thickness of metal being secured.
7. Seams:
a. Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
OR
Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.
8. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints where necessary for strength.

9. Do not use graphite pencils to mark metal surfaces.

F. Roof Drainage Sheet Metal Fabrications

1. Hanging Gutters: Fabricate to cross section indicated, complete with end pieces, outlet tubes, and other accessories as required. Fabricate in minimum 96-inch- (2400-mm-) long sections. Furnish flat-stock gutter spacers and gutter brackets fabricated from same metal as gutters, of size recommended by SMACNA but not less than twice the gutter thickness. Fabricate expansion joints, expansion-joint covers, gutter bead reinforcing bars, and gutter accessories from same metal as gutters.
   a. Gutter Style: SMACNA designation A **OR** B **OR** C **OR** D **OR** E **OR** F **OR** G **OR** H **OR** I **OR** J **OR** K **OR** L, **as directed**.
   b. Expansion Joints: Lap type **OR** Butt type **OR** Butt type with cover plate **OR** Built in, **as directed**.
   c. Accessories: Continuous removable leaf screen with sheet metal frame and hardware cloth screen **OR** Wire ball downspout strainer **OR** Valley baffles, **as directed**.
   d. Gutters with Girth up to 15 Inches (380 mm): Fabricate from the following materials:
      1) Copper: 16 oz./sq. ft. (0.55 mm thick).
      2) Aluminum: 0.032 inch (0.81 mm) thick.
      3) Stainless Steel: 0.016 inch (0.40 mm) thick.
      4) Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
      5) Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
      6) Galvanized Steel: 0.022 inch (0.56 mm) thick.
      7) Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
      8) Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
   e. Gutters with Girth 16 to 20 Inches (410 to 510 mm): Fabricate from the following materials:
      1) Copper: 16 oz./sq. ft. (0.55 mm thick).
      2) Aluminum: 0.040 inch (1.02 mm) thick.
      3) Stainless Steel: 0.019 inch (0.48 mm) thick.
      4) Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
      5) Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
      6) Galvanized Steel: 0.028 inch (0.71 mm) thick.
      7) Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.
      8) Zinc: 0.039 inch (1.00 mm) **OR** 0.048 inch (1.25 mm), **as directed**, thick.
   f. Gutters with Girth 21 to 25 Inches (530 to 640 mm): Fabricate from the following materials:
      1) Copper: 20 oz./sq. ft. (0.68 mm thick).
      2) Aluminum: 0.050 inch (1.27 mm) thick.
      3) Stainless Steel: 0.025 inch (0.64 mm) thick.
      4) Zinc-Tin Alloy-Coated Stainless Steel: 0.024 inch (0.61 mm) thick.
      5) Zinc-Tin Alloy-Coated Copper: 20 oz./sq. ft. (0.68 mm thick).
      6) Galvanized Steel: 0.034 inch (0.86 mm) thick.
      7) Aluminum-Zinc Alloy-Coated Steel: 0.034 inch (0.86 mm) thick.
      8) Zinc: 0.048 inch (1.25 mm) **OR** 0.059 inch (1.50 mm), **as directed**, thick.
   g. Gutters with Girth 26 to 30 Inches (660 to 760 mm): Fabricate from the following materials:
      1) Copper: 24 oz./sq. ft. (0.82 mm thick).
      2) Aluminum: 0.063 inch (1.60 mm) thick.
      3) Stainless Steel: 0.031 inch (0.79 mm) thick.
      4) Zinc-Tin Alloy-Coated Copper: 24 oz./sq. ft. (0.82 mm thick).
      5) Galvanized Steel: 0.040 inch (1.02 mm) thick.
      6) Aluminum-Zinc Alloy-Coated Steel: 0.040 inch (1.02 mm) thick.
   h. Gutters with Girth 31 to 35 Inches (790 to 890 mm): Fabricate from the following materials:
      1) Copper: 24 oz./sq. ft. (0.82 mm thick).
      2) Stainless Steel: 0.038 inch (0.95 mm) thick.
      3) Zinc-Tin Alloy-Coated Copper: 25 oz./sq. ft. (0.87 mm thick).
      4) Galvanized Steel: 0.052 inch (1.32 mm) thick.
      5) Aluminum-Zinc Alloy-Coated Steel: 0.052 inch (1.32 mm) thick.

2. Built-in Gutters: Fabricate to cross section indicated, with riveted and soldered joints, complete with end pieces, outlet tubes, and other special accessories as required. Fabricate in minimum 96-inch- (2400-mm-) long sections. Fabricate expansion joints and accessories from same metal as gutters unless otherwise indicated.
   a. Fabricate gutters with built-in expansion joints and gutter-end expansion joints at walls.
   b. Accessories: Continuous removable leaf screen with sheet metal frame and hardware cloth screen **OR** Bronze wire ball downspout strainer **OR** Wire ball downspout strainer, **as directed**.
   c. Fabricate from the following materials:
      1) Copper: 16 oz./sq. ft. (0.55 mm thick).
      2) Stainless Steel: 0.016 inch (0.40 mm) thick.
      3) Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
      4) Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
      5) Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
3. Downspouts: Fabricate round **OR** rectangular **OR** open-face, **as directed**, downspouts complete with mitered elbows. Furnish with metal hangers, from same material as downspouts, and anchors.
   a. Fabricated Hanger Style: SMACNA figure designation 1-35A **OR** 1-35B **OR** 1-35C **OR** 1-35D **OR** 1-35E **OR** 1-35F **OR** 1-35G **OR** 1-35H **OR** 1-35I **OR** 1-35J, **as directed**.
   b. Manufactured Hanger Style: SMACNA figure designation 1-34A **OR** 1-34B **OR** 1-34C **OR** 1-34D **OR** 1-34E, **as directed**.
   c. Hanger Style: <**Insert description**>.
   d. Fabricate from the following materials:
      1) Copper: 16 oz./sq. ft. (0.55 mm thick).
      2) Aluminum: 0.024 inch (0.61 mm) thick.
      3) Stainless Steel: 0.016 inch (0.40 mm) thick.
      4) Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
      5) Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
      6) Galvanized Steel: 0.022 inch (0.56 mm) thick.
      7) Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
      8) Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
4. Parapet Scuppers: Fabricate scuppers of dimensions required with closure flange trim to exterior, 4-inch- (100-mm-) wide wall flanges to interior, and base extending 4 inches (100 mm) beyond cant or tapered strip into field of roof. Fasten gravel guard angles to base of scupper. Fabricate from the following materials:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Aluminum: 0.032 inch (0.81 mm) thick.
   c. Stainless Steel: 0.019 inch (0.48 mm) thick.
   d. Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
   e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
   f. Galvanized Steel: 0.028 inch (0.71 mm) thick.
   g. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.
   h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
5. Conductor Heads: Fabricate conductor heads with flanged back and stiffened top edge and of dimensions and shape indicated complete with outlet tubes, exterior flange trim, and built-in overflows. Fabricate from the following materials:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Aluminum: 0.032 inch (0.81 mm) thick.
   c. Stainless Steel: 0.016 inch (0.40 mm) thick.
   d. Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
   e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
   f. Galvanized Steel: 0.028 inch (0.71 mm) thick.
   g. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.
   h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
6. Splash Pans: Fabricate from the following materials:

a. Copper: 16 oz./sq. ft. (0.55 mm thick).
b. Aluminum: 0.040 inch (1.02 mm) thick.
c. Stainless Steel: 0.019 inch (0.48 mm) thick.
d. Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
f. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.

G. Low-Slope Roof Sheet Metal Fabrications
1. Roof-Edge Flashing (Gravel Stop) and Fascia Cap: Fabricate in minimum 96-inch- (2400-mm-) long, but not exceeding 10-foot- (3-m-) long, sections. Furnish with 6-inch- (150-mm-) wide, joint cover plates.
   a. Joint Style: Lap, 4 inches (100 mm) wide **OR** Butt, with 12-inch- (300-mm-) wide, concealed backup plate **OR** Butt, with 6-inch- (150-mm-) wide, exposed cover plates **OR** Butt, with 12-inch- (300-mm-) wide, concealed backup plate and 6-inch- (150-mm-) wide, exposed cover plates, **as directed**.
   b. Fabricate with scuppers spaced 10 feet (3 m) apart, of dimensions required with 4-inch- (100-mm-) wide flanges and base extending 4 inches (100 mm) beyond cant or tapered strip into field of roof. Fasten gravel guard angles to base of scupper.
   c. Fabricate from the following materials:
      1) Copper: 20 oz./sq. ft. (0.68 mm thick).
      2) Aluminum: 0.050 inch (1.27 mm) thick.
      3) Stainless Steel: 0.019 inch (0.48 mm) thick.
      4) Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
      5) Zinc-Tin Alloy-Coated Copper: 20 oz./sq. ft. (0.68 mm thick).
      6) Galvanized Steel: 0.028 inch (0.71 mm) thick.
      7) Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.
      8) Zinc: 0.048 inch (1.25 mm) **OR** 0.059 inch (1.50 mm), **as directed**, thick.
2. Copings: Fabricate in minimum 96-inch- (2400-mm-) long, but not exceeding 10-foot- (3-m-) long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and drill elongated holes for fasteners on interior leg. Miter corners, seal, and solder or weld watertight.
   a. Coping Profile: SMACNA figure designation 3-4A **OR** 3-4B **OR** 3-4C **OR** 3-4D **OR** 3-4E **OR** 3-4F **OR** 3-4G, **as directed**.
   b. Joint Style: Butt, with 12-inch- (300-mm-) wide, concealed backup plate **OR** Butt, with 6-inch- (150-mm-) wide, exposed cover plates **OR** Butt, with 12-inch- (300-mm-) wide, concealed backup plate and 6-inch- (150-mm-) wide, exposed cover plates, **as directed**.
   c. Fabricate from the following materials:
      1) Copper: 24 oz./sq. ft. (0.82 mm thick).
      2) Aluminum: 0.050 inch (1.27 mm) thick.
      3) Stainless Steel: 0.025 inch (0.64 mm) thick.
      4) Zinc-Tin Alloy-Coated Stainless Steel: 0.024 inch (0.61 mm) thick.
      5) Zinc-Tin Alloy-Coated Copper: 24 oz./sq. ft. (0.82 mm thick).
      6) Galvanized Steel: 0.040 inch (1.02 mm) thick.
      7) Aluminum-Zinc Alloy-Coated Steel: 0.040 inch (1.02 mm) thick.
      8) Zinc: 0.048 inch (1.25 mm) **OR** 0.059 inch (1.50 mm), **as directed**, thick.
3. Roof and Roof to Wall Transition **OR** Roof to Roof Edge Flashing (Gravel Stop) Transition **OR** Roof to Roof Edge Flashing (Gravel Stop) and Fascia Cap Transition, **as directed,** Expansion-Joint Cover: Fabricate from the following materials:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Aluminum: 0.050 inch (1.27 mm) thick.
   c. Stainless Steel: 0.025 inch (0.64 mm) thick.
   d. Zinc-Tin Alloy-Coated Stainless Steel: 0.024 inch (0.61 mm) thick.
   e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick)>.
   f. Galvanized Steel: 0.034 inch (0.86 mm) thick.
   g. Aluminum-Zinc Alloy-Coated Steel: 0.034 inch (0.86 mm) thick.
   h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.

4. Base Flashing: Fabricate from the following materials:
   a. Copper: 20 oz./sq. ft. (0.68 mm thick)>.
   b. Aluminum: 0.040 inch (1.02 mm) thick.
   c. Stainless Steel: 0.019 inch (0.48 mm) thick.
   d. Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
   e. Zinc-Tin Alloy-Coated Copper: 20 oz./sq. ft. (0.68 mm thick)>.
   f. Galvanized Steel: 0.028 inch (0.71 mm) thick.
   g. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.
   h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
5. Counterflashing: Fabricate from the following materials:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Aluminum: 0.032 inch (0.81 mm) thick.
   c. Stainless Steel: 0.019 inch (0.48 mm) thick.
   d. Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
   e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick)>.
   f. Galvanized Steel: 0.022 inch (0.56 mm) thick.
   g. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
   h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
6. Flashing Receivers: Fabricate from the following materials:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Aluminum: 0.032 inch (0.81 mm) thick.
   c. Stainless Steel: 0.016 inch (0.40 mm) thick.
   d. Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
   e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
   f. Galvanized Steel: 0.022 inch (0.56 mm) thick.
   g. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
   h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
7. Roof-Penetration Flashing: Fabricate from the following materials:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Stainless Steel: 0.019 inch (0.48 mm) thick.
   c. Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
   d. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
   e. Galvanized Steel: 0.028 inch (0.71 mm) thick.
   f. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.
   g. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
8. Roof-Drain Flashing: Fabricate from the following materials:
   a. Copper: 12 oz./sq. ft. (0.41 mm thick).
   b. Stainless Steel: 0.016 inch (0.40 mm) thick.
   c. Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.

H. Steep-Slope Roof Sheet Metal Fabrications
1. Apron, Step, Cricket, and Backer Flashing: Fabricate from the following materials:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Aluminum: 0.032 inch (0.81 mm) thick.
   c. Stainless Steel: 0.016 inch (0.40 mm) thick.
   d. Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
   e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
   f. Galvanized Steel: 0.022 inch (0.56 mm) thick.
   g. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
   h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
2. Valley Flashing: Fabricate from the following materials:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Stainless Steel: 0.019 inch (0.48 mm) thick.
   c. Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
   d. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).

e. Galvanized Steel: 0.028 inch (0.71 mm) thick.
f. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.
g. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.

3. Drip Edges: Fabricate from the following materials:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Aluminum: 0.032 inch (0.81 mm) thick.
   c. Stainless Steel: 0.016 inch (0.40 mm) thick.
   d. Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
   e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
   f. Galvanized Steel: 0.022 inch (0.56 mm) thick.
   g. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
   h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
4. Eave, Rake, Ridge, and Hip Flashing: Fabricate from the following materials:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Aluminum: 0.032 inch (0.81 mm) thick.
   c. Stainless Steel: 0.016 inch (0.40 mm) thick.
   d. Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
   e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
   f. Galvanized Steel: 0.022 inch (0.56 mm) thick.
   g. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
   h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
5. Counterflashing: Fabricate from the following materials:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Aluminum: 0.032 inch (0.81 mm) thick.
   c. Stainless Steel: 0.019 inch (0.48 mm) thick.
   d. Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
   e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
   f. Galvanized Steel: 0.022 inch (0.56 mm) thick.
   g. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
   h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
6. Flashing Receivers: Fabricate from the following materials:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Aluminum: 0.032 inch (0.81 mm) thick.
   c. Stainless Steel: 0.016 inch (0.40 mm) thick.
   d. Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
   e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
   f. Galvanized Steel: 0.022 inch (0.56 mm) thick.
   g. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
   h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
7. Roof-Penetration Flashing: Fabricate from the following materials:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Stainless Steel: 0.019 inch (0.48 mm) thick.
   c. Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
   d. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick)>.
   e. Galvanized Steel: 0.028 inch (0.71 mm) thick.
   f. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.
   g. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.

I. Wall Sheet Metal Fabrications
1. Through-Wall Flashing: Fabricate continuous flashings in minimum 96-inch- (2400-mm-) long, but not exceeding 12-foot- (3.6-m-) long, sections, under copings, at shelf angles, and where indicated. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches (150 mm) beyond each side of wall openings. Form with 2-inch- (50-mm-) high, end dams where flashing is discontinuous. Fabricate from the following materials:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Stainless Steel: 0.016 inch (0.40 mm) thick.

c. Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
d. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
e. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.

2. Opening Flashings in Frame Construction: Fabricate head, sill, jamb, and similar flashings to extend 4 inches (100 mm) beyond wall openings. Form head and sill flashing with 2-inch- (50-mm-) high, end dams. Fabricate from the following materials:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Aluminum: 0.032 inch (0.81 mm) thick.
   c. Stainless Steel: 0.016 inch (0.40 mm) thick.
   d. Zinc-Tin Alloy-Coated Stainless Steel: 0.015 inch (0.38 mm) thick.
   e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
   f. Galvanized Steel: 0.022 inch (0.56 mm) thick.
   g. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
   h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.
3. Wall Expansion-Joint Cover: Fabricate from the following materials:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Aluminum: 0.040 inch (1.02 mm) thick.
   c. Stainless Steel: 0.019 inch (0.48 mm) thick.
   d. Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
   e. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
   f. Galvanized Steel: 0.028 inch (0.71 mm) thick.
   g. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.
   h. Zinc: 0.032 inch (0.80 mm) **OR** 0.039 inch (1.00 mm), **as directed**, thick.

J. Miscellaneous Sheet Metal Fabrications
1. Equipment Support Flashing: Fabricate from the following materials:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Stainless Steel: 0.019 inch (0.48 mm) thick.
   c. Zinc-Tin Alloy-Coated Stainless Steel: 0.018 inch (0.46 mm) thick.
   d. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft. (0.55 mm thick).
   e. Galvanized Steel: 0.028 inch (0.71 mm) thick.
   f. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.
2. Overhead-Piping Safety Pans: Fabricate from the following materials:
   a. Copper: 24 oz./sq. ft. (0.82 mm thick).
   b. Stainless Steel: 0.025 inch (0.64 mm) thick.
   c. Zinc-Tin Alloy-Coated Stainless Steel: 0.024 inch (0.61 mm) thick.
   d. Zinc-Tin Alloy-Coated Copper: 24 oz./sq. ft. (0.82 mm thick).
   e. Galvanized Steel: 0.040 inch (1.02 mm) thick.
   f. Aluminum-Zinc Alloy-Coated Steel: 0.040 inch (1.02 mm) thick.

1.3 EXECUTION

A. Underlayment Installation
1. General: Install underlayment as indicated on Drawings.
2. Polyethylene Sheet: Install polyethylene sheet with adhesive for anchorage to minimize use of mechanical fasteners under sheet metal flashing and trim. Apply in shingle fashion to shed water, with lapped and taped joints of not less than 2 inches (50 mm).
3. Felt Underlayment: Install felt underlayment with adhesive for temporary anchorage to minimize use of mechanical fasteners under sheet metal flashing and trim. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches (50 mm).
4. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free. Apply primer if required by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures. Apply in shingle fashion to shed water, with end laps of not

less than 6 inches (150 mm) staggered 24 inches (600 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps with roller. Cover underlayment within 14 days.

B. Installation, General
1. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
   a. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
   b. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
   c. Space cleats not more than 12 inches (300 mm) apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.
   d. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
   e. Install sealant tape where indicated.
   f. Torch cutting of sheet metal flashing and trim is not permitted.
   g. Do not use graphite pencils to mark metal surfaces.
2. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by SMACNA.
   a. Coat back side of uncoated aluminum and stainless-steel sheet metal flashing and trim with bituminous coating where flashing and trim will contact wood, ferrous metal, or cementitious construction.
   b. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet or install a course of polyethylene sheet.
3. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (600 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with sealant concealed within joints.
4. Fastener Sizes: Use fasteners of sizes that will penetrate wood sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws **OR** metal decking not less than recommended by fastener manufacturer to achieve maximum pull-out resistance, **as directed**.
5. Seal joints as shown and as required for watertight construction.
   a. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch (25 mm) into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F (4 deg C).
   b. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants".
6. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches (38 mm), except reduce pre-tinning where pre-tinned surface would show in completed Work.
   a. Do not solder metallic-coated steel and aluminum sheet.
   b. Pre-tinning is not required for zinc-tin alloy-coated stainless steel and zinc-tin alloy-coated copper.
   c. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

d. Stainless-Steel Soldering: Tin edges of uncoated sheets using solder recommended for stainless steel and acid flux. Promptly remove acid flux residue from metal after tinning and soldering. Comply with solder manufacturer's recommended methods for cleaning and neutralization.
e. Copper Soldering: Tin edges of uncoated copper sheets using solder for copper.

7. Rivets: Rivet joints in uncoated aluminum **OR** zinc, **as directed**, where indicated and where necessary for strength.

C. Roof Drainage System Installation

1. General: Install sheet metal roof drainage items to produce complete roof drainage system according to SMACNA recommendations and as indicated. Coordinate installation of roof perimeter flashing with installation of roof drainage system.
2. Hanging Gutters: Join sections with riveted and soldered joints or with lapped joints sealed with sealant. Provide for thermal expansion. Attach gutters at eave or fascia to firmly anchored gutter brackets **OR** straps **OR** twisted straps, **as directed**, spaced not more than 36 inches (900 mm) apart. Provide end closures and seal watertight with sealant. Slope to downspouts.
   a. Fasten gutter spacers to front and back of gutter.
   b. Loosely lock straps to front gutter bead and anchor to roof deck.
   c. Anchor and loosely lock back edge of gutter to continuous cleat **OR** eave or apron flashing, **as directed**.
   d. Anchor back of gutter that extends onto roof deck with cleats spaced not more than 24 inches (600 mm) apart.
   e. Anchor gutter with spikes and ferrules spaced not more than 24 inches (600 mm) **OR** 30 inches (750 mm), **as directed**, apart.
   f. Install gutter with expansion joints at locations indicated, but not exceeding, 50 feet (15.24 m) apart. Install expansion-joint caps.
   g. Install continuous gutter screens on gutters with noncorrosive fasteners, removable **OR** hinged to swing open, **as directed**, for cleaning gutters.
3. Built-in Gutters: Join sections with riveted and soldered or lapped joints sealed with sealant. Provide for thermal expansion. Slope to downspouts. Provide end closures and seal watertight with sealant.
   a. Install felt underlayment layer in built-in gutter trough and extend to drip edge at eaves and under felt underlayment on roof sheathing. Lap sides a minimum of 2 inches (50 mm) over underlying course. Lap ends a minimum of 4 inches (100 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm). Fasten with roofing nails. Install slip sheet over felt underlayment.
   b. Anchor and loosely lock back edge of gutter to continuous cleat **OR** eave or apron flashing, **as directed**.
   c. Anchor back of gutter that extends onto roof deck with cleats spaced not more than 24 inches (600 mm) apart.
   d. Install gutter with expansion joints at locations indicated, but not exceeding, 50 feet (15.24 m) apart. Install expansion-joint caps.
4. Downspouts: Join sections with 1-1/2-inch (38-mm) telescoping joints.
   a. Provide hangers with fasteners designed to hold downspouts securely to walls. Locate hangers at top and bottom and at approximately 60 inches (1500 mm) o.c. in between.
   b. Provide elbows at base of downspout to direct water away from building.
   c. Connect downspouts to underground drainage system indicated.
5. Splash Pans: Install where downspouts discharge on low-slope roofs. Set in asphalt roofing cement **OR** elastomeric sealant, **as directed**, compatible with roofing membrane.
6. Parapet Scuppers: Install scuppers where indicated through parapet. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
   a. Anchor scupper closure trim flange to exterior wall and solder or seal with elastomeric sealant to scupper.
   b. Loosely lock front edge of scupper with conductor head.

c. Solder or seal with elastomeric sealant exterior wall scupper flanges into back of conductor head.

7. Conductor Heads: Anchor securely to wall with elevation of conductor head rim 1 inch (25 mm) below scupper **OR** gutter, **as directed**, discharge.
8. Expansion-Joint Covers: Install expansion-joint covers at locations and of configuration indicated. Lap joints a minimum of 4 inches (100 mm) in direction of water flow.

D. Roof Flashing Installation
1. General: Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
2. Roof Edge Flashing:
   a. Anchor to resist uplift and outward forces according to recommendations in SMACNA's "Architectural Sheet Metal Manual" and as indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at staggered 3-inch (75-mm) centers.
      OR
      Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49 for specified wind zone and as indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at 24-inch (600-mm) **OR** 16-inch (400-mm), **as directed**, centers.
3. Copings: Anchor to resist uplift and outward forces according to recommendations in SMACNA's "Architectural Sheet Metal Manual" and as indicated.
   a. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate at 24-inch (600-mm) **OR** 16-inch (400-mm), **as directed**, centers.
   b. Anchor interior leg of coping with washers and screw fasteners through slotted holes at 24-inch (600-mm) centers.
4. Copings: Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49 for specified wind zone and as indicated.
   a. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate at 24-inch (600-mm) **OR** 16-inch (400-mm), **as directed**, centers.
   b. Anchor interior leg of coping with screw fasteners and washers at 24-inch (600-mm) **OR** 20-inch (500-mm), **as directed**, centers.
5. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending a minimum of 4 inches (100 mm) over base flashing. Install stainless-steel draw band and tighten.
6. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches (100 mm) over base flashing. Lap counterflashing joints a minimum of 4 inches (100 mm) and bed with sealant. Secure in a waterproof manner by means of snap-in installation and sealant or lead wedges and sealant **OR** interlocking folded seam or blind rivets and sealant **OR** anchor and washer at 36-inch (900-mm) centers, **as directed**.
7. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric **OR** butyl, **as directed**, sealant and clamp flashing to pipes that penetrate roof.

E. Wall Flashing Installation
1. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to SMACNA recommendations and as indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.
2. Through-Wall Flashing: Installation of through-wall flashing is specified in Division 04 Section(s) "Unit Masonry Assemblies" OR "Stone Masonry", **as directed**.
3. Reglets: Installation of reglets is specified in Division 03 Section(s) "Cast-in-place Concrete" OR Division 04 Section(s) "Unit Masonry Assemblies", **as directed**.

4. Opening Flashings in Frame Construction: Install continuous head, sill, jamb, and similar flashings to extend 4 inches (100 mm) beyond wall openings.

F. Miscellaneous Flashing Installation
1. Overhead-Piping Safety Pans: Suspend pans independent from structure above as indicated on Drawings. Pipe and install drain line to plumbing waste or drainage system.
2. Equipment Support Flashing: Coordinate installation of equipment support flashing with installation of roofing and equipment. Weld or seal flashing with elastomeric sealant to equipment support member.

G. Erection Tolerances
1. Installation Tolerances:
a. Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.
OR
Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

H. Cleaning And Protection
1. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
2. Clean and neutralize flux materials. Clean off excess solder.
3. Clean off excess sealants.
4. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of installation, remove unused materials and clean finished surfaces. Maintain in a clean condition during construction.
5. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07620

Task	Specification	Specification Description
07620	01352	No Specification Required
07620	06110	Rough Carpentry

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SECTION 07631 - MANUFACTURED ROOF SPECIALTIES

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for manufactured roof specialties. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Copings.
   b. Roof-edge flashings.
   c. Roof-edge drainage systems.
   d. Reglets and counterflashings.

C. Performance Requirements
1. General Performance: Roof specialties shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
2. FM Approvals' Listing (if Project is FM Global insured or if FM Approvals' requirements set a minimum quality standard): Manufacture and install copings and roof-edge flashings that are listed in FM Approvals' "RoofNav" and approved for windstorm classification, Class 1-60 **OR** Class 1-75 **OR** Class 1-90 **OR** Class 1-105 **OR** Class 1-120, **as directed**. Identify materials with FM Approvals' markings.
3. SPRI Wind Design Standard (if Project is governed by the IBC or if SPRI ES-1 sets a minimum quality standard): Manufacture and install copings and roof-edge flashings tested according to SPRI ES-1 and capable of resisting the following design pressures:
   a. Design Pressure: As indicated on Drawings **OR** As directed.
4. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

D. Submittals
1. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Shop Drawings: For roof specialties. Include plans, elevations, expansion-joint locations, keyed details, and attachments to other work. Distinguish between plant- and field-assembled work. Include the following:
   a. Details for expansion and contraction; locations of expansion joints, including direction of expansion and contraction.
   b. Pattern of seams and layout of fasteners, cleats, clips, and other attachments.
   c. Details of termination points and assemblies, including fixed points.
   d. Details of special conditions.
3. Samples: For copings **OR** roof-edge flashings **OR** roof-edge drainage systems **OR** reglets and counterflashings, **as directed**, made from 12-inch (300-mm) lengths of full-size components including fasteners, cover joints, accessories, and attachments.
4. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for copings and roof-edge flashings.

5. Maintenance Data: For roofing specialties to include in maintenance manuals.
6. Warranty: Sample of special warranty.

E. Quality Assurance
1. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.
2. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof specialties installation.

G. Warranty
1. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.
   a. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
      1) Color fading more than 5 Hunter units when tested according to ASTM D 2244.
      2) Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
      3) Cracking, checking, peeling, or failure of paint to adhere to bare metal.
   b. Finish Warranty Period: 20 **OR** 10, **as directed**, years from date of Substantial Completion.

1.2 PRODUCTS

A. Exposed Metals
1. Copper Sheet: ASTM B 370, cold-rolled copper sheet, H00 or H01 temper.
   a. Non-Patinated Exposed Finish: Mill.
   b. Pre-Patinated Copper-Sheet Finish: Pre-patinated according to ASTM B 882.
2. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer for finish required, with temper to suit forming operations and performance required.
   a. Surface: Smooth, flat **OR** Embossed, **as directed**, finish.
   b. Mill Finish: As manufactured.
   c. Exposed Coil-Coated Finishes: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      1) Two-Coat Fluoropolymer: AAMA 620. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
      2) Three-Coat Fluoropolymer: AAMA 620. System consisting of primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent PVDF resin by weight.
      3) Concealed Surface: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).
   d. Clear Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.
   e. Color Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
3. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), alloy and temper recommended by manufacturer for type of use and finish indicated, finished as follows:
   a. Exposed High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1) Two-Coat Fluoropolymer: AAMA 2604 **OR** AAMA 2605, **as directed**. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
2) Three-Coat Fluoropolymer: AAMA 2605. System consisting of primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent PVDF resin by weight.

b. Clear Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.
c. Color Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

4. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304.
5. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation.
   a. Surface: Smooth, flat **OR** Embossed, **as directed**, finish.
   b. Mill-Phosphatized Finish: Manufacturer's standard for field painting.
   c. Exposed Coil-Coated Finishes: Prepainted by the coil-coating process to comply with ASTM A 755/A 755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      1) Two-Coat Fluoropolymer: AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
      2) Three-Coat Fluoropolymer: AAMA 621. System consisting of primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent PVDF resin by weight.

B. Concealed Metals
1. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy and temper recommended by manufacturer for type of use and structural performance indicated, mill finished.
2. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), alloy and temper recommended by manufacturer for type of use and structural performance indicated, mill finished.
3. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304.
4. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation.

C. Underlayment Materials
1. Felt: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
2. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils (0.76 to 1.0 mm) thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
   a. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F (116 deg C).
   b. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F (29 deg C).
3. Polyethylene Sheet: 6-mil- (0.15-mm-) thick polyethylene sheet complying with ASTM D 4397.
4. Slip Sheet: Building paper, 3-lb/100 sq. ft. (0.16-kg/sq. m) minimum, rosin sized.

D. Miscellaneous Materials
1. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.
2. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to meet performance requirements. Furnish the following unless otherwise indicated:
   a. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.
   b. Fasteners for Copper Sheet: Copper, hardware bronze, or passivated Series 300 stainless steel.
   c. Fasteners for Aluminum: Aluminum or Series 300 stainless steel.
   d. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.

e. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A 153/A 153M or ASTM F 2329.

3. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane **OR** silicone, **as directed**, polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.
4. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
5. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.
6. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.
7. Solder for Copper: ASTM B 32, lead-free solder **OR** Grade Sn50, 50 percent tin and 50 percent lead, **as directed**.

E. Copings

1. Copings: Manufactured coping system consisting of formed-metal coping cap in section lengths not exceeding 12 feet (3.6 m), concealed anchorage; corner units, end cap units, and concealed splice plates with same finish as coping caps.
   a. Coping-Cap Material: Copper, 20 oz./sq. ft. (0.68 mm thick) **OR** weight (thickness) as required to meet performance requirements, **as directed**.
      1) Finish: Non-patinated, mill **OR** Pre-patinated dark brown **OR** Pre-patinated verdigris, **as directed**.

      OR

      Coping-Cap Material: Formed **OR** Extruded, **as directed**, aluminum, 0.040 inch (1.02 mm) thick **OR** 0.050 inch (1.27 mm) thick **OR** 0.063 inch (1.60 mm) thick **OR** 0.080 inch (2.03 mm) thick **OR** 0.125 inch (3.18 mm) thick **OR** thickness as required to meet performance requirements, **as directed**.
      1) Finish: Mill **OR** Two-coat fluoropolymer **OR** Three-coat fluoropolymer **OR** Clear anodic **OR** Color anodic, **as directed**.
      2) Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

      OR

      Coping-Cap Material: Zinc-coated steel, nominal 0.028-inch (0.71-mm) thickness **OR** 0.034-inch (0.86-mm) thickness **OR** thickness as required to meet performance requirements, **as directed**.
      1) Finish: Mill phosphatized for field painting **OR** Two-coat fluoropolymer **OR** Three-coat fluoropolymer, **as directed**.
      2) Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   b. Corners: Factory mitered and soldered **OR** continuously welded **OR** mechanically clinched and sealed watertight, **as directed**.
   c. Special Fabrications: Radiussed sections **OR** Arched sections **OR** Bullnose face leg **OR** Two-way sloped coping cap, **as directed**.
   d. Coping-Cap Attachment Method: Snap-on **OR** Face leg hooked to continuous cleat with back leg fastener exposed, **as directed**, fabricated from coping-cap material.
   e. Snap-on-Coping Anchor Plates: Concealed, galvanized-steel sheet, 12 inches (300 mm) wide, with integral cleats.

      OR

      Face Leg Cleats: Concealed, continuous galvanized-steel sheet **OR** stainless steel, **as directed**.

F. Roof-Edge Flashings

1. Canted Roof-Edge and Fascia **OR** Fascia and Gravel Stop, **as directed**: Manufactured, two-piece, roof-edge fascia consisting of snap-on **OR** compression-clamped, **as directed**, metal fascia cover in section lengths not exceeding 12 feet (3.6 m) and a continuous formed

galvanized-steel sheet cant, 0.028 inch (0.71 mm) thick, minimum, with extended vertical leg terminating in a drip-edge cleat. Provide matching corner units.

a. Fascia Cover: Fabricated from the following exposed metal:
   1) Formed Aluminum: 0.040 inch (1.02 mm) thick **OR** 0.050 inch (1.27 mm) thick **OR** 0.063 inch (1.60 mm) thick **OR** Thickness as required to meet performance requirements, **as directed**.
   2) Extruded Aluminum: 0.080 inch (2.03 mm) thick **OR** Thickness as required to meet performance requirements, **as directed**.
   3) Zinc-Coated Steel: Nominal 0.028-inch (0.71-mm) thickness **OR** 0.034-inch (0.86-mm) thickness **OR** thickness as required to meet performance requirements, **as directed**.
b. Corners: Factory mitered and soldered **OR** continuously welded **OR** mechanically clinched and sealed watertight, **as directed**.
c. Splice Plates: Concealed **OR** Exposed, **as directed**, of same material, finish, and shape as fascia cover.
d. Special Fabrications: Radiussed sections **OR** Arched sections **OR** Bullnose fascia cover **OR** Cornice fascia cover **OR** Cove fascia cover, **as directed**.
e. Fascia Accessories: Fascia extenders with continuous hold-down cleats **OR** Wall cap **OR** Soffit trim **OR** Overflow scuppers **OR** Overflow scuppers with perforated screens **OR** Spillout scuppers **OR** Downspout scuppers with integral conductor head and downspout adapters **OR** Downspout scuppers with integral conductor head and downspout adapters and perforated screens, **as directed**.

2. Roof-Edge Fascia: Manufactured, two-piece, roof-edge fascia consisting of snap-on metal fascia cover in section lengths not exceeding 12 feet (3.6 m) and a continuous formed- or extruded-aluminum anchor bar with integral drip-edge cleat to engage fascia cover. Provide matching corner units.
   a. Fascia Cover: Fabricated from the following exposed metal:
      1) Formed Aluminum: 0.032 inch (0.81 mm) thick **OR** 0.040 inch (1.02 mm) thick **OR** 0.050 inch (1.27 mm) thick **OR** 0.063 inch (1.60 mm) thick **OR** Thickness as required to meet performance requirements, **as directed**.
      2) Zinc-Coated Steel: Nominal 0.028 inch (0.71 mm) thick **OR** 0.034 inch (0.86 mm) thick **OR** thickness as required to meet performance requirements, **as directed**.
   b. Corners: Factory mitered and soldered **OR** continuously welded **OR** mechanically clinched and sealed watertight, **as directed**.
   c. Splice Plates: Concealed **OR** Exposed, **as directed**, of same material, finish, and shape as fascia cover.
   d. Special Fabrications: Radiussed sections **OR** Arched sections **OR** Bullnose fascia cover **OR** Cornice fascia cover **OR** Cove fascia cover, **as directed**.
   e. Fascia Accessories: Fascia extenders with continuous hold-down cleats **OR** Wall cap **OR** Soffit trim **OR** Overflow scuppers **OR** Overflow scuppers with perforated screens **OR** Spillout scuppers **OR** Downspout scuppers with integral conductor head and downspout adapters **OR** Downspout scuppers with integral conductor head and downspout adapters and perforated screens, **as directed**.
3. One-Piece Gravel Stops: Manufactured, one-piece, metal gravel stop in section lengths not exceeding 12 feet (3.6 m), with a horizontal flange and vertical leg, drain-through, **as directed**, fascia terminating in a drip edge, **as directed**, and concealed splice plates of same material, finish, and shape as gravel stop. Provide matching corner units.
   a. Fabricate from the following exposed metal:
      1) Copper: 16 oz./sq. ft. (0.55 mm thick) **OR** Weight (thickness) as required to meet performance requirements, **as directed**.
      2) Formed Aluminum: 0.032 inch (0.81 mm) thick **OR** 0.040 inch (1.02 mm) thick **OR** 0.050 inch (1.27 mm) thick **OR** Thickness as required to meet performance requirements, **as directed**.
      3) Extruded Aluminum: 0.080 inch (2.03 mm) thick **OR** Thickness as required to meet performance requirements, **as directed**.

4) Stainless Steel: 0.025 inch (0.64 mm) thick **OR** Thickness as required to meet performance requirements, **as directed**.
5) Zinc-Coated Steel: Nominal 0.028-inch (0.71-mm) thickness **OR** 0.034-inch (0.86-mm) thickness **OR** thickness as required to meet performance requirements, **as directed**.

b. Corners: Factory mitered and soldered **OR** continuously welded **OR** mechanically clinched and sealed watertight, **as directed**.
c. Accessories: Fascia extenders with continuous hold-down cleats **OR** Wall cap **OR** Soffit trim, **as directed**.

4. Copper Finish: Non-patinated, mill **OR** Pre-patinated dark brown **OR** Pre-patinated verdigris, **as directed**.
5. Aluminum Finish: Mill **OR** Two-coat fluoropolymer **OR** Three-coat fluoropolymer **OR** Clear anodic **OR** Color anodic, **as directed**.
   a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
6. Stainless-Steel Finish: No. 2B (bright, cold rolled) **OR** No. 3 (coarse, polished directional satin) **OR** No. 4 (bright, polished directional satin), **as directed**.
7. Zinc-Coated Steel Finish: Mill phosphatized for field painting **OR** Two-coat fluoropolymer **OR** Three-coat fluoropolymer, **as directed**.
   a. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

G. Roof-Edge Drainage Systems
1. Gutters: Manufactured in uniform section lengths not exceeding 12 feet (3.6 m), with matching corner units, ends, outlet tubes, and other accessories. Elevate back edge at least 1 inch (25 mm) above front edge. Furnish flat-stock gutter straps, gutter brackets, expansion joints, and expansion-joint covers fabricated from same metal as gutters.
   a. Fabricate from the following exposed metal:
      1) Copper: 16 oz./sq. ft. (0.55 mm thick) **OR** 20 oz./sq. ft. (0.68 mm thick), **as directed**.
      2) Formed Aluminum: 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm) **OR** 0.063 inch (1.60 mm), **as directed**, thick.
      3) Zinc-Coated Steel: Nominal 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, thickness.
   b. Gutter Profile: Style A **OR** Style B **OR** Style F **OR** Style G **OR** Style H **OR** Style I **OR** Style K **OR** Style K highback **OR** Half-round single bead **OR** Half-round highback **OR** Quarter round **OR** Ogee **OR** As indicated, **as directed**, according to SMACNA's "Architectural Sheet Metal Manual."
   c. Embossed Surface: Embossed with design as indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   d. Applied Fascia Cover (Concealed Gutter): Exposed, formed copper, 16 oz./sq. ft. (0.55 mm thick) **OR** aluminum, 0.040 inch (1.02 mm) thick, **as directed**, with factory-mitered corners, ends, and concealed splice joints.
   e. Corners: Factory mitered and soldered **OR** continuously welded **OR** mechanically clinched and sealed watertight, **as directed**.
   f. Gutter Supports: Gutter brackets **OR** Straps **OR** Spikes and ferrules **OR** Manufacturer's standard supports as selected by the Owner, **as directed**, with finish matching the gutters.
   g. Special Fabrications: Radiussed sections.
   h. Gutter Accessories: Continuous screened leaf guard with sheet metal frame **OR** Continuous hinged leaf guard of solid metal designed to shed leaves **OR** Continuous snap-in plastic leaf guard **OR** Bronze wire ball downspout strainer **OR** Wire ball downspout strainer **OR** Flat ends **OR** Bullnose ends for half-round gutter, **as directed**.
2. Downspouts: Plain round **OR** Corrugated round **OR** Plain rectangular **OR** Corrugated rectangular **OR** Open-face rectangular, **as directed**, complete with machine-crimped **OR** mitered **OR**

smooth-curve, **as directed**, elbows, manufactured from the following exposed metal. Furnish with metal hangers, from same material as downspouts, and anchors.
a. Copper: 16 oz./sq. ft. (0.55 mm thick).
b. Formed Aluminum: 0.032 inch (0.81 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.050 inch (1.27 mm) **OR** 0.063 inch (1.60 mm), **as directed**, thick.
c. Extruded Aluminum: 0.125 inch (3.18 mm) thick.
d. Zinc-Coated Steel: Nominal 0.028-inch (0.71-mm) **OR** 0.034-inch (0.86-mm), **as directed**, thickness.

3. Parapet Scuppers: Manufactured with closure flange trim to exterior, 4-inch- (100-mm-) wide wall flanges to interior, and base extending 4 inches (100 mm) beyond cant or tapered strip into field of roof. Fasten gravel guard angles to base of scuppers, **as directed**.
a. Fabricate from the following exposed metal:
1) Copper: 16 oz./sq. ft. (0.55 mm thick).
2) Formed Aluminum: 0.032 inch (0.81 mm) thick.
3) Stainless Steel: 0.019 inch (0.48 mm) thick.
4) Zinc-Coated Steel: Nominal 0.028-inch (0.71-mm) thickness.

4. Conductor Heads: Manufactured conductor heads, each with flanged back and stiffened top edge and of dimensions and shape indicated, complete with outlet tube that nests into upper end of downspout, exterior flange trim, **as directed**, and built-in overflow, **as directed**.
a. Fabricate from the following exposed metal:
1) Copper: 16 oz./sq. ft. (0.55 mm thick).
2) Formed Aluminum: 0.032 inch (0.81 mm) thick.
3) Stainless Steel: 0.016 inch (0.40 mm) thick.
4) Zinc-Coated Steel: Nominal 0.028-inch (0.71-mm) thickness.

5. Splash Pans: Fabricate from the following exposed metal:
a. Copper: 16 oz./sq. ft. (0.55 mm thick).
b. Formed Aluminum: 0.040 inch (1.02 mm) thick.
c. Stainless Steel: 0.019 inch (0.48 mm) thick.
d. Zinc-Coated Steel: Nominal 0.028-inch (0.71-mm) thickness.

6. Copper Finish: Non-patinated, mill **OR** Pre-patinated dark brown **OR** Pre-patinated verdigris, **as directed**.

7. Aluminum Finish: Mill **OR** Two-coat fluoropolymer **OR** Three-coat fluoropolymer **OR** Clear anodic **OR** Color anodic, **as directed**.
a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As indicated by manufacturer's designations **OR** As selected from manufacturer's full rang, **as directed**.

8. Stainless-Steel Finish: No. 2B (bright, cold rolled, unpolished) **OR** No. 3 (coarse, polished directional satin) **OR** No. 4 (bright, polished directional satin), **as directed**.

9. Zinc-Coated Steel Finish: Mill phosphatized for field painting **OR** Two-coat fluoropolymer **OR** Three-coat fluoropolymer, **as directed**.
a. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

H. Reglets And Counterflashings
1. Reglets: Manufactured units formed to provide secure interlocking of separate reglet and counterflashing pieces, from the following exposed metal:
a. Copper: 16 oz./sq. ft. (0.55 mm thick).
b. Formed Aluminum: 0.024 inch (0.61 mm) **OR** 0.050 inch (1.27 mm), **as directed**, thick.
c. Stainless Steel: 0.019 inch (0.48 mm) **OR** 0.025 inch (0.64 mm), **as directed**, thick.
d. Zinc-Coated Steel: Nominal 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm), **as directed**, thickness.
e. Corners: Factory mitered and soldered **OR** continuously welded **OR** mechanically clinched and sealed watertight, **as directed**.
f. Surface-Mounted Type: Provide reglets with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.

g. Stucco Type, Embedded: Provide reglets with upturned fastening flange and extension leg of length to match thickness of applied finish materials.
h. Concrete Type, Embedded: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
i. Masonry Type, Embedded: Provide reglets with offset top flange for embedment in masonry mortar joint.
j. Multiuse Type, Embedded: For multiuse embedment in cast-in-place concrete **OR** masonry mortar joints, **as directed**.

2. Counterflashings: Manufactured units of heights to overlap top edges of base flashings by 4 inches (100 mm) and in lengths not exceeding 12 feet (3.6 m) designed to snap into reglets or through-wall-flashing receiver and compress against base flashings with joints lapped, from the following exposed metal:
   a. Copper: 16 oz./sq. ft. (0.55 mm thick).
   b. Formed Aluminum: 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.
   c. Stainless Steel: 0.019 inch (0.48 mm) **OR** 0.025 inch (0.64 mm), **as directed**, thick.
   d. Zinc-Coated Steel: Nominal 0.022-inch (0.56-mm) **OR** 0.028-inch (0.71-mm), **as directed**, thickness.
3. Accessories:
   a. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where reglet is provided separate from metal counterflashing.
   b. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.
4. Copper Finish: Non-patinated, mill **OR** Pre-patinated dark brown **OR** Pre-patinated verdigris, **as directed**.
5. Aluminum Finish: Mill **OR** Two-coat fluoropolymer **OR** Three-coat fluoropolymer **OR** Clear anodic **OR** Color anodic, **as directed**.
   a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
6. Stainless-Steel Finish: No. 2B (bright, cold rolled, unpolished) **OR** No. 3 (coarse, polished directional satin) **OR** No. 4 (bright, polished directional satin), **as directed**.
7. Zinc-Coated Steel Finish: Mill phosphatized for field painting **OR** Two-coat fluoropolymer **OR** Three-coat fluoropolymer, **as directed**.
   a. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

I. General Finish Requirements
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
3. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

1.3 EXECUTION

A. Examination
1. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
2. Examine walls, roof edges, and parapets for suitable conditions for roof specialties.
3. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
4. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Underlayment Installation
   1. Felt Underlayment: Install with adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches (50 mm).
   2. Self-Adhering Sheet Underlayment: Install wrinkle free. Apply primer if required by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures. Apply in shingle fashion to shed water. Overlap edges not less than 3-1/2 inches (90 mm). Roll laps with roller. Cover underlayment within 14 days.
   3. Polyethylene Sheet: Install with adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped and taped joints of not less than 2 inches (50 mm).
   4. Slip Sheet: Install with tape or adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches (50 mm).

C. Installation, General
   1. General: Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete roof-specialty systems.
      a. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
      b. Provide uniform, neat seams with minimum exposure of solder and sealant.
      c. Install roof specialties to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
      d. Torch cutting of roof specialties is not permitted.
      e. Do not use graphite pencils to mark metal surfaces.
   2. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
      a. Coat concealed side of uncoated aluminum and stainless-steel roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
      b. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet **OR** self-adhering, high-temperature sheet underlayment **OR** polyethylene sheet, **as directed**.
      c. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.
   3. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.
      a. Space movement joints at a maximum of 12 feet (3.6 m) with no joints within 18 inches (450 mm) of corners or intersections unless otherwise shown on Drawings.
      b. When ambient temperature at time of installation is between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.
   4. Fastener Sizes: Use fasteners of sizes that will penetrate wood blocking or sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws **OR** substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance, **as directed**.
   5. Seal joints with elastomeric **OR** butyl, **as directed**, sealant as required by roofing-specialty manufacturer.
   6. Seal joints as required for watertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F (4 deg C).
   7. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches (38 mm) except reduce pre-tinning where pre-tinned surface would show in completed Work. Tin edges of uncoated copper sheets using solder for copper. Do not use torches for soldering. Heat surfaces to receive solder and flow

solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

D. Coping Installation
1. Install cleats, anchor plates, and other anchoring and attachment accessories and devices with concealed fasteners.
2. Anchor copings to meet performance requirements.
   a. Interlock face and back leg drip edges of snap-on coping cap into cleated anchor plates anchored to substrate at 30-inch (760-mm) centers **OR** 40-inch (1015-mm) centers **OR** manufacturer's required spacing that meets performance requirements, **as directed**.
   b. Interlock face leg drip edge into continuous cleat anchored to substrate at 24-inch (600-mm) centers **OR** 16-inch (400-mm) centers **OR** manufacturer's required spacing that meets performance requirements, **as directed**. Anchor back leg of coping with screw fasteners and elastomeric washers at 24-inch (600-mm) centers **OR** 16-inch (400-mm) centers **OR** manufacturer's required spacing that meets performance requirements, **as directed**.

E. Roof-Edge Flashing Installation
1. Install cleats, cants, and other anchoring and attachment accessories and devices with concealed fasteners.
2. Anchor roof edgings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.

F. Roof-Edge Drainage-System Installation
1. General: Install components to produce a complete roof-edge drainage system according to manufacturer's written instructions. Coordinate installation of roof perimeter flashing with installation of roof-edge drainage system.
2. Gutters: Join and seal gutter lengths. Allow for thermal expansion. Attach gutters to firmly anchored gutter supports spaced not more than 12 inches (305 mm) **OR** 24 inches (610 mm) **OR** 30 inches (762 mm), **as directed**, apart. Attach ends with rivets and seal with sealant **OR** solder, **as directed**, to make watertight. Slope to downspouts.
   a. Install gutter with expansion joints at locations indicated but not exceeding 50 feet (15.2 m) apart. Install expansion joint caps.
   b. Install continuous leaf guards on gutters with noncorrosive fasteners, removable **OR** hinged to swing open, **as directed**, for cleaning gutters.
3. Downspouts: Join sections with manufacturer's standard telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls and 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1500 mm) o.c.
   a. Provide elbows at base of downspout to direct water away from building.
      OR
      Connect downspouts to underground drainage system indicated.
4. Splash Pans: Install where downspouts discharge on low-slope roofs. Set in asphalt roofing cement **OR** elastomeric sealant, **as directed**.
5. Parapet Scuppers: Install scuppers through parapet where indicated. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
   a. Anchor scupper closure trim flange to exterior wall and seal or solder to scupper.
   b. Loosely lock front edge of scupper with conductor head.
   c. Seal or solder exterior wall scupper flanges into back of conductor head.
6. Conductor Heads: Anchor securely to wall with elevation of conductor top edge 1 inch (25 mm) below scupper **OR** gutter, **as directed**, discharge.

G. Reglet And Counterflashing Installation
1. General: Coordinate installation of reglets and counterflashings with installation of base flashings.

2. Embedded Reglets: See Division 03 Section "Cast-in-place Concrete" and Division 04 Section "Unit Masonry Assemblies" for installation of reglets.
3. Surface-Mounted Reglets: Install reglets to receive flashings where flashing without embedded reglets is indicated on Drawings. Install at height so that inserted counterflashings overlap 4 inches (100 mm) over top edge of base flashings.
4. Counterflashings: Insert counterflashings into reglets or other indicated receivers; ensure that counterflashings overlap 4 inches (100 mm) over top edge of base flashings. Lap counterflashing joints a minimum of 4 inches (100 mm) and bed with elastomeric **OR** butyl, **as directed**, sealant. Fit counterflashings tightly to base flashings.

H. Cleaning And Protection
1. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
2. Clean and neutralize flux materials. Clean off excess solder and sealants.
3. Remove temporary protective coverings and strippable films as roof specialties are installed. On completion of installation, clean finished surfaces including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof specialties in a clean condition during construction.
4. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 07631

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Task	Specification	Specification Description
07631	01352	No Specification Required
07631	05720a	Miscellaneous Ornamental Metals
07631	07620	Sheet Metal Flashing And Trim
07650	01352	No Specification Required
07650	07620	Sheet Metal Flashing And Trim
07660	01352	No Specification Required
07660	07631	Manufactured Roof Specialties

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SECTION 07670 - ROOF ACCESSORIES

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for roof accessories. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
   a. Roof curbs.
   b. Equipment supports.
   c. Roof hatches.
   d. Dropout-type heat and smoke vents.
   e. Hatch-type heat and smoke vents.
   f. Gravity ventilators.
   g. Roof supports.
   h. Roof walkways.
   i. Preformed flashings.

C. Submittals
1. Product Data: For each type of roof accessory indicated.
2. Shop Drawings: Show fabrication and installation details for roof accessories.
3. Samples: For each type of exposed factory-applied color finish required and for each type of roof accessory indicated, prepared on Samples of size to adequately show color.

D. Quality Assurance
1. Sheet Metal Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" details for fabrication of units, including flanges and cap flashing to coordinate with type of roofing indicated.

E. Delivery, Storage, And Handling
1. Pack, handle, and ship roof accessories properly labeled in heavy-duty packaging to prevent damage.

F. Warranty
1. Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace roof accessories that show evidence of deterioration of factory-applied finishes within 20 years from date of Substantial Completion.

1.2 PRODUCTS

A. Metal Materials
1. Galvanized Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coated and mill phosphatized for field painting.
2. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, AZ50 (AZM150) coated.
3. Prepainted, Metallic-Coated Steel Sheet: Steel sheet metallic coated by hot-dip process and prepainted by coil-coating process to comply with ASTM A 755/A 755M.
   a. Galvanized Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coated.
   b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 (Class AZM150) coated.

c. Exposed Finishes: Manufacturer's standard 2-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight.

4. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy and temper recommended by manufacturer for type of use and mill finish. Coil-coat finish as follows:
   a. Factory-Prime Coating: Where painting after installation is indicated, provide pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat; with a minimum dry film thickness of 0.2 mil (0.005 mm).
   b. Clear **OR** Color, **as directed**, Anodic Finish: Architectural Class II, complying with AAMA 611.
      1) Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** Champagne, **as directed**.
   c. Baked-Enamel Finish: Organic Coating: Thermosetting, modified-acrylic enamel primer/topcoat system complying with AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm), medium gloss.
      1) Color and Gloss: As selected from manufacturer's full range.
   d. High-Performance Organic Finish: Manufacturer's standard 2-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight.
      1) Color and Gloss: As selected from manufacturer's full range.
   e. Powder-Coat Finish: Immediately after cleaning and pretreating, electrostatically apply manufacturer's standard baked-polymer thermosetting powder finish.
      1) Color and Gloss: As selected from manufacturer's full range.
5. Stainless-Steel Shapes or Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304 or Type 316, No. 2D finish.
6. Aluminum Extrusions and Tubes: ASTM B 221 (ASTM B 221M), alloy and temper recommended by manufacturer for type of use, mill finished.
7. Steel Shapes: ASTM A 36/A 36M, hot-dip galvanized to comply with ASTM A 123/A 123M, unless otherwise indicated.
8. Steel Tube: ASTM A 500, round tube, baked-enamel finished.
9. Galvanized Steel Tube: ASTM A 500, round tube, hot-dip galvanized to comply with ASTM A 123/A 123M.
10. Galvanized Steel Pipe: ASTM A 53/A 53M.

B. Miscellaneous Materials
1. Acrylic Glazing: ASTM D 4802, thermoformable, monolithic sheet, category as standard with manufacturer, Type UVA (formulated with UV absorber), Finish 1 (smooth or polished).
2. Polycarbonate Glazing: Thermoformable, monolithic polycarbonate sheets manufactured by extrusion process, burglar-resistance rated per UL 972 with an average impact strength of 12 to 16 ft-lbf/in. (640 to 854 J/m) of width when tested according to ASTM D 256, Method A (Izod).
3. Cellulosic-Fiber Board Insulation: ASTM C 208, Type II, Grade 1, 1 inch (25 mm) thick.
4. Glass-Fiber Board Insulation: ASTM C 726, 1 inch (25 mm) thick.
5. Polyisocyanurate Board Insulation: ASTM C 1289, 1 inch (25 mm) thick.
6. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, complying with AWPA C2; not less than 1-1/2 inches (38 mm) thick.
7. Security Grilles: 3/4-inch- (19-mm-) diameter, ASTM A 1011/A 1011M steel bars spaced 6 inches (150 mm) o.c. in 1 direction and 12 inches (300 mm) o.c. in the other; factory primed.
   a. Factory Finish:
      1) Surface Preparation: Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
      2) Factory Priming for Field-Painted Finish: Apply shop primer specified below immediately after surface preparation and pretreatment.
      3) Shop Primer: Manufacturer's or fabricator's standard, fast-curing, lead- and chromate-free, universal primer; selected for resistance to normal atmospheric

corrosion, for compatibility with substrate and field-applied finish paint system indicated, and for capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.

8. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.
9. Polyethylene Sheet: 6-mil- (0.15-mm-) thick, polyethylene sheet complying with ASTM D 4397.
10. Felt: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
    a. Slip Sheet: Rosin-sized paper, minimum 3 lb/100 sq. ft. (0.16 kg/sq. m).
11. Fasteners: Same metal as metals being fastened, or nonmagnetic stainless steel or other noncorrosive metal as recommended by roof accessory manufacturer. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners.
12. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, or PVC; or flat design of foam rubber, sponge neoprene, or cork.
13. Elastomeric Sealant: ASTM C 920, polyurethane **OR** polysulfide **OR** silicone, **as directed**, sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
14. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant, polyisobutylene plasticized, and heavy bodied for hooked-type expansion joints with limited movement.
15. Roofing Cement: ASTM D 4586, nonasbestos, fibrated asphalt cement designed for trowel application or other adhesive compatible with roofing system.

C. Roof Curbs
1. Roof Curbs: Provide metal roof curbs, internally reinforced and capable of supporting superimposed live and dead loads, including equipment loads and other construction to be supported on roof curbs. Fabricate with welded or sealed mechanical corner joints, with integral metal cant, **OR** stepped integral metal cant raised the thickness of roof insulation, **as directed**, and integral formed mounting flange at perimeter bottom. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.
    a. Load Requirements: As required to satisfy local code requirements.
    b. Material:
        1) Galvanized **OR** Aluminum-zinc alloy-coated, **as directed**, steel sheet, 0.052 inch (1.32 mm) **OR** 0.079 inch (2.0 mm), **as directed**, thick.
        2) Aluminum sheet, 0.090 inch (2.28 mm) thick.
        3) Stainless-steel sheet, 0.078 inch (1.98 mm) thick.
    c. Finish:
        1) Prime painted **OR** Baked enamel **OR** High-performance organic coating **OR** Powder coat, **as directed**.
        2) Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
    d. Liner: Same material as curb, of manufacturer's standard thickness and finish.
    e. Factory install wood nailers at tops of curbs.
    f. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
    g. Factory insulate curbs with 1-1/2-inch- (38-mm-) thick, cellulosic-fiber **OR** glass-fiber, **as directed**, board insulation.
    h. Curb height may be determined by adding thickness of roof insulation and minimum base flashing height recommended by roofing membrane manufacturer. Fabricate units to minimum height of 12 inches (300 mm), unless otherwise indicated.
    i. Sloping Roofs: Where slope of roof deck exceeds 1:48, fabricate curb units with water diverter or cricket and with height tapered to match slope to level tops of units.

D. Equipment Supports
1. Equipment Supports: Provide metal equipment supports, internally reinforced and capable of supporting superimposed live and dead loads, including equipment loads and other construction to be supported. Fabricate with welded or sealed mechanical corner joints, with integral metal

cant **OR** stepped integral metal cant raised the thickness of roof insulation, **as directed**, and integral formed mounting flange at perimeter bottom. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

a. Load Requirements: As required to satisfy local code requirements.
b. Material:
   1) Galvanized **OR** Aluminum-zinc alloy-coated, **as directed**, steel sheet, 0.052 inch (1.32 mm) **OR** 0.079 inch (2.0 mm), **as directed**, thick.
   2) Aluminum sheet, 0.090 inch (2.28 mm) thick.
   3) Stainless-steel sheet, 0.078 inch (1.98 mm) thick.
c. Finish:
   1) Prime painted **OR** Baked enamel **OR** High-performance organic coating **OR** Powder coat, **as directed**.
   2) Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
d. Factory-install continuous wood nailers 3-1/2 inches (90 mm) **OR** 5-1/2 inches (140 mm), **as directed**, wide at tops of equipment supports.
e. Metal Counterflashing: Manufacturer's standard removable counterflashing, fabricated of same metal and finish as equipment support.
f. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
g. Fabricate units to minimum height of 12 inches (300 mm), unless otherwise indicated.
h. Sloping Roofs: Where slope of roof deck exceeds 1:48, fabricate curb units with water diverter or cricket and with height tapered to match slope to level tops of units.

E. Roof Hatches

1. Roof Hatches: Fabricate roof hatches with insulated double-wall lids and insulated single-wall **OR** double-wall, **as directed**, curb frame with integral deck mounting flange and lid frame counterflashing. Fabricate with welded or mechanically fastened and sealed corner joints. Provide continuous weathertight perimeter gasketing and equip with corrosion-resistant or hot-dip galvanized hardware.
   a. Loads: Fabricate roof hatches to withstand 40-lbf/sq. ft. (1.9-kPa) external and 20-lbf/sq. ft. (0.95-kPa) internal loads.
   b. Type and Size: Single-leaf lid, 30 by 36 inches (750 by 900 mm) **OR** 30 by 54 inches (750 by 1370 mm) **OR** 30 by 96 inches (750 by 2440 mm), **as directed**.
   c. Type and Size: Double-leaf lid, 72 by 96 inches (1830 by 2440 mm).
   d. Curb and Lid Material:
      1) Galvanized **OR** Aluminum-zinc alloy-coated, **as directed**, steel sheet, 0.079 inch (2.0 mm) thick.
      2) Aluminum sheet, 0.090 inch (2.28 mm) thick.
      3) Stainless-steel sheet, 0.078 inch (1.98 mm) thick.
   e. Finish:
      1) Prime painted **OR** Baked enamel **OR** High-performance organic coating **OR** Powder coat, **as directed**.
      2) Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
   f. Insulation: Cellulosic-fiber **OR** Glass-fiber **OR** Polyisocyanurate, **as directed**, board.
   g. Interior Lid Liner: Manufacturer's standard metal liner of same material and finish as outer metal lid.
   h. Exterior Curb Liner: Manufacturer's standard metal liner of same material and finish as metal curb.
   i. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
   j. Fabricate units to minimum height of 12 inches (300 mm), unless otherwise indicated.
   k. Sloping Roofs: Where slope or roof deck exceeds 1:48, fabricate hatch curbs with height constant **OR** tapered to match slope to level tops of units, **as directed**.
   l. Hardware: Galvanized steel **OR** Stainless-steel, **as directed**, spring latch with turn handles, butt- or pintle-type hinge system, and padlock hasps inside and outside.
      1) Provide 2-point latch on covers larger than 84 inches (2130 mm).
      2) Provide remote-control operation.

m. Ladder Safety Post: Manufacturer's standard ladder safety post. Post to lock in place on full extension. Provide release mechanism to return post to closed position.

n. Safety Railing System: Manufacturer's standard complete system including rails, clamps, fasteners, safety barrier at railing opening, and all accessories required for a complete installation.

F. Heat And Smoke Vents

1. Dropout-Type Heat and Smoke Vents: Manufacturer's standard gravity-operated, automatic smoke and heat vents with integral double-wall insulated curbs and frame with welded or sealed mechanical corner joints, integral condensation gutter, cap flashing, and heat-sensitive dome glazing that will deform and drop out of vent opening within 5 minutes of exposure to a simulated fire represented by a time-temperature gradient that reaches an air temperature of 500 deg F (260 deg C) within 5 minutes.
   a. Loads: Fabricate heat and smoke vents to withstand a minimum 40-lbf/sq. ft. (1.9-kPa) external live load and 30-lbf/sq. ft. (1.4-kPa) uplift.
      1) Dome glazing shall have a thickness capable of resisting 40-lbf/sq. ft. (1.9-kPa) external and 20-lbf/sq. ft. (0.95-kPa) internal loads.
   b. Regulatory Requirements: Comply with UL 793 and NFPA 204.
   c. Heat and Smoke Vent Compliance: Provide units that have been tested and UL listed **OR** FMG approved, **as directed**.
   d. Integral Curb and Framing Material:
      1) Galvanized **OR** Aluminum-zinc alloy-coated, **as directed**, steel sheet, 0.079 inch (2.0 mm) thick.
      2) Aluminum sheet, 0.090 inch (2.28 mm) thick.
      3) Stainless-steel sheet, 0.078 inch (1.98 mm) thick.
   e. Finish:
      1) Prime painted **OR** Baked enamel **OR** High-performance organic coating **OR** Powder coat, **as directed**.
      2) Finish: Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
   f. Insulation: Cellulosic-fiber **OR** Glass-fiber **OR** Polyisocyanurate, **as directed**, board.
   g. Exterior Curb Liner: Manufacturer's standard metal liner of same material and finish as metal curb.
   h. Fabricate integral curbs to minimum height of 12 inches (300 mm), unless otherwise indicated.
   i. Sloping Roofs: Where slope of roof deck exceeds 1:48, fabricate curbs with height constant **OR** tapered to match slope to level tops of units, **as directed**.
   j. Dome Glazing: Single **OR** Double, **as directed,** acrylic **OR** polycarbonate, **as directed**, glazing.
      1) Single-Dome Color: Colorless, transparent **OR** White, translucent **OR** Gray tinted, transparent **OR** Bronze tinted, transparent, **as directed**.
      2) Outer Double-Dome Color: Colorless, transparent **OR** White, translucent **OR** Gray tinted, transparent **OR** Bronze tinted, transparent, **as directed**.
      3) Inner Double-Dome Color: Colorless, transparent **OR** White, translucent **OR** Gray tinted, transparent **OR** Bronze tinted, transparent, **as directed**.

2. Hatch-Type Heat and Smoke Vents: Manufacturer's standard single-leaf **OR** double-leaf, **as directed**, hatch-type heat and smoke vents with integral double-wall insulated curbs and frame, with welded or sealed mechanical corner joints, integral condensation gutter, and cap flashing. Fabricate with insulated double-wall lid, continuous weathertight perimeter lid gaskets, and equip with automatic self-lifting mechanisms, UL-listed fusible links rated at 165 deg F (74 deg C) **OR** fire-suppression system **OR** smoke-detection system, **as directed**, and corrosion-resistant or hot-dip galvanized hardware including hinges, hold-open devices, and independent manual-release devices for inside and outside operation of lids.
   a. Loads: Fabricate heat and smoke vent to withstand a minimum 40-lbf/sq. ft. (1.9-kPa) external live load and 30-lbf/sq. ft. (1.4-kPa) uplift.
      1) When release is actuated, lid shall open against 10-lbf/sq. ft. (0.5-kPa) snow or wind load and lock in position.

b. Regulatory Requirements: UL 793 and NFPA 204.
c. Heat and Smoke Vent Compliance: Provide units that have been tested and UL listed **OR** FMG approved, **as directed**.
d. Fire Resistance of Lids: UL Class A rating.
e. Integral Curb, Framing, and Lid Material:
   1) Galvanized **OR** Aluminum-zinc alloy-coated, **as directed**, steel sheet, 0.079 inch (2.0 mm) thick.
   2) Aluminum sheet, 0.090 inch (2.28 mm) thick.
   3) Stainless-steel sheet, 0.078 inch (1.98 mm) thick.
f. Finish:
   1) Prime painted **OR** Baked enamel **OR** High-performance organic coating **OR** Powder coat, **as directed**.
   2) Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
g. Insulation: Cellulosic-fiber **OR** Glass-fiber **OR** Polyisocyanurate, **as directed**, board.
h. Fabricate integral curbs to minimum height of 12 inches (300 mm), unless otherwise indicated.
i. Sloping Roofs: Where slope of roof deck exceeds 1:48, fabricate curbs with height constant **OR** tapered to match slope to level tops of units, **as directed**.

G. Gravity Ventilators
1. Low-Profile, Cylindrical-Style Gravity Ventilators: Manufacturer's standard unit fabricated from the following materials, with manufacturer's standard welded or sealed mechanical joints:
   a. Provide integral base flange, vent cylinder, cylinder bird screen, and rain cap **OR** hood, **as directed**.
   b. Dimensions: As indicated.
   c. Style: As indicated.
   d. Bird Screens: Manufacturer's standard mesh with rewireable frame.
   e. Insect Screens: Manufacturer's standard mesh with rewireable frame.
   f. Vent Cylinder, Base Flange, and Rain-Cap **OR** Hood, **as directed** Material: Galvanized steel **OR** Aluminum **OR** Stainless-steel, **as directed**, sheet, of manufacturer's standard thickness.
   g. Finish:
      1) Prime painted **OR** Baked enamel **OR** High-performance organic coating **OR** Powder coat, **as directed**.
      2) Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
2. Low-Profile, Louvered Penthouse-Style Gravity Ventilators: Manufacturer's standard unit fabricated from the following materials, with manufacturer's standard welded or sealed mechanical joints:
   a. Provide integral frame with base flange, weathertight cap, louver bird screen, and weatherproof sidewall louvers.
   b. Dimensions: As indicated.
   c. Style: As indicated.
   d. Bird Screens: Manufacturer's standard mesh with rewireable frame.
   e. Insect Screens: Manufacturer's standard mesh with rewireable frame.
   f. Integral Frame, Base Flange, Weathertight Cap, and Louver Material: Galvanized steel **OR** Aluminum **OR** Stainless-steel, **as directed**, sheet, of manufacturer's standard thickness.
   g. Finish:
      1) Prime painted **OR** Baked enamel **OR** High-performance organic coating **OR** Powder coat, **as directed**.
      2) Mill **OR** Clear anodic **OR** Color anodic, **as directed**.
3. Directional Louvered Pedestal-Style Gravity Ventilators: Manufacturer's standard unit fabricated from the following materials, with manufacturer's standard welded or sealed mechanical joints:
   a. Provide integral weathertight base cap, integral outlet duct, weathertight sidewalls, bird screen, and weatherproof sidewall louver.

b. Dimensions: As indicated.
c. Style: As indicated.
d. Bird Screens: Manufacturer's standard mesh with rewireable frame.
e. Insect Screens: Manufacturer's standard mesh with rewireable frame.
f. Weathertight Base Cap, Outlet Duct, Sidewall, and Louver Material: Galvanized steel **OR** Aluminum **OR** Stainless-steel, **as directed**, sheet, of manufacturer's standard thickness.
g. Finish:
1) Prime painted **OR** Baked enamel **OR** High-performance organic coating **OR** Powder coat, **as directed**.
2) Mill **OR** Clear anodic **OR** Color anodic, **as directed**.

4. Turbine-Style Gravity Ventilators: Manufacturer's standard unit fabricated from the following materials, with manufacturer's standard welded or sealed mechanical joints:
a. Provide integral weathertight base cap, outlet duct, and rotating louvered turbine.
b. Dimensions: As indicated.
c. Style: As indicated.
d. Bird Screens: Manufacturer's standard mesh with rewireable frame.
e. Insect Screens: Manufacturer's standard mesh with rewireable frame.
f. Weathertight Base Cap, Outlet Duct, and Turbine Material: Galvanized steel **OR** Aluminum, **as directed**, sheet, of manufacturer's standard thickness.
g. Finish:
1) Prime painted **OR** Baked enamel **OR** High-performance organic coating **OR** Powder coat, **as directed**.
2) Mill **OR** Clear anodic **OR** Color anodic, **as directed**.

H. Roof Supports
1. Pipe Roof Supports: Adjustable height, extruded-aluminum tube, urethane insulation filled, 2 inches (50 mm) in diameter, with aluminum base plates and manufacturer's recommended hardware for mounting to structure **OR** structural roof deck, **as directed**, and extruded-aluminum carrier assemblies, suitable for quantity of pipe runs and sizes, with EPDM end caps. Include manufacturer's standard hardware for mounting to structure or structural roof deck.
a. Pipe Support Height: As indicated.
b. Pipe Roller Assembly: Stainless-steel roller assembly sized for supported pipes with extruded aluminum.
c. Pipe Support Flashing: Insulated **OR** Uninsulated, **as directed**, sleeve flashings with integral base flange, and EPDM grommetted top seal and base seals.
1) Metal: Aluminum sheet, 0.064 inch (1.6 mm) thick **OR** Copper sheet, 16 oz. (0.55 mm) thick, **as directed**.
2. Terrace Lighting Roof Supports: Epoxy-coated hollow structural section steel pipe support, urethane insulation filled, with epoxy-coated steel base plates and manufacturer's recommended hardware for mounting to structure **OR** structural roof deck, **as directed**, 14 inches (356 mm) **OR** 18 inches (457 mm), **as directed**, high, with galvanized threaded cap.
a. Lighting Pole Mounting: Stainless-steel lighting pole adapter **OR** Epoxy-coated steel plate with stainless-steel studs, **as directed**.
b. Pipe Support Flashing: Insulated **OR** Uninsulated, , metal sleeve flashings with integral base flange, and EPDM grommetted top seal and base seals.
1) Metal: Aluminum sheet, 0.064 inch (1.6 mm) thick **OR** Copper sheet, 16 oz. (0.55 mm) thick, **as directed**.
3. Light-Duty Pipe Roof Supports: Extruded-aluminum base assembly and Type 304 stainless-steel roller assembly for pipe sizes indicated, including manufacturer's standard hardware for mounting to structure or structural roof deck.
4. Duct Roof Supports: 2-inch- (50-mm-) diameter, extruded-aluminum, urethane-insulated supports, including manufacturer's standard hardware for mounting to structure or structural roof deck.

I. Roof Walkways

1. Roof Walkway: Multiple C-shaped-channel formed-metal planks, as follows, with upper surface punched in serrated diamond or rectangular shapes to produce raised slip-resistant surface and drainage holes. Provide support framing, brackets, connectors, nosings, and other accessories and components needed for complete installation. Include step units for changes in elevation.
   a. Plank Width: 4-3/4 inches (121 mm) **OR** 7 inches (178 mm) **OR** 9-1/2 inches (241 mm) **OR** 11-3/4 inches (298 mm) **OR** 18-3/4 inches (476 mm) **OR** 24 inches (610 mm) **OR** As indicated, **as directed**.
   b. Walkway Width: As indicated.
   c. Channel Depth: 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 2-1/2 inches (64 mm) **OR** 3 inches (76 mm) **OR** As indicated., **as directed**
   d. Metal Material: -0.079-inch- (2.0-mm-) thick, hot-dip galvanized steel sheet **OR** 0.108-inch- (2.8-mm-) thick, hot-dip galvanized steel sheet **OR** 0.062-inch- (1.6-mm-) thick, stainless-steel sheet **OR** 0.078-inch- (1.98-mm-) thick, stainless-steel sheet **OR** 0.080-inch- (2.03-mm-) thick, mill-finished aluminum sheet **OR** 0.100-inch- (2.5-mm-) thick, mill-finished aluminum sheet, **as directed**.
   e. Provide isolation pads attached to supports so supports are completely isolated from roof membrane surface.

J. Preformed Flashings
1. Exhaust Vent Flashings: Double-wall metal flashing sleeve, urethane insulation filled, with integral deck flange, 12 inches (300 mm) high, with removable metal hood and slotted **OR** perforated, **as directed**, metal collar, and as follows:
   a. Metal: Aluminum sheet, 0.064 inch (1.6 mm) thick, mill finished **OR** Copper sheet, 16 oz. (0.55 mm thick), **as directed**.
   b. Diameter: As indicated.
2. Vent Stack Flashing: Metal flashing sleeve, with integral deck flange, uninsulated, and as follows:
   a. Metal: Aluminum sheet, 0.064 inch (1.6 mm) thick, mill finished **OR** Copper sheet, 16 oz. (0.55 mm thick), **as directed**.
   b. Height: As indicated..
   c. Diameter: As indicated.

1.3 EXECUTION

A. Installation
1. General: Install roof accessories according to manufacturer's written instructions. Anchor roof accessories securely in place and capable of resisting forces specified. Use fasteners, separators, sealants, and other miscellaneous items as required for completing roof accessory installation. Install roof accessories to resist exposure to weather without failing, rattling, leaking, and fastener disengagement.
2. Install roof accessories to fit substrates and to result in watertight performance.
3. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
   a. Coat concealed side of uncoated aluminum **OR** stainless-steel, **as directed**, roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
   b. Underlayment: Where installing exposed-to-view components of roof accessories directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet, or install a course of polyethylene underlayment.
   c. Bed flanges in thick coat of asphalt roofing cement where required by roof accessory manufacturers for waterproof performance.
4. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.

5. Seal joints with elastomeric **OR** butyl, **as directed**, sealant as required by manufacturer of roof accessories.

END OF SECTION 07670

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Task	Specification	Specification Description
07670	01352	No Specification Required
07713	01352	No Specification Required

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SECTION 07714 - ROOF EXPANSION ASSEMBLIES

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for roof expansion assemblies. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Metal-flanged, bellows-type roof expansion assemblies.
b. Aluminum roof expansion assemblies.
c. Seismic roof expansion assemblies.

C. Performance Requirements
1. General: Provide roof expansion assemblies that, when installed, remain watertight within movement limitations specified by manufacturer.

D. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Include plans, elevations, sections, details, joints, splices, locations of joints and splices, intersections, transitions, fittings, and attachments to other work. Where joint assemblies change planes, provide isometric drawings depicting how components interconnect to achieve continuity.
3. Samples: For each type of exposed factory-applied finish required, prepared on Samples of size to adequately show color.
4. Research/Evaluation Reports: For roof expansion assemblies.
5. Warranties: Special warranties specified in this Section.

E. Quality Assurance
1. Fire-Test-Response Characteristics: Provide fire-barrier assemblies with fire-test-response characteristics not less than that of adjacent construction, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Assemblies shall be capable of anticipated movement while maintaining fire rating. Identify assemblies with appropriate markings of applicable testing and inspecting agency.
a. Fire-Resistance Ratings: UL 2079 **OR** ASTM E 119, **as directed**.

F. Warranty
1. Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace roof expansion assemblies that leak, deteriorate in excess of rates specified in manufacturer's published product literature, or otherwise fail to perform within Two years from date of Substantial Completion.
2. Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair or replace components that show evidence of deterioration of factory-applied fluoropolymer finishes within 20 years from date of Substantial Completion.

1.2 PRODUCTS

A. Metals

1. Galvanized Steel Sheet: ASTM A 653/A 653M, hot-dip zinc-coating designation G90 (Z275), stretcher-leveled standard of flatness and either commercial or forming steel, minimum 0.019 inch (0.5 mm) thick.
2. Stainless-Steel Sheet: ASTM A 666, Type 304, stretcher-leveled standard of flatness, minimum 0.015 inch (0.4 mm) thick.
3. Copper Sheet: ASTM B 370, Temper H00 (cold rolled) unless Temper 060 is required for forming, minimum 16 oz./sq. ft. (0.55 mm thick).
4. Sheet Aluminum: ASTM B 209 (ASTM B 209M); Alloy 3003-H14, 5052-H32, or 6061-T6; minimum 0.032 inch (0.8 mm) thick.
5. Extruded Aluminum: ASTM B 221 (ASTM B 221M), Alloy 6063-T5 or 6063-T52, minimum 0.040 inch (1.0 mm) thick.
6. Aluminum Finishes:
   a. Mill Finish: AA-M10 (Mechanical Finish: as fabricated; no other applied finish unless buffing is required to removed scratches, welding, or grinding produced in fabrication process).
   b. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.
   c. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
   d. Class II, Color Anodic Finish: AA-M12C22A32/A34 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, integrally colored or electrolytically deposited color coating 0.010 mm or thicker).
   e. Class I, Color Anodic Finish: AA-M12C22A42/A44 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
      1) Color: As selected from manufacturer's full range.
   f. High-Performance Organic Finish (2-Coat Fluoropolymer): AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coating; Organic Coating: manufacturer's standard 2-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2604 and with coating and resin manufacturers' written instructions.
      1) Color and Gloss: As selected from manufacturer's full range.

B. Miscellaneous Materials
1. Roof Cement: ASTM D 4586, Type II.
2. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane **OR** polysulfide **OR** silicone, **as directed,** polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and to remain watertight.
3. Mineral-Fiber Blanket: ASTM C 665.
4. Flexible Cellular Sponge or Expanded Rubber: ASTM D 1056.
5. Silicone Extrusions: Classified according to ASTM D 2000, UV stabilized, and do not propagate flame.
6. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to withstand design loads.
   a. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.

C. Fire Barriers
1. Fire Barriers: Devices complying with requirements specified in Part 1.1 "Quality Assurance" Article for fire-test-response characteristics and designed for dynamic structural movement

without material degradation or fatigue when tested according to ASTM E 1399. Provide roof expansion assemblies with manufacturer's continuous, standard, flexible fire-barrier seals in back of joint system at locations indicated to provide fire-resistance rating not less than rating of adjacent construction.

D. Bellows-Type Roof Expansion Assemblies
   1. Metal-Flanged, Bellows-Type Roof Expansion Assemblies: Provide manufacturer's standard assemblies of sizes and types indicated, with prefabricated units for corner and joint intersections and horizontal and vertical transitions including those to other building expansion joints, splicing units, adhesives, coatings, and other components as recommended by roof expansion assembly manufacturer for complete installation. Fabricate assemblies specifically for roof-to-roof **OR** roof-to-wall **OR** curb-to-curb **OR** curb-to-wall, **as directed,** applications.
   2. Provide assemblies consisting of exposed polymeric sheet over foam bellows, securely anchored at both edges to 3- to 4-inch- (76- to 100-mm-) wide sheet metal nailing flanges, either flat or angle formed to fit cant or curbs as required. Insulate bellows with closed-cell, flexible rubber or plastic foam not less than 5/16 inch (8 mm) thick; adhere bellows to underside of polymeric sheet.
      a. Polymeric Sheet: Manufacturer's standard **OR** Neoprene, 60 mils (1.5 mm) thick **OR** EPDM, 60 mils (1.5 mm) thick, black **OR** EPDM, 60 mils (1.5 mm) thick, white **OR** Reinforced chlorinated polyethylene, 30 mils (0.8 mm) thick **OR** Chlorosulfonated polyethylene, 36 mils (0.9 mm) thick **OR** Glass-reinforced PVC, 40 to 50 mils (1.0 to 1.3 mm) thick, **as directed**.
      b. Metal Flanges: Zinc-coated (galvanized) steel, minimum 0.019 inch (0.5 mm) thick **OR** Copper, minimum 16 oz./sq. ft. (0.55 mm thick) **OR** Stainless steel, minimum 0.015 inch (0.4 mm) thick **OR** Sheet aluminum, minimum 0.032 inch (0.8 mm) thick, mill finish, **as directed**.
         1) Mortar Flanges: Where flanges will be embedded in concrete or mortar, provide manufacturer's standard perforated-metal mortar flanges.
      c. Moisture Barrier: Manufacturer's standard, flexible, continuous, polymeric moisture barrier looped under roof expansion assemblies at locations indicated. Fill space with blanket-type, mineral-fiber insulation.
      d. Fire Barrier: Provide manufacturer's standard fire barrier.

E. Aluminum Roof Expansion Assemblies
   1. Aluminum Roof Expansion Assemblies: Provide assemblies consisting of aluminum base members with sloped cants and provisions for anchoring and sealing to roofing membrane or flashing in a waterproof-sealed joint. Provide free-to-move, extruded-aluminum cover plate anchored against displacement and waterproofed by integral seals. Provide prefabricated units for corner and joint intersections and horizontal and vertical transitions, including those to other building expansion joints, splicing units, adhesives, coatings, and other components as recommended by roof expansion assembly manufacturer for complete installation. Fabricate assemblies specifically for curb-to-curb **OR** wall, **as directed,** applications.
      a. Base Frame Members: Extruded aluminum with mill **OR** anodic **OR** high-performance organic, **as directed,** finish.
      b. Extruded-Aluminum Covers: Minimum 0.080 inch (2.03 mm) **OR** 0.125 inch (3 mm), **as directed,** thick, with mill **OR** clear anodic **OR** color anodic **OR** high-performance organic, **as directed,** finish.
      c. Formed-Aluminum Covers: Minimum 0.078 inch (2 mm) thick, with mill **OR** clear anodic **OR** color anodic **OR** high-performance organic, **as directed,** finish.
      d. Moisture Barrier:
         1) Semiconcealed, captive, polymeric sheet bellows unit of neoprene, EPDM, reinforced chlorinated polyethylene, or PVC, not less than 30 mils (0.8 mm) thick.
         2) Semiconcealed, captive gaskets at both curb members, of neoprene, EPDM, or PVC, with spring-loaded mechanism to maintain positive pressure between gaskets and curb cap.
      e. Fire Barrier: Provide manufacturer's standard fire barrier.

F. Seismic Roof Expansion Assemblies
1. General: Provide manufacturer's assemblies designed to accommodate seismic movement. Provide prefabricated units for corner and joint intersections and horizontal and vertical transitions including those to other building expansion joints, splicing units, inner seals, adhesives, coatings, and other components as recommended by roof expansion assembly manufacturer for complete installation. Fabricate assemblies specifically for roof-to-roof **OR** roof-to-wall **OR** curb-mounted, **as directed,** applications.
2. Extruded Seals: Two continuous, single-layered elastomeric profiles made of a vinyl inner seal and silicone **OR** neoprene **OR** Santoprene, **as directed,** outer seal, both seals retained in a pair of compatible extruded-aluminum frames.
   a. Exterior Seal Color: As selected from manufacturer's full range.
3. Aluminum Roof Expansion Assemblies: Assemblies consisting of pairs of aluminum curb units with sloped cants and provisions for anchoring and sealing to roofing membrane or flashing in a waterproof-sealed joint. Provide free-to-move, extruded-aluminum curb cap anchored against displacement and waterproofed by integral seals, with interior of expansion joint filled with blanket-type mineral-fiber insulation.
   a. Base Frame Members: Extruded aluminum with mill **OR** clear anodic **OR** color anodic **OR** high-performance organic, **as directed,** finish.
   b. Extruded-Aluminum Covers: Minimum 0.080 inch (2.03 mm) **OR** 0.125 inch (3 mm), **as directed,** thick, with mill **OR** clear anodic **OR** color anodic **OR** high-performance organic, **as directed,** finish.
   c. Formed-Aluminum Covers: Minimum 0.078 inch (2 mm) thick, with mill **OR** clear anodic **OR** color anodic **OR** high-performance organic, **as directed,** finish.
   d. Moisture Barrier:
      1) Semiconcealed, captive, polymeric sheet bellows unit of neoprene, EPDM, reinforced chlorinated polyethylene, or PVC, not less than 30 mils (0.8 mm) thick.
      2) Semiconcealed, captive gaskets at both curb members, of neoprene, EPDM, or PVC, with spring-loaded mechanism to maintain positive pressure between gaskets and curb cap.
   e. Fire Barrier: Provide manufacturer's standard fire barrier.

1.3 EXECUTION

A. Installation
1. Comply with manufacturer's written instructions for handling and installing roof expansion assemblies and materials unless more stringent requirements are indicated.
2. Coordinate installation of roof expansion assembly materials and associated work so complete assemblies comply with assembly performance requirements.
3. Install fire barriers to provide continuous, uninterrupted fire resistance throughout length of roof expansion assembly, including transitions and end joints.
4. Extend roof expansion assemblies over curbs, parapets, cornices, gutters, valleys, fasciae, and other elements in the construction profile, with factory-fabricated intersections and transitions to provide continuous, uninterrupted, waterproof roof expansion assemblies.
   a. Install factory-fabricated transitions between roof expansion assemblies and building architectural joint systems, specified in Division 05 Section "Architectural Joint Systems", to provide continuous, uninterrupted, watertight construction.
5. Splice roof expansion assemblies with materials provided by roof expansion assembly manufacturer for this purpose, according to manufacturer's written instructions, to provide continuous, uninterrupted, waterproof roof expansion assemblies.
6. Provide uniform profile of roof expansion assembly throughout length of each installation; do not stretch polymeric sheets.
7. Install mineral-fiber blanket insulation to fill joint space within joint and moisture barrier.
8. Bed anchorage flanges in cement or sealant recommended by manufacturer and securely nail to curbs and cant strips as recommended by manufacturer but not less than 6 inches (150 mm) o.c.

9. Anchor roof expansion assemblies complying with manufacturer's written instructions.
10. Embed flanges not less than 4 inches (100 mm) in bituminous membranes, with hot bitumen or roof cement. Cover with stripping material and install according to requirements in roofing section.
11. On single-ply roofing, install roof expansion assemblies complying with manufacturer's written instructions. Anchor to cants or curbs and seal to membrane with sealant compatible with roofing membrane and roof expansion assembly. Cover flanges with stripping or flashing and install according to requirements in roofing section.

B. Protection
1. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensures that roof expansion assemblies are without damage or deterioration at time of Substantial Completion.

END OF SECTION 07714

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Task	Specification	Specification Description
07714	05805	Architectural Joint Systems
07720	07620	Sheet Metal Flashing And Trim
07721	07310	Asphalt Shingles
07721	07670	Roof Accessories
07730	07670	Roof Accessories
07740	07670	Roof Accessories
07750	01352	No Specification Required
07760	07212	Built-Up Asphalt Roofing
07760	07212a	Built-Up Coal-Tar Roofing
07760	07212b	EPDM Membrane Roofing
07760	07212c	CSPE Membrane Roofing
07760	07212d	APP-Modified Bituminous Membrane Roofing
07760	07212e	SBS-Modified Bituminous Membrane Roofing
07760	07213	Fluid-Applied Protected Membrane Roofing

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SECTION 07810 - SPRAYED FIRE-RESISTIVE MATERIALS

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for sprayed fire-resistive materials. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
   a. Concealed SFRM.
   b. Exposed SFRM.
   c. Exposed intumescent mastic fire-resistive coatings.

C. Definitions
1. SFRM: Sprayed fire-resistive material.
2. Concealed: Fire-resistive materials applied to surfaces that are concealed from view behind other construction when the Work is completed and have not been defined as exposed, **as directed**.
3. Exposed: Fire-resistive materials applied to surfaces that are exposed to view when the Work is completed, that are accessible through suspended ceilings **OR** that are in elevator shafts and machine rooms **OR** that are in mechanical rooms **OR** that are in air-handling plenums **OR** and that are identified as exposed on Drawings, **as directed**.

D. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Show extent of sprayed fire-resistive material for each construction and fire-resistance rating, applicable fire-resistive design designations of a qualified testing and inspecting agency acceptable to authorities having jurisdiction, and minimum thicknesses.
3. Product certificates **OR** test reports, **as directed**.
4. Compatibility and adhesion test reports.
5. Research/evaluation reports.
6. Field quality-control test and special inspection, **as directed**, reports.

E. Quality Assurance
1. Installer Qualifications: A qualified installer approved by SFRM manufacturer to install manufacturer's products. A manufacturer's willingness to sell its SFRM to Contractor or to an installer engaged by Contractor does not in itself confer qualification on the buyer.
2. SFRM Testing: By a qualified testing and inspecting agency engaged by Contractor or manufacturer to test for compliance with specified requirements for performance and test methods.
   a. SFRMs are randomly selected for testing from bags bearing the applicable classification marking of UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
   b. Testing is performed on specimens of SFRMs that comply with laboratory testing requirements specified in Part 2 and are otherwise identical to installed fire-resistive materials, including application of accelerant, sealers, topcoats, tamping, troweling, rolling, and water overspray, if any of these are used in final application.
   c. Testing is performed on specimens whose application the independent testing and inspecting agency witnessed during preparation and conditioning. Include in test reports a full description of preparation and conditioning of laboratory test specimens.

3. Compatibility and Adhesion Testing: Engage a qualified testing and inspecting agency to test for compliance with requirements for specified performance and test methods.
   a. Test for bond per ASTM E 736 and requirements in UL's "Fire Resistance Directory" for coating materials. Provide bond strength indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.
   b. Verify that manufacturer, through its own laboratory testing or field experience, has not found primers or coatings to be incompatible with SFRM.
4. Fire-Test-Response Characteristics: Where indicated, provide products identical to those tested for fire resistance per ASTM E 119 by a testing agency acceptable to authorities having jurisdiction.
   a. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.
   b. Identify products with appropriate markings of applicable testing and inspecting agency.
5. Provide products containing no detectable asbestos as determined according to the method specified in 40 CFR 763, Subpart E, Appendix E, Section 1, "Polarized Light Microscopy."
6. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Deliver products to Project site in original, unopened packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, shelf life if applicable, and fire-resistance ratings applicable to Project.
2. Use materials with limited shelf life within period indicated. Remove from Project site and discard materials whose shelf life has expired.
3. Store materials inside, under cover, and aboveground; keep dry until ready for use. Remove from Project site and discard wet or deteriorated materials.

G. Project Conditions
1. Environmental Limitations: Do not apply SFRM when ambient or substrate temperature is 40 deg F (4 deg C) or lower unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours before, during, and for 24 hours after product application.
2. Ventilation: Ventilate building spaces during and after application of SFRM. Use natural means or, if they are inadequate, forced-air circulation until fire-resistive material dries thoroughly.

H. Warranty
1. Special Warranty: Manufacturer's standard form, signed by Contractor and by Installer, in which manufacturer agrees to repair or replace SFRMs that fail in materials or workmanship within two years from date of Substantial Completion.

1.2 PRODUCTS

A. Concealed SFRM
1. Material Composition: Manufacturer's standard product, as follows **OR** either of the following, **as directed**:
   a. Concealed Cementitious SFRM: Factory-mixed, dry formulation of gypsum or portland cement binders, additives, and lightweight mineral or synthetic aggregates mixed with water at Project site to form a slurry or mortar for conveyance and application.
   b. Concealed Sprayed-Fiber Fire-Resistive Material: Factory-mixed, dry formulation of inorganic binders, mineral fibers, fillers, and additives conveyed in a dry state by pneumatic equipment and mixed with water at spray nozzle to form a damp, as-applied product.
2. Physical Properties: Minimum values, unless otherwise indicated, or higher values required to attain designated fire-resistance ratings, measured per standard test methods referenced with each property as follows:

a. Dry Density: 15 lb/cu. ft. (240 kg/cu. m) for average and individual densities, or greater if required to attain fire-resistance ratings indicated, per ASTM E 605 or AWCI Technical Manual 12-A, Section 5.4.5, "Displacement Method."
b. Thickness: Minimum average thickness required for fire-resistance design indicated according to the following criteria, but not less than 0.375 inch (9 mm), per ASTM E 605:
   1) Where the referenced fire-resistance design lists a thickness of 1 inch (25 mm) or more, the minimum allowable individual thickness of SFRM is the design thickness minus 0.25 inch (6 mm).
   2) Where the referenced fire-resistance design lists a thickness of less than 1 inch (25 mm) but more than 0.375 inch (9 mm), the minimum allowable individual thickness of SFRM is the greater of 0.375 inch (9 mm) or 75 percent of the design thickness.
   3) No reduction in average thickness is permitted for those fire-resistance designs whose fire-resistance ratings were established at densities of less than 15 lb/cu. ft. (240 kg/cu. m).
c. Bond Strength: 150 lbf/sq. ft. (7.2 kPa) minimum per ASTM E 736 based on laboratory testing of 0.75-inch (19-mm) minimum thickness of SFRM.
d. Compressive Strength: 5.21 lbf/sq. in. (35.9 kPa) minimum per ASTM E 761. Minimum thickness of SFRM tested shall be 0.75 inch (19 mm) and minimum dry density shall be as specified but not less than 15 lb/cu. ft. (240 kg/cu. m).
e. Corrosion Resistance: No evidence of corrosion per ASTM E 937.
f. Deflection: No cracking, spalling, or delamination per ASTM E 759.
g. Effect of Impact on Bonding: No cracking, spalling, or delamination per ASTM E 760.
h. Air Erosion: Maximum weight loss of 0.025 g/sq. ft. (0.270 g/sq. m) in 24 hours per ASTM E 859. For laboratory tests, minimum thickness of SFRM is 0.75 inch (19 mm), maximum dry density is 15 lb/cu. ft. (240 kg/cu. m), test specimens are not prepurged by mechanically induced air velocities, and tests are terminated after 24 hours.
i. Fire-Test-Response Characteristics: Provide SFRM with the following surface-burning characteristics as determined by testing identical products per ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
   1) Flame-Spread Index: 10 or less.
   2) Smoke-Developed Index: 0.
j. Fungal Resistance: No observed growth on specimens per ASTM G 21.

B. Exposed SFRM
1. Material Composition: Manufacturer's standard product, as follows:
   a. Exposed Cementitious SFRM: Factory-mixed, dry, cement aggregate formulation; or chloride-free formulation of gypsum or portland cement binders, additives, and inorganic aggregates mixed with water at Project site to form a slurry or mortar for conveyance and application.
   b. Exposed Sprayed-Fiber Fire-Resistive Material: Factory-mixed, dry formulation of inorganic binders, mineral fibers, fillers, and additives conveyed in a dry state by pneumatic equipment and mixed with water at spray nozzle to form a damp, as-applied product.
2. Physical Properties: Minimum values, unless otherwise indicated, or higher values required to attain designated fire-resistance ratings, measured per standard test methods referenced with each property as follows:
   a. Dry Density: Values for average and individual densities as required for fire-resistance ratings indicated, per ASTM E 605 or AWCI Technical Manual 12-A, Section 5.4.5, "Displacement Method," but with an average density of not less than 22 lb/cu. ft. (352 kg/cu. m).
   b. Bond Strength: 434 lbf/sq. ft. (21 kPa) minimum per ASTM E 736.
   c. Compressive Strength: 51 lbf/sq. in. (351 kPa) minimum per ASTM E 761.
   d. Dry Density: Values for average and individual densities as required for fire-resistance ratings indicated, per ASTM E 605 or AWCI Technical Manual 12-A, Section 5.4.5, "Displacement Method," but with an average density of not less than 39 lb/cu. ft. (625 kg/cu. m).
   e. Bond Strength: 1000 lbf/sq. ft. (48 kPa) minimum per ASTM E 736.

f. Compressive Strength: 300 lbf/sq. in. (2067 kPa) minimum per ASTM E 761.
g. Corrosion Resistance: No evidence of corrosion per ASTM E 937.
h. Deflection: No cracking, spalling, or delamination per ASTM E 759.
i. Effect of Impact on Bonding: No cracking, spalling, or delamination per ASTM E 760.
j. Air Erosion: Maximum weight loss of 0.025 g/sq. ft. (0.270 g/sq. m) per ASTM E 859.
k. Combustion Characteristics: Passes ASTM E 136.
l. Fire-Test-Response Characteristics: Provide SFRM with the following surface-burning characteristics as determined by testing identical products per ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
   1) Flame-Spread Index: 10 or less.
   2) Smoke-Developed Index: 0.
m. Fungal Resistance: No observed growth on specimens per ASTM G 21.
n. For exterior applications of SFRM, provide formulation listed and labeled by testing and inspecting agency acceptable to authorities having jurisdiction for surfaces exposed to exterior.

C. Exposed Intumescent Mastic Fire-Resistive Coatings
1. Fire-Resistive, Intumescent Mastic Coating: Factory-mixed formulation.
   a. Water-Based Formulation: Approved by manufacturer and authorities having jurisdiction and investigated for Interior General **OR** Conditioned Interior Space, **as directed**, Purpose by UL.
   b. Non-Water-Based Formulation: Approved by manufacturer and UL or another testing and inspecting agency acceptable to authorities having jurisdiction and investigated for Interior General Purpose by UL **OR** investigated for Interior General Purpose and Exterior Use by UL **OR** tested per ASTM E 1529 **OR** tested per UL 1709, **as directed**.
   c. Multicomponent system consisting of intumescent base coat and topcoat.
2. Color and Gloss: As selected from manufacturer's full range.

D. Auxiliary Fire-Resistive Materials
1. General: Provide auxiliary fire-resistive materials that are compatible with SFRM and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.
2. Substrate Primers: For use on each substrate and with each sprayed fire-resistive product, provide primer that complies with one or more of the following requirements:
   a. Primer's bond strength complies with requirements specified in UL's "Fire Resistance Directory" for coating materials based on a series of bond tests per ASTM E 736.
   b. Primer is identical to those used in assemblies tested for fire-test-response characteristics of SFRM per ASTM E 119 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
3. Adhesive for Bonding Fire-Resistive Material: Product approved by manufacturer of SFRM.
4. Metal Lath: Expanded metal lath fabricated from material of weight, configuration, and finish required to comply with fire-resistance designs indicated and fire-resistive material manufacturer's written recommendations. Include clips, lathing accessories, corner beads, and other anchorage devices required to attach lath to substrates and to receive SFRM.
5. Reinforcing Fabric: Glass- or carbon-fiber fabric of type, weight, and form required to comply with fire-resistance designs indicated; approved and provided by manufacturer of SFRM.
6. Reinforcing Mesh: Metallic mesh reinforcement of type, weight, and form required to comply with fire-resistance designs indicated; approved and provided by manufacturer of intumescent mastic coating fire-resistive material. Include pins and attachment.
7. Sealer for Sprayed-Fiber Fire-Resistive Material: Transparent-drying, water-dispersible, tinted protective coating recommended in writing by manufacturer of sprayed-fiber fire-resistive material.
8. Topcoat: Type recommended in writing by manufacturer of each SFRM for application over concealed **OR** exposed, **as directed**, SFRM.

9. Cement-Based Topcoat: Factory-mixed, cementitious hardcoat formulation recommended in writing by manufacturer of SFRM for trowel or spray application over concealed **OR** exposed, **as directed**, SFRM.
10. Veneer-Plaster Topcoat: Factory-mixed formulation of a latex-modified, portland cement-based veneer plaster recommended in writing by manufacturer of SFRM for trowel or spray application over concealed **OR** exposed, **as directed**, SFRM.
11. Water-Based Permeable Topcoat: Factory-mixed formulation recommended in writing by manufacturer of SFRM for brush, roller, or spray application over concealed **OR** exposed, **as directed**, SFRM. Provide application at a rate of 120 sq. ft./gal. (3 sq. m/L) **OR** 60 sq. ft./gal. (1.5 sq. m/L) **OR** 30 sq. ft./gal. (0.75 sq. m/L), **as directed**.

1.3 EXECUTION

A. Preparation
1. Cover other work subject to damage from fallout or overspray of fire-resistive materials during application.
2. Clean substrates of substances that could impair bond of fire-resistive material, including dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, and incompatible primers, paints, and encapsulants.
3. Prime substrates where recommended in writing by SFRM manufacturer unless compatible shop primer has been applied and is in satisfactory condition to receive SFRM.
4. For exposed applications, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in finished surface of SFRM. Remove minor projections and fill voids that would telegraph through fire-resistive products after application.

B. Application, General
1. Comply with fire-resistive material manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and spray on fire-resistive material, as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.
2. Apply SFRM that is identical to products tested as specified in Part 1.1 "Quality Assurance" Article and substantiated by test reports, with respect to rate of application, accelerator use, sealers, topcoats, tamping, troweling, water overspray, or other materials and procedures affecting test results.
3. Install metal lath and reinforcing fabric, as required, to comply with fire-resistance ratings and fire-resistive material manufacturer's written recommendations for conditions of exposure and intended use. Securely attach lath and fabric, as required, to substrate in position required for support and reinforcement of fire-resistive material. Use anchorage devices of type recommended in writing by SFRM manufacturer. Attach accessories where indicated or required for secure attachment of lath and fabric, as required, to substrate.
4. Coat substrates with bonding adhesive before applying fire-resistive material where required to achieve fire-resistance rating or as recommended in writing by SFRM manufacturer for material and application indicated.
5. Extend fire-resistive material in full thickness over entire area of each substrate to be protected. Unless otherwise recommended in writing by SFRM manufacturer, install body of fire-resistive covering in a single course.
6. Spray apply fire-resistive materials to maximum extent possible. Following the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by SFRM manufacturer.
7. For applications over encapsulant materials, including lockdown (post-removal) encapsulants, apply SFRM that differs in color from that of encapsulant over which it is applied.
8. Where sealers are used, apply products that are tinted to differentiate them from SFRM over which they are applied.

C. Application, Concealed SFRM

1. Apply concealed SFRM in thicknesses and densities not less than those required to achieve fire-resistance ratings designated for each condition, but apply in greater thicknesses and densities if specified in Part 1.2 "Concealed SFRM" Article.
2. Apply water overspray to concealed sprayed-fiber fire-resistive material as required to obtain designated fire-resistance rating and where indicated.
3. Cure concealed SFRM according to product manufacturer's written recommendations.
4. Apply sealer to concealed SFRM where indicated.
5. Apply topcoat to concealed SFRM where indicated.

D. Application, Exposed SFRM
1. Apply exposed SFRM in thicknesses and densities not less than those required to achieve fire-resistance ratings designated for each condition, but apply in greater thicknesses and densities if indicated.
   a. For steel beams and bracing, provide a thickness of not less than 1 inch (25 mm).
   b. For metal floor or roof decks, provide a thickness of not less than 1/2 inch (13 mm).
2. Provide a uniform finish complying with description indicated for each type of material and matching the Owner's sample or, if none, finish approved for field-erected mockup.
3. Apply exposed cementitious SFRM to produce the following finish:
   a. Spray-textured finish with no further treatment.
   b. Even, spray-textured finish, produced by rolling flat surfaces of fire-protected members with a damp paint roller to remove drippings and excessive roughness.
   c. Skip-troweled finish with leveled surface, smoothed-out texture, and neat edges.
   d. Smooth, troweled finish with surface markings eliminated and edges squared.
4. Apply exposed sprayed-fiber fire-resistive material to produce the following finish:
   a. Spray-textured finish.
   b. Sealer where indicated.
   c. Topcoat where indicated\.
5. Cure exposed SFRM according to product manufacturer's written recommendations.

E. Application, Exposed Intumescent Mastic Fire-Resistive Coatings
1. Apply exposed intumescent mastic fire-resistive coatings in thicknesses and densities not less than those required to achieve fire-resistance ratings designated for each condition.
2. Apply intumescent mastic fire-resistive coating as follows:
   a. Install reinforcing fabric as required to obtain designated fire-resistance rating and where indicated.
   b. Finish: Spray-textured finish with no further treatment.
   c. Finish: Even, spray-textured finish produced by lightly rolling flat surfaces of fire-protected members before fire-resistive material dries, to smooth out surface irregularities and to seal in surface fibers.

F. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
   a. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.
2. Tests and Inspections: Testing and inspecting of completed applications of SFRM shall take place in successive stages, in areas of extent and using methods as follows. Do not proceed with application of SFRM for the next area until test results for previously completed applications of SFRM show compliance with requirements. Tested values must equal or exceed values indicated and required for approved fire-resistance design.
   a. Thickness for Floor, Roof, and Wall Assemblies: For each 1000-sq. ft. (93-sq. m) area, or partial area, on each floor, from the average of 4 measurements from a 144-sq. in. (0.093-sq. m) sample area, with sample width of not less than 6 inches (152 mm) per ASTM E 605.

b. Thickness for Structural Frame Members: From a sample of 25 percent of structural members per floor, taking 9 measurements at a single cross section for structural frame beams or girders, 7 measurements of a single cross section for joists and trusses, and 12 measurements of a single cross section for columns per ASTM E 605.

c. Density for Floors, Roofs, Walls, and Structural Frame Members: At frequency and from sample size indicated for determining thickness of each type of construction and structural framing member, per ASTM E 605 or AWCI Technical Manual 12-A, Section 5.4.5, "Displacement Method."

d. Bond Strength for Floors, Roofs, Walls, and Structural Framing Members: For each 10,000-sq. ft. (929 sq. m) area, or partial area, on each floor, cohesion and adhesion from one sample of size indicated for determining thickness of each type of construction and structural framing member, per ASTM E 736.

1) Field test SFRM that is applied to flanges of wide-flange, structural-steel members on surfaces matching those that will exist for remainder of steel receiving fire-resistive material.

2) If surfaces of structural steel receiving SFRM are primed or otherwise painted for coating materials, perform series of bond tests specified in UL's "Fire Resistance Directory." Provide bond strength indicated in referenced UL fire-resistance criteria, but not less than 150 lbf/sq. ft. (7.2 kPa) minimum per ASTM E 736.

e. If testing finds applications of SFRM are not in compliance with requirements, testing and inspecting agency will perform additional random testing to determine extent of noncompliance.

3. Remove and replace applications of SFRM that do not pass tests and inspections for cohesion and adhesion, for density, or for both and retest as specified above.

4. Apply additional SFRM, per manufacturer's written instructions, where test results indicate that thickness does not comply with specified requirements, and retest as specified above.

G. Cleaning, Protecting, And Repair

1. Cleaning: Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.

2. Protect SFRM, according to advice of product manufacturer and Installer, from damage resulting from construction operations or other causes so fire protection will be without damage or deterioration at time of Substantial Completion.

3. Coordinate application of SFRM with other construction to minimize need to cut or remove fire protection. As installation of other construction proceeds, inspect SFRM and patch any damaged or removed areas.

4. Repair or replace work that has not successfully protected steel.

END OF SECTION 07810

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SECTION 07820 - BOARD FIRE PROTECTION

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for board fire protection. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Calcium silicate board fire protection.
b. Mineral-fiber board fire protection.

C. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Structural framing plans indicating the following:
a. Locations and types of surface preparations required before applying board fire protection.
b. Extent of board fire protection for each construction and fire-resistance rating, including the following:
1) Applicable fire-resistance design designations of a qualified testing and inspecting agency acceptable to authorities having jurisdiction.
a) For steel joist assemblies, include applicable fire-resistance design designations, with each steel joist tested with same maximum tensile stress as each steel joist indicated on Drawings **OR** in a schedule, **as directed**. Design designations with steel joists tested at lower maximum tensile stress than those indicated are not permitted.
2) Minimum thicknesses needed to achieve required fire-resistance ratings of structural components and assemblies.
3) Treatment of sprayed fire-resistive material after application.
3. Product Certificates: For each type of board fire protection, from manufacturer.
4. Research/Evaluation Reports: For board fire protection.

D. Quality Assurance
1. Source Limitations: Obtain board fire-protection materials from single source from single manufacturer.
2. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" **OR** UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency, **as directed**, acceptable to authorities having jurisdiction, for board fireproofing serving as direct-applied protection tested per ASTM E 119.

E. Coordination
1. Coordinate installation of board fire protection with other construction specified in other Sections.
a. Do not install board fire protection on structural members until piping and other construction behind fire-resistive materials have been completed, uninterrupted coverage of fire-resistive materials can be provided, and the need for subsequent cutting and patching of fire-resistive materials has been eliminated.
b. Do not install enclosing or concealing construction until after board fire protection has been applied and inspected by authorities having jurisdiction.

1.2 PRODUCTS

A. Board Fire Protection
1. Calcium Silicate Board: Rigid board containing no asbestos and consisting primarily of lime, silica, inert fillers, and cellulosic reinforcing fibers; of thickness required to produce fire-resistance rating indicated; with flame-spread and smoke-developed indexes of zero per ASTM E 84; passing ASTM E 136 for combustion characteristics.
a. Finish: Sanded finish on both sides **OR** one side, **as directed**.
2. Mineral-Fiber Board: Unfaced **OR** Foil-faced **OR** Fiberglass mat-faced, **as directed**, rigid board produced by combining slag-wool-/rock-wool fibers with thermosetting resin binders passing ASTM E 136 for combustion characteristics; of thickness required to produce fire-resistance rating indicated.
a. Maximum Density: 8 lb/cu. ft. (128 kg/cu. m) **OR** 10 lb/cu. ft. (160 kg/cu. m) **OR** 12 lb/cu. ft. (192 kg/cu. m), **as directed**, per ASTM C 612.
b. Surface-Burning Characteristics: Flame-spread and smoke-developed indexes of 15 **OR** zero, **as directed**, and 5 **OR** zero, **as directed**, respectively, per ASTM E 84.

B. Accessories
1. Anchorage Accessories: Provide manufacturer's standard board-anchorage components complying with related design of UL or of another testing and inspecting agency acceptable to authorities having jurisdiction.
2. Joint Treatment and Finishing Materials: For exposed calcium silicate board applications, provide joint treatment tape and joint compounds recommended in writing by board manufacturer for finishing surfaces.

1.3 EXECUTION

A. Preparation
1. Remove rust and scale from steel substrates at welded steel stud anchorage locations.

B. Installation
1. Install board fire protection according to manufacturer's written instructions.
2. Install board fire protection to comply with requirements for layer thicknesses and number, construction of joints and corners, and anchorage methods applicable to fire-resistance-rated assemblies indicated.
3. Finish exposed calcium silicate board to comply with board manufacturer's written instructions and as follows:
a. At joints in calcium silicate board, embed tape in joint compound and apply first, fill, and finish coats of joint compounds over tape, fastener heads, and accessories.
b. Apply a thin, uniform skim coat of joint compound over entire surface.
c. Touch up and sand between coats and after last coat as needed to produce a surface free of visual defects, tool marks, and ridges.

C. Protection
1. Replace or repair board fire protection that has been cut away to facilitate other construction. Maintain complete coverage of full thickness on members and substrates protected by board fire protection.
a. Provide final protection and maintain conditions in a manner acceptable to Installer, manufacturer, and authorities having jurisdiction to ensure that board fire protection is without damage or deterioration at time of Substantial Completion.

END OF SECTION 07820

Task	Specification	Specification Description
07820	07810	Sprayed Fire-Resistive Materials

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SECTION 07840 - THROUGH-PENETRATION FIRESTOP SYSTEMS

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for through-penetration firestop systems. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes through-penetration firestop systems for penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items.

C. Performance Requirements
1. General: For penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
2. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per ASTM E 814 or UL 1479:
   a. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
   b. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings, where systems protect penetrating items exposed to potential contact with adjacent materials in occupiable floor areas:
      1) Penetrations located outside wall cavities.
      2) Penetrations located outside fire-resistance-rated shaft enclosures.
   c. L-Rated Systems: Where through-penetration firestop systems are indicated in smoke barriers, provide **OR** Provide, **as directed**, through-penetration firestop systems with L-ratings indicated **OR** of not more than, **as directed**, 3.0 cfm/sq. ft (0.01524cu. m/s x sq. m) at both ambient temperatures and 400 deg F (204 deg C).
3. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
   a. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
   b. For floor penetrations with annular spaces exceeding 4 inches (100 mm) in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved, either by installing floor plates or by other means.
   c. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.
4. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

D. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: For each through-penetration firestop system, submit documentation, including illustrations, from a qualified testing and inspecting agency, showing each type of construction condition penetrated, relationships to adjoining construction, and type of penetrating item.

a. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular through-penetration firestop condition, submit illustration, with modifications marked, approved by through-penetration firestop system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

E. Quality Assurance
1. Installation Responsibility: Assign installation of through-penetration firestop systems and fire-resistive joint systems in Project to a single qualified installer.
2. Fire-Test-Response Characteristics: Provide through-penetration firestop systems that comply with the following requirements and those specified in Part 1.1 "Performance Requirements" Article:
a. Firestopping tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL **OR** OPL **OR** ITS, **as directed**, or another agency performing testing and follow-up inspection services for firestop systems acceptable to authorities having jurisdiction.
b. Through-penetration firestop systems are identical to those tested per testing standard referenced in "Part 1.1 Performance Requirements" Article. Provide rated systems bearing classification marking of qualified testing and inspecting agency.
3. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
4. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until each installation has been examined by Owner's inspecting agency and building inspector, if required by authorities having jurisdiction.

F. Delivery, Storage, And Handling
1. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, lot number, shelf life if applicable, qualified testing and inspecting agency's classification marking applicable to Project, curing time, and mixing instructions for multicomponent materials.
2. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.2 PRODUCTS

A. Firestopping
1. Compatibility: Provide through-penetration firestop systems that are compatible with one another; with the substrates forming openings; and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.
2. Accessories: Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with Part 1.1 "Performance Requirements" Article. Use only components specified by through-penetration firestop system manufacturer and approved by qualified testing and inspecting agency for firestop systems indicated. Accessories include, but are not limited to, the following items:
a. Permanent forming/damming/backing materials, including the following:
1) Slag-/rock-wool-fiber insulation.
2) Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
3) Fire-rated form board.
4) Fillers for sealants.
b. Temporary forming materials.
c. Substrate primers.

d. Collars.
e. Steel sleeves.

B. Fill Materials
1. General: Provide through-penetration firestop systems containing the types of fill materials indicated in the Through-Penetration Firestop System Schedule at the end of Part 1.3 by referencing the types of materials described in this Article. Fill materials are those referred to in directories of referenced testing and inspecting agencies as "fill," "void," or "cavity" materials.
2. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
3. Latex Sealants: Single-component latex formulations that after cure do not re-emulsify during exposure to moisture.
4. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
5. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized steel sheet.
6. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.
7. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
8. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
9. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives.
10. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
11. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:
    a. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and other surfaces requiring a nonslumping, gunnable sealant, unless indicated firestop system limits use to nonsag grade for both opening conditions.
    b. Grade for Horizontal Surfaces: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces.
    c. Grade for Vertical Surfaces: Nonsag formulation for openings in vertical and other surfaces.

C. Mixing: For those products requiring mixing before application, comply with through-penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

1.3 EXECUTION

A. Through-Penetration Firestop System Installation
1. General: Install through-penetration firestop systems to comply with Part 1.1 "Performance Requirements" Article and with firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.

2. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
   a. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.
3. Install fill materials for firestop systems by proven techniques to produce the following results:
   a. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
   b. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
   c. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.
4. Identification: Identify through-penetration firestop systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of edge of the firestop systems so that labels will be visible to anyone seeking to remove penetrating items or firestop systems. Use mechanical fasteners for metal labels. Include the following information on labels:
   a. The words "Warning - Through-Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."
   b. Contractor's name, address, and phone number.
   c. Through-penetration firestop system designation of applicable testing and inspecting agency.
   d. Date of installation.
   e. Through-penetration firestop system manufacturer's name.
   f. Installer's name.

B. Field Quality Control
1. Inspecting Agency: Owner will engage an independent inspecting agency to inspect through-penetration firestops. Independent inspecting agency shall comply with ASTM E 2174 requirements including those related to qualifications, conducting inspections, and preparing test reports.
2. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with requirements.
3. Proceed with enclosing through-penetration firestop systems with other construction only after inspection reports are issued and firestop installations comply with requirements.

C. Cleaning And Protecting
1. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not damage materials in which openings occur.
2. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

D. Through-Penetration Firestop System Schedule
1. Choices in the following paragraphs which are contained within brackets shall be as required to satisfy building and local code requirements.
2. Where UL-classified systems are indicated, they refer to alpha-alpha-numeric designations listed in UL's "Fire Resistance Directory" under product Category XHEZ.
3. Where OPL-classified systems are indicated, they refer to alpha-numeric design numbers in OPL's "Directory of Listed Building Products, Materials, & Assemblies."

4. Where ITS-listed systems are indicated, they refer to design numbers listed in ITS's "Directory of Listed Products," "Firestop Systems" Section.
5. Firestop Systems with No Penetrating Items:
   a. UL-Classified Systems: [C-AJ-] [C-BJ-] [F-A-] [W-J-] [W-L-] <Insert one or more four-digit numbers> [0001-0999].
   b. OPL-Classified Systems: FS <Insert one or more OPL design numbers> [F] [W], Penetrating Item Type G.
   c. ITS-Listed Systems: <Insert ITS design number(s).>
   d. Type of Fill Materials: One or more of the following:
      1) Latex sealant.
      2) Silicone sealant.
      3) Intumescent putty.
      4) Mortar.
6. Firestop Systems for Metallic Pipes, Conduit, or Tubing:
   a. UL-Classified Systems: [C-AJ-] [C-BJ-] [C-BK-] [F-A-] [F-B-] [F-C-] [W-J-] [W-K-] [W-L-] <Insert one or more four-digit numbers> [1001-1999].
   b. OPL-Classified Systems: FS <Insert one or more OPL design numbers> [F] [W], Penetrating Item Type A.
   c. ITS-Listed Systems: <Insert ITS design number(s).>
   d. Type of Fill Materials: One or more of the following:
      1) Latex sealant.
      2) Silicone sealant.
      3) Intumescent putty.
      4) Mortar.
7. Firestop Systems for Nonmetallic Pipe, Conduit, or Tubing:
   a. UL-Classified Systems: [C-AJ-] [C-BJ-] [F-A-] [F-B-] [F-C-] [W-J-] [W-L-] <Insert one or more four-digit numbers> [2001-2999].
   b. OPL-Classified Systems: FS <Insert one or more OPL design numbers> [F] [W], Penetrating Item Type B.
   c. ITS-Listed Systems: <Insert ITS design number(s).>
   d. Type of Fill Materials: One or more of the following:
      1) Latex sealant.
      2) Silicone sealant.
      3) Intumescent putty.
      4) Intumescent wrap strips.
      5) Firestop device.
8. Firestop Systems for Electrical Cables:
   a. UL-Classified Systems: [C-AJ-] [C-BJ-] [F-A-] [F-B-] [F-C-] [W-J-] [W-L-] <Insert one or more four-digit numbers> [3001-3999].
   b. OPL-Classified Systems: FS <Insert one or more OPL design numbers> [F] [W], Penetrating Item Type D.
   c. ITS-Listed Systems: <Insert ITS design number(s).>
   d. Type of Fill Materials: One or more of the following:
      1) Latex sealant.
      2) Silicone sealant.
      3) Intumescent putty.
      4) Silicone foam.
      5) Pillows/bags.
9. Firestop Systems for Cable Trays:
   a. UL-Classified Systems: [C-AJ-] [C-BJ-] [F-A-] [F-B-] [F-C-] [W-J-] [W-K-] [W-L-] <Insert one or more four-digit numbers> [4001-4999].
   b. OPL-Classified Systems: FS <Insert one or more OPL design numbers> [F] [W], Penetrating Item Type D.
   c. ITS-Listed Systems: <Insert ITS design number(s).>
   d. Type of Fill Materials: One or more of the following:
      1) Latex sealant.

2) Intumescent putty.
3) Silicone foam.
4) Pillows/bags.
5) Mortar.

10. Firestop Systems for Insulated Pipes:
    a. UL-Classified Systems: [C-AJ-] [C-BJ-] [F-A-] [F-C-] [W-J-] [W-L-] <Insert one or more four-digit numbers> [5001-5999].
    b. OPL-Classified Systems: FS <Insert one or more OPL design numbers> [F] [W], Penetrating Item Type C.
    c. ITS-Listed Systems: <Insert ITS design number(s).>
    d. Type of Fill Materials: One or more of the following:
        1) Latex sealant.
        2) Intumescent putty.
        3) Silicone foam.
        4) Intumescent wrap strips.
11. Firestop Systems for Miscellaneous Electrical Penetrants:
    a. UL-Classified Systems: [C-AJ-] [F-A-] [W-L-] <Insert one or more four-digit numbers> [6001-6999].
    b. OPL-Classified Systems: FS <Insert one or more OPL design numbers> [F] [W], Penetrating Item Type E.
    c. ITS-Listed Systems: <Insert ITS design number(s).>
    d. Type of Fill Materials: One or more of the following:
        1) Latex sealant.
        2) Intumescent putty.
        3) Mortar.
12. Firestop Systems for Miscellaneous Mechanical Penetrants:
    a. UL-Classified Systems: [C-AJ-] [F-C-] [W-J-] [W-L-] <Insert one or more four-digit numbers> [7001-7999].
    b. ITS-Listed Systems: <Insert ITS design number(s).>
    c. Type of Fill Materials: One or both of the following:
        1) Latex sealant.
        2) Mortar.
13. Firestop Systems for Groupings of Penetrants:
    a. UL-Classified Systems: [C-AJ-] [C-BJ-] [F-A-] [F-C-] [W-J-] [W-L-] <Insert one or more four-digit numbers> [8001-8999].
    b. ITS-Listed Systems: <Insert ITS design number(s).>
    c. Type of Fill Materials: One or more of the following:
        1) Latex sealant.
        2) Mortar.
        3) Intumescent wrap strips.
        4) Firestop device.
        5) Intumescent composite sheet.

END OF SECTION 07840

SECTION 07840a - FIRE-RESISTIVE JOINT SYSTEMS

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for fire-resistive joint systems. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes fire-resistive joint systems for the following:
   a. Floor-to-floor joints.
   b. Floor-to-wall joints.
   c. Head-of-wall joints.
   d. Wall-to-wall joints.
   e. Perimeter fire-resistive joint systems consisting of floor-to-wall joints between perimeter edge of fire-resistance-rated floor assemblies and exterior curtain walls.

C. Performance Requirements
1. General: Provide fire-resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assembly in which fire-resistive joint systems are installed.
2. Joint Systems in and between Fire-Resistance-Rated Constructions: Provide systems with assembly ratings equaling or exceeding the fire-resistance ratings of construction that they join, and with movement capabilities and L-ratings indicated as determined by UL 2079.
   a. Load-bearing capabilities as determined by evaluation during the time of test.
3. Perimeter Fire-Resistive Joint Systems: For joints between edges of fire-resistance-rated floor assemblies and exterior curtain walls, provide systems of type and with ratings indicated below and those indicated in the Fire-Resistive Joint System Schedule at the end of Part 1.3, as determined by UBC Standard 26-9 **OR** NFPA 285, **as directed,** and UL 2079.
   a. UL-Listed, Perimeter Fire-Containment Systems: Integrity ratings equaling or exceeding fire-resistance ratings of floor or floor/ceiling assembly forming one side of joint.
   b. OPL-Listed, Perimeter Fire-Barrier Systems: F-ratings equaling or exceeding fire-resistance ratings of floor or floor/ceiling assembly forming one side of joint.
4. For fire-resistive systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

D. Submittals
1. Product Data: For each product indicated.
2. Shop Drawings: For each fire-resistive joint system.
3. Qualification Data: For Installer.
4. Field quality-control test reports.
5. Evaluation Reports: Evidence of fire-resistive joint systems' compliance with ICBO ES AC30, from the ICBO Evaluation Service.
6. Research/Evaluation Reports: For each type of fire-resistive joint system.

E. Quality Assurance
1. Installer Qualifications: A firm that has been approved by FMG according to FMG 4991, "Approval of Firestop Contractors."
2. Installation Responsibility: Assign installation of through-penetration firestop systems and fire-resistive joint systems in Project to a single qualified installer.
3. Fire-Test-Response Characteristics: Provide fire-resistive joint systems that comply with the following requirements and those specified in Part 1 "Performance Requirements" Article:

a. Fire-resistance tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL **OR** OPL, **as directed**, or another agency performing testing and follow-up inspection services for fire-resistive joint systems acceptable to authorities having jurisdiction.
b. Fire-resistive joint systems are identical to those tested per methods indicated in Part 1 "Performance Requirements" Article and comply with the following:
1) Fire-resistive joint system products bear classification marking of qualified testing and inspecting agency.
2) Fire-resistive joint systems correspond to those indicated by referencing system designations of the qualified testing and inspecting agency.

4. Coordinate construction of joints to ensure that fire-resistive joint systems are installed according to specified requirements.
5. Do not cover up fire-resistive joint system installations that will become concealed behind other construction until inspecting agency and building inspector of authorities having jurisdiction have examined each installation.

F. Delivery, Storage, And Handling
1. Deliver fire-resistive joint system products to Project site in original, unopened containers or packages with qualified testing and inspecting agency's classification marking applicable to Project and with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, lot number, shelf life, curing time, and mixing instructions for multicomponent materials.
2. Store and handle materials for fire-resistive joint systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.2 PRODUCTS

A. Fire-Resistive Joint Systems
1. Compatibility: Provide fire-resistive joint systems that are compatible with joint substrates, under conditions of service and application, as demonstrated by fire-resistive joint system manufacturer based on testing and field experience.
2. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install fill materials and to comply with Part 1 "Performance Requirements" Article. Use only components specified by fire-resistive joint system manufacturer and approved by the qualified testing and inspecting agency for systems indicated.

1.3 EXECUTION

A. Installation
1. Install fire-resistive joint systems to comply with Part 1.1 "Performance Requirements" Article and fire-resistive joint system manufacturer's written installation instructions for products and applications indicated.
2. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

B. Field Quality Control
1. Inspecting Agency: Engage a qualified independent inspecting agency to inspect fire-resistive joint systems and prepare inspection reports.
2. Testing Services: Inspecting of completed installations of fire-resistive joint systems shall take place in successive stages as installation of fire-resistive joint systems proceeds. Do not proceed with installation of joint systems for the next area until inspecting agency determines completed work shows compliance with requirements.

a. Inspecting agency shall state in each report whether inspected fire-resistive joint systems comply with or deviate from requirements.

3. Remove and replace fire-resistive joint systems where inspections indicate that they do not comply with specified requirements.
4. Proceed with enclosing fire-resistive joint systems with other construction only after inspection reports are issued and fire-resistive joint systems comply with requirements.

C. Fire-Resistive Joint System Schedule

1. Designation System for Joints in or between Fire-Resistance-Rated Constructions: Alphanumeric systems listed in UL's "Fire Resistance Directory" under Product Category XHBN.
2. Designation System for Joints at the Intersection of Fire-Resistance-Rated Floor or Floor/Ceiling Assembly and an Exterior Curtain-Wall Assembly: Alphanumeric systems listed in UL's "Fire Resistance Directory" under Product Category XHDG **OR** OPL's "Directory of Listed Building Products, Materials, & Assemblies" as perimeter fire-barrier systems, **as directed**.

END OF SECTION 07840a

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SECTION 07840b - FIRESTOPPING

1.1 DESCRIPTION OF WORK

A. This specification covers the furnishing and installation of materials for firestopping. Products shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 GENERAL

A. System Description
   1. Performance Requirements: Comply with following:
      a. Firestopping: Consist of material or combination of materials to form effective barrier against spread of flame, smoke, and gases, and maintain integrity of fire-resistance rated walls, partitions, floors, and ceiling-floor assemblies at penetrations.
         1) Penetrations: Include annular space around pipes, ducts, chimneys, tubes, conduit, wires, cables, and vents.

B. Submittals
   1. Product Data:
      a. Composition and performance characteristics.
      b. List of FM, UL, or WH classification number of systems installed.
   2. Quality Assurance/Control Submittals:
      a. Test Reports: If not FM, UL, or WH listed, submit certified test results for ASTM E 814 tests by UL, FM, WH, or other accredited independent laboratory demonstrating compliance of firestopping with specified requirements.
      b. Manufacturers installation instructions.

C. Quality Assurance
   1. Regulatory Requirements: Comply with applicable building-code requirements for firestopping.

D. Delivery, Storage, And Handling
   1. Packing, Shipping, Handling, and Unloading: Deliver in original, unopened containers with manufacturer's labels.
      a. Products: FM, UL, or WH labeled and FM, UL, or WHI listed.
   2. Storage and Protection: Store firestopping materials in accordance with manufacturer's recommendations.

1.3 PRODUCTS

A. Fire-Rated Penetration Sealant Systems
   1. Firestopping Materials: Commercially manufactured asbestos-free products complying with following minimum requirements:
      a. Material:
         1) Flame Spread: ASTM E 84 or UL 723, 25 or less.
         2) Smoke Developed Rating: ASTM E 84 or UL 723, 50 or less.
         3) Material: Approved firestopping material as listed in UL 05, FM P7825, or WH Certified Listing.
      b. Material Properties:
         1) Contain no flammable or toxic solvents and have no dangerous or flammable outgassing during the drying or curing of products.

2) Non-toxic to human beings at all stages of application and during fire conditions.
3) Water-resistant after drying or curing and unaffected by high humidity, condensation, or transient water exposure.

c. Devices and systems requiring heat activation to seal opening created by burning or melting of penetrant shall exhibit demonstrated ability to function as required for floors and walls of construction and thickness similar to those to be firestopped.

2. Firestopping System Requirements: Materials from single manufacturer capable of maintaining effective barrier against flame, smoke, and gases in accordance with ASTM E 814 and UL 1479.
   a. Fire-Resistance Rating: Equal or greater than fire-resistance rating of assembly in which it is being placed.
   b. F Ratings: Equal to or greater than fire-resistance rating of assembly penetrated.
   c. T Ratings: Equal to or greater than fire-resistance rating of assembly penetrated at following locations:
      1) Penetrations located outside of wall cavities.
      2) Penetrations located outside of fire-resistive shaft enclosures.
      3) Penetrations located in enclosures with doors required to have temperature-rise rating.
      4) Penetrations with penetrating hems larger than 100 mm (4 inch) diameter nominal pipe or 10 320 sq. mm (16 square inches) in cross-sectional area.
   d. System: Listed in UL 05, FM 7825, or WH Certified Listing, or tested by approved laboratory in accordance with ASTM E 814.
   e. System: Suitable for firestopping of penetrations made by steel, glass, plastic. and insulated pipe.
   f. Penetration by Insulated Pipe: Does not require removal of insulation.

1.4 EXECUTION

A. Examination
   1. Verification of Conditions:
      a. Existing Conditions: Examine penetrations before beginning installation.
      b. Do not proceed with installation until conditions are satisfactory.

B. Installation
   1. Fire-Rated Penetration Sealant Systems: Install in accordance with UL 05, FM P7825, or WH systems and manufacturers recommendations to maintain required fire-separation rating.
      a. Preparation: Clean surfaces in contact with firestopping materials that may affect proper fitting or required fire rating. Prime if required. Dam void if required.
      b. Penetrations: Completely fill void with sealant materials to smooth surface, flush with adjacent surfaces and in contact with surfaces formed by openings and penetrating items ensuring adhesion. Provide sealant in thickness to achieve required fire rating and smoke barrier.
      c. Firestopping at Voids 100 mm (4 inches) or More in Any Direction: Capable of supporting same load as floor is designed to support or protected by permanent barrier.
      d. Remove any excess sealant from adjacent surfaces.
   2. Firestopping: Provide at following locations:
      a. Penetrations of duct, chimney, conduit, tubing, cable, and pipe through floors and through fire-resistance rated walls, partitions, and ceiling-floor assemblies.
      b. Penetrations of vertical shafts such as pipe chases, elevator shafts, and utility chutes.
      c. Gaps at intersection of fire-rated floor stabs and walls.
      d. Gaps at perimeter of fire-rated walls and partitions, such as between top of walls and bottom of floor or roof decks.
      e. Construction joints in fire-rated floors, walls, and partitions.
      f. Other locations where required to maintain fire-resistance rating of the construction.
      g. Other locations as indicated on Drawings (if any).

C. Field Quality Control
   1. Inspection: Examine areas to be firestopped prior to concealing or enclosing to ensure proper installation.
      a. Keep areas of firestopping work accessible until inspection by authorities having jurisdiction over work.

END OF SECTION 07840b

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Task	Specification	Specification Description
07840	07810	Sprayed Fire-Resistive Materials
07840	07820	Board Fire Protection
07910	07920	Joint Sealants

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SECTION 07920 - JOINT SEALANTS

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for joint sealants. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Silicone joint sealants.
   b. Urethane joint sealants.
   c. Polysulfide joint sealants.
   d. Latex joint sealants.
   e. Solvent-release-curing joint sealants.
   f. Preformed joint sealants.
   g. Acoustical joint sealants.

C. Preconstruction Testing
1. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
   a. Use ASTM C 1087 **OR** manufacturer's standard test method, **as directed**, to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
   b. Submit not fewer than eight pieces of each kind of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
   c. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
   d. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
   e. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.
2. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:
   a. Locate test joints where indicated on Project or, if not indicated, as directed by the Owner.
   b. Conduct field tests for each application indicated below:
      1) Each kind of sealant and joint substrate indicated.
   c. Notify the Owner seven days in advance of dates and times when test joints will be erected.
   d. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
      1) Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
         a) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
   e. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
   f. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with

requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

D. Submittals
1. Product Data: For each joint-sealant product indicated.
2. LEED Submittal:
   a. Product Data for Credit EQ 4.1: For sealants and sealant primers used inside the weatherproofing system, including printed statement of VOC content.
3. Samples: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
4. Joint-Sealant Schedule: Include the following information:
   a. Joint-sealant application, joint location, and designation.
   b. Joint-sealant manufacturer and product name.
   c. Joint-sealant formulation.
   d. Joint-sealant color.
5. Qualification Data: For qualified Installer and testing agency.
6. Product Certificates: For each kind of joint sealant and accessory, from manufacturer.
7. Sealant, Waterproofing, and Restoration Institute (SWRI) Validation Certificate: For each sealant specified to be validated by SWRI's Sealant Validation Program.
8. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that sealants comply with requirements.
9. Preconstruction Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:
   a. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
   b. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
10. Preconstruction Field-Adhesion Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.
11. Field-Adhesion Test Reports: For each sealant application tested.
12. Warranties: Sample of special warranties.

E. Quality Assurance
1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
2. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.
3. Product Testing: Test joint sealants using a qualified testing agency.
   a. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
   b. Test according to SWRI's Sealant Validation Program for compliance with requirements specified by reference to ASTM C 920 for adhesion and cohesion under cyclic movement, adhesion-in-peel, and indentation hardness.
4. Preinstallation Conference: Conduct conference at Project site.

F. Project Conditions
1. Do not proceed with installation of joint sealants under the following conditions:
   a. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C, **as directed**.
   b. When joint substrates are wet.
   c. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.

d. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

G. Warranty
1. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
a. Warranty Period: Two years from date of Substantial Completion.
2. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
a. Movement of the structure caused by structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
b. Disintegration of joint substrates from natural causes exceeding design specifications.
c. Mechanical damage caused by individuals, tools, or other outside agents.
d. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

1.2 PRODUCTS

A. Materials, General
1. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
2. VOC Content of Interior Sealants: Provide sealants and sealant primers for use inside the weatherproofing system that comply with the following limits for VOC content when calculated according to 40 CFR 59, Part 59, Subpart D (EPA Method 24):
a. Architectural Sealants: 250 g/L.
b. Sealant Primers for Nonporous Substrates: 250 g/L.
c. Sealant Primers for Porous Substrates: 775 g/L.
3. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
a. Suitability for Immersion in Liquids. Where sealants are indicated for Use I for joints that will be continuously immersed in liquids, provide products that have undergone testing according to ASTM C 1247. Liquid used for testing sealants is deionized water, unless otherwise indicated.
4. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
5. Suitability for Contact with Food: Where sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.
6. Colors of Exposed Joint Sealants: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

B. Silicone Joint Sealants
1. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 100/50, for Use NT.
2. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT.
3. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.
4. Single-Component, Nonsag, Acid-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.

5. Single-Component, Nonsag, Traffic-Grade, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 100/50, for Use T.
6. Single-Component, Pourable, Traffic-Grade, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade P, Class 100/50, for Use T.
7. Multicomponent, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type M, Grade NS, Class 50, for Use NT.
8. Multicomponent, Pourable, Traffic-Grade, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type M, Grade P, Class 100/50, for Use T.
9. Mildew-Resistant, Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.
10. Mildew-Resistant, Single-Component, Acid-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.

C. Urethane Joint Sealants
1. Single-Component, Nonsag, Urethane Joint Sealant: ASTM C 920, Type S, Grade NS, Class 100/50, for Use NT.
2. Single-Component, Nonsag, Urethane Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT.
3. Single-Component, Nonsag, Urethane Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.
4. Single-Component, Nonsag, Traffic-Grade, Urethane Joint Sealant: ASTM C 920. Type S, Grade NS, Class 25, for Use T.
5. Single-Component, Pourable, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type S, Grade P, Class 25, for Use T.
6. Multicomponent, Nonsag, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 50, for Use NT.
7. Multicomponent, Nonsag, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use NT.
8. Multicomponent, Nonsag, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 50, for Use T.
9. Multicomponent, Nonsag, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use T.
10. Immersible, Single-Component, Nonsag, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Uses T and I.
11. Immersible, Single-Component, Pourable, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type S, Grade P, Class 25, for Uses T and I.
12. Immersible Multicomponent, Nonsag, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Uses T and I.
13. Immersible Multicomponent, Pourable, Traffic-Grade, Urethane Joint Sealant: ASTM C 920. Type M, Grade P, Class 25, for Use T and I.

D. Polysulfide Joint Sealants
1. Single-Component, Nonsag, Polysulfide Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.
2. Multicomponent, Nonsag, Polysulfide Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use NT.
3. Multicomponent, Nonsag, Traffic-Grade, Polysulfide Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use T.
4. Multicomponent, Pourable, Traffic-Grade, Polysulfide Joint Sealant: ASTM C 920, Type M, Grade P, Class 25, for Use T.
5. Immersible, Multicomponent Nonsag, Traffic-Grade, Polysulfide Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use T and Use I.

E. Latex Joint Sealants
1. Latex Joint Sealant: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

F. Solvent-Release-Curing Joint Sealants
1. Acrylic-Based Joint Sealant: ASTM C 1311.
2. Butyl-Rubber-Based Joint Sealant: ASTM C 1311.

G. Preformed Joint Sealants
1. Preformed Silicone Joint Sealants: Manufacturer's standard sealant consisting of precured low-modulus silicone extrusion, in sizes to fit joint widths indicated, combined with a neutral-curing silicone sealant for bonding extrusions to substrates.
2. Preformed Foam Joint Sealant: Manufacturer's standard preformed, precompressed, open-cell foam sealant manufactured from urethane foam with minimum density of 10 lb/cu. ft. (160 kg/cu. m) and impregnated with a nondrying, water-repellent agent. Factory produce in precompressed sizes in roll or stick form to fit joint widths indicated; coated on one side with a pressure-sensitive adhesive and covered with protective wrapping.

H. Acoustical Joint Sealants
1. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

I. Joint Sealant Backing
1. General: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
2. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin) **OR** Type O (open-cell material) **OR** Type B (bicellular material with a surface skin) **OR** or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, **as directed**, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
3. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

J. Miscellaneous Materials
1. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
2. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
3. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

1.3 EXECUTION

A. Examination
1. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

a. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
b. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
    1) Concrete.
    2) Masonry.
    3) Unglazed surfaces of ceramic tile.
    4) Exterior insulation and finish systems.
c. Remove laitance and form-release agents from concrete.
d. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
    1) Metal.
    2) Glass.
    3) Porcelain enamel.
    4) Glazed surfaces of ceramic tile.

2. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
3. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

C. Installation Of Joint Sealants
1. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
2. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
3. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
    a. Do not leave gaps between ends of sealant backings.
    b. Do not stretch, twist, puncture, or tear sealant backings.
    c. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
4. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
5. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
    a. Place sealants so they directly contact and fully wet joint substrates.
    b. Completely fill recesses in each joint configuration.
    c. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
6. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
    a. Remove excess sealant from surfaces adjacent to joints.

b. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
c. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.
d. Provide flush joint profile where indicated per Figure 8B in ASTM C 1193.
e. Provide recessed joint configuration of recess depth and at locations indicated per Figure 8C in ASTM C 1193.
1) Use masking tape to protect surfaces adjacent to recessed tooled joints.

7. Installation of Preformed Silicone-Sealant System: Comply with the following requirements:
a. Apply masking tape to each side of joint, outside of area to be covered by sealant system.
b. Apply silicone sealant to each side of joint to produce a bead of size complying with preformed silicone-sealant system manufacturer's written instructions and covering a bonding area of not less than 3/8 inch (10 mm). Hold edge of sealant bead 1/4 inch (6 mm) inside masking tape.
c. Within 10 minutes of sealant application, press silicone extrusion into sealant to wet extrusion and substrate. Use a roller to apply consistent pressure and ensure uniform contact between sealant and both extrusion and substrate.
d. Complete installation of sealant system in horizontal joints before installing in vertical joints. Lap vertical joints over horizontal joints. At ends of joints, cut silicone extrusion with a razor knife.

8. Installation of Preformed Foam Sealants: Install each length of sealant immediately after removing protective wrapping. Do not pull or stretch material. Produce seal continuity at ends, turns, and intersections of joints. For applications at low ambient temperatures, apply heat to sealant in compliance with sealant manufacturer's written instructions.

9. Acoustical Sealant Installation: At sound-rated assemblies and elsewhere as indicated, seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations.

D. Field Quality Control
1. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
a. Extent of Testing: Test completed and cured sealant joints as follows:
1) Perform 10 tests for the first 1000 feet (300 m) of joint length for each kind of sealant and joint substrate.
2) Perform 1 test for each 1000 feet (300 m) of joint length thereafter or 1 test per each floor per elevation.
b. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
c. Inspect tested joints and report on the following:
1) Whether sealants filled joint cavities and are free of voids.
2) Whether sealant dimensions and configurations comply with specified requirements.
3) Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.
d. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
e. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

2. Evaluation of Field-Adhesion Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

E. Cleaning
1. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

F. Protection
1. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

G. Joint-Sealant Schedule
1. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces.
   a. Joint Locations:
      1) Control and expansion joints in brick pavers.
      2) Isolation and contraction joints in cast-in-place concrete slabs.
      3) Joints between plant-precast architectural concrete paving units.
      4) Joints in stone paving units, including steps.
      5) Tile control and expansion joints.
      6) Joints between different materials listed above.
      7) Other joints as indicated.
   b. Silicone Joint Sealant: Single component, nonsag, traffic grade, neutral curing **OR** Single component, pourable, traffic grade, neutral curing **OR** Multicomponent, pourable, traffic grade, neutral curing, **as directed**.
   c. Urethane Joint Sealant: Single component, nonsag, traffic grade **OR** Single component, pourable, traffic grade **OR** Multicomponent, nonsag, traffic grade, Class 50 **OR** Multicomponent, nonsag, traffic grade, Class 25, **as directed**.
   d. Polysulfide Joint Sealant: Multicomponent, nonsag, traffic grade **OR** Multicomponent, pourable, traffic grade, **as directed**.
   e. Preformed Joint Sealant: Preformed foam sealant.
   f. Joint-Sealant Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range of colors, **as directed**.
2. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces subject to water immersion.
   a. Joint Locations:
      1) Joints in pedestrian plazas.
      2) Joints in swimming pool decks.
      3) Other joints as indicated.
   b. Urethane Joint Sealant: Immersible, single component, nonsag, traffic grade **OR** Immersible, single component, pourable, traffic grade **OR** Immersible, multicomponent, nonsag, traffic grade **OR** Immersible, multicomponent, pourable, traffic grade, **as directed**.
   c. Polysulfide Joint Sealant: Immersible, multicomponent, nonsag, traffic grade.
   d. Joint-Sealant Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range of colors, **as directed**.
3. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.
   a. Joint Locations:
      1) Construction joints in cast-in-place concrete.
      2) Joints between plant-precast architectural concrete units.
      3) Control and expansion joints in unit masonry.
      4) Joints in dimension stone cladding.

5) Joints in glass unit masonry assemblies.
6) Joints in exterior insulation and finish systems.
7) Joints between metal panels.
8) Joints between different materials listed above.
9) Perimeter joints between materials listed above and frames of doors, windows and louvers.
10) Control and expansion joints in ceilings and other overhead surfaces.
11) Other joints as indicated.

b. Silicone Joint Sealant: Single component, nonsag, neutral curing, Class 100/50 **OR** Single component, nonsag, neutral curing, Class 50 **OR** Single component, nonsag, neutral curing, Class 25 **OR** Single component, nonsag, acid curing **OR** Multicomponent, nonsag, neutral curing, **as directed**.

c. Urethane Joint Sealant: Single component, nonsag, Class 100/50 **OR** Single component, nonsag, Class 50 **OR** Single component, nonsag, Class 25 **OR** Multicomponent, nonsag,, Class 50 **OR** Multicomponent, nonsag,, Class 25, **as directed**.

d. Polysulfide Joint Sealant: Single component, nonsag **OR** Multicomponent, nonsag, **as directed**.

e. Preformed Joint Sealant: Preformed silicone **OR** Preformed foam, **as directed**.

f. Joint-Sealant Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range of colors, **as directed**.

4. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.

a. Joint Locations:
1) Isolation joints in cast-in-place concrete slabs.
2) Control and expansion joints in stone flooring.
3) Control and expansion joints in brick flooring.
4) Control and expansion joints in tile flooring.
5) Other joints as indicated.

b. Silicone Joint Sealant: Single component, nonsag, traffic grade, neutral curing **OR** Single component, pourable, traffic grade, neutral curing **OR** Multicomponent, pourable, traffic grade, neutral curing, **as directed**.

c. Urethane Joint Sealant: Single component, nonsag, traffic grade **OR** Single component, pourable, traffic grade **OR** Multicomponent, nonsag, traffic grade, Class 50 **OR** Multicomponent, nonsag, traffic grade, Class 25, **as directed**.

d. Polysulfide Joint Sealant: Multicomponent, nonsag, traffic grade **OR** Multicomponent, pourable, traffic grade, **as directed**.

e. Preformed Joint Sealant: Preformed foam.

f. Joint-Sealant Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range of colors, **as directed**.

5. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.

a. Joint Locations:
1) Control and expansion joints on exposed interior surfaces of exterior walls.
2) Perimeter joints of exterior openings where indicated.
3) Tile control and expansion joints.
4) Vertical joints on exposed surfaces of interior unit masonry and concrete walls and partitions.
5) Joints on underside of plant-precast structural concrete beams and planks.
6) Perimeter joints between interior wall surfaces and frames of interior doors, windows and elevator entrances.
7) Other joints as indicated.

b. Joint Sealant: Latex **OR** Acrylic based **OR** Butyl rubber based, **as directed**.

c. Joint-Sealant Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range of colors, **as directed**.

6. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.

a. Joint Sealant Location:
1) Joints between plumbing fixtures and adjoining walls, floors, and counters.

2) Tile control and expansion joints where indicated.
3) Other joints as indicated.

b. Joint Sealant: Mildew resistant, single component, nonsag, neutral curing, Silicone **OR** Single component, nonsag, mildew resistant, acid curing, **as directed**.

c. Joint-Sealant Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range of colors, **as directed**.

7. Joint-Sealant Application: Interior acoustical joints in vertical surfaces and horizontal nontraffic surfaces.

a. Joint Location:
1) Acoustical joints where indicated.
2) Other joints as indicated.

b. Joint Sealant: Acoustical.

c. Joint-Sealant Color: As selected from manufacturer's full range.

END OF SECTION 07920

SECTION 08110 - STEEL DOORS AND FRAMES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for steel doors and frames. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Standard hollow metal doors and frames.
b. Custom hollow metal doors and frames.

C. Definitions
1. Minimum Thickness: Minimum thickness of base metal without coatings.
2. Standard Hollow Metal Work: Hollow metal work fabricated according to ANSI/SDI A250.8.
3. Custom Hollow Metal Work: Hollow metal work fabricated according to ANSI/NAAMM-HMMA 861.

D. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Include elevations, door edge details, frame profiles, metal thicknesses, preparations for hardware, and other details.
3. Samples for Verification: For each type of exposed finish required.
4. Schedule: Prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings.
5. Oversize Construction Certification: For assemblies required to be fire rated and exceeding limitations of labeled assemblies.
6. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of hollow metal door and frame assembly.

E. Quality Assurance
1. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure **OR** as close to neutral pressure as possible, **as directed**, according to NFPA 252 **OR** UBC Standard 7-2, **as directed**, or UL 10B**OR** UL 10C, **as directed**.
a. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
b. Temperature-Rise Limit: Where indicated **OR** At vertical exit enclosures and exit passageways, **as directed**, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.
2. Fire-Rated, Borrowed-Light Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled, by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9 **OR** UBC Standard 7-4, **as directed**. Label each individual glazed lite.
3. Smoke-Control Door Assemblies: Comply with NFPA 105 or UL 1784 **OR** UBC Standard 7-2, **as directed**.

F. Delivery, Storage, And Handling

1. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
   a. Provide additional protection to prevent damage to finish of factory-finished units.
2. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
3. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch- (102-mm-) high wood blocking. Do not store in a manner that traps excess humidity.
   a. Provide minimum 1/4-inch (6-mm) space between each stacked door to permit air circulation.

1.2 PRODUCTS

A. Materials
1. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
2. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
3. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum A40 (ZF120) **OR** G60 (Z180) or A60 (ZF180), **as directed**, metallic coating.
4. Frame Anchors: ASTM A 591/A 591M, Commercial Steel (CS), 40Z (12G) coating designation; mill phosphatized.
   a. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.
5. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
6. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow metal frames of type indicated.
7. Grout: ASTM C 476, except with a maximum slump of 4 inches (102 mm), as measured according to ASTM C 143/C 143M.
8. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool with 6- to 12-lb/cu. ft. (96- to 192-kg/cu. m) density; with maximum flame-spread and smoke-development indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.
9. Glazing: Comply with requirements in Division 08 Section "Glazing".
10. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat.

B. Standard Hollow Metal Doors
1. General: Provide doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8.
   a. Design: Flush panel **OR** Embossed panel **OR** As indicated, **as directed**.
   b. Core Construction: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core.
      1) Fire Door Core: As required to provide fire-protection and temperature-rise ratings indicated.
      2) Thermal-Rated (Insulated) Doors: Where indicated, provide doors fabricated with thermal-resistance value (R-value) of not less than 4.0 deg F x h x sq. ft./Btu (0.704 K x sq. m/W) **OR** 6.0 deg F x h x sq. ft./Btu (1.057 K x sq. m/W) **OR** 12.3 deg F x h x sq. ft./Btu (2.166 K x sq. m/W), **as directed**, when tested according to ASTM C 1363.
         a) Locations: Exterior doors and interior doors where indicated, **as directed**.

c. Vertical Edges for Single-Acting Doors: Beveled edge **OR** Square edge **OR** Manufacturer's standard, **as directed**.
   1) Beveled Edge: 1/8 inch in 2 inches (3 mm in 50 mm).
d. Vertical Edges for Double-Acting Doors: Round vertical edges with 2-1/8-inch (54-mm) radius.
e. Top and Bottom Edges: Closed with flush or inverted 0.042-inch- (1.0-mm-) thick, end closures or channels of same material as face sheets.
f. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."

2. Exterior Doors: Face sheets fabricated from metallic-coated steel sheet. Provide doors complying with ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
   a. Level 1 and Physical Performance Level C (Standard Duty), Model 1 (Full Flush) **OR** Model 2 (Seamless), **as directed**.
      1) Width: 1-3/4 inches (44.5 mm) **OR** 1-3/8 inches (34.9 mm) **OR** As indicated on Drawings, **as directed**.
   b. Level 2 and Physical Performance Level B (Heavy Duty), Model 1 (Full Flush) **OR** Model 2 (Seamless), **as directed**.
   c. Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 1 (Full Flush) **OR** Model 2 (Seamless) **OR** Model 3 (Stile and Rail), **as directed**.
   d. Level 4 and Physical Performance Level A (Maximum Duty), Model 1 (Full Flush) **OR** Model 2 (Seamless), **as directed**.
3. Interior Doors: Face sheets fabricated from cold-rolled steel sheet unless metallic-coated sheet is indicated. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
   a. Level 1 and Physical Performance Level C (Standard Duty), Model 1 (Full Flush) **OR** Model 2 (Seamless), **as directed**.
      1) Width: 1-3/4 inches (44.5 mm) **OR** 1-3/8 inches (34.9 mm) **OR** As indicated on Drawings, **as directed**.
   b. Level 2 and Physical Performance Level B (Heavy Duty), Model 1 (Full Flush) **OR** Model 2 (Seamless), **as directed**.
   c. Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 1 (Full Flush) **OR** Model 2 (Seamless) **OR** Model 3 (Stile and Rail), **as directed**.
   d. Level 4 and Physical Performance Level A (Maximum Duty), Model 1 (Full Flush) **OR** Model 2 (Seamless), **as directed**.
4. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.
5. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.

C. Standard Hollow Metal Frames
1. General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile.
2. Exterior Frames: Fabricated from metallic-coated steel sheet.
   a. Fabricate frames with mitered or coped corners.
   b. Fabricate frames as knocked down **OR** face welded **OR** full profile welded, **as directed,** unless otherwise indicated.
   c. Frames for Level 1 Steel Doors: 0.042-inch- (1.0-mm-) thick steel sheet.
   d. Frames for Level 2 Steel Doors: 0.053-inch- (1.3-mm-) thick steel sheet.
   e. Frames for Level 3 Steel Doors: 0.053-inch- (1.3-mm-) thick steel sheet.
   f. Frames for Level 4 Steel Doors: 0.067-inch- (1.7-mm-) thick steel sheet.
3. Interior Frames: Fabricated from cold-rolled steel sheet unless metallic-coated sheet is indicated.
   a. Fabricate frames with mitered or coped corners.
   b. Fabricate frames as knocked down **OR** face welded **OR** full profile welded, **as directed**, unless otherwise indicated.
   c. Fabricate knocked-down, drywall slip-on frames for in-place gypsum board partitions**, as directed**.

d. Frames for Level 1 Steel Doors: 0.042-inch- (1.0-mm-) thick steel sheet.
e. Frames for Level 2 Steel Doors: 0.053-inch- (1.3-mm-) thick steel sheet.
f. Frames for Level 3 Steel Doors: 0.053-inch- (1.3-mm-) thick steel sheet.
g. Frames for Level 4 Steel Doors: 0.067-inch- (1.7-mm-) thick steel sheet.
h. Frames for Wood Doors: 0.042-inch- (1.0-mm-) **OR** 0.053-inch- (1.3-mm-) **OR** 0.067-inch- (1.7-mm-), **as directed**, thick steel sheet.
i. Frames for Borrowed Lights: 0.042-inch- (1.0-mm-) thick steel sheet **OR** 0.053-inch- (1.3-mm-) thick steel sheet **OR** 0.067-inch- (1.7-mm-) thick steel sheet **OR** Same as adjacent door frame, **as directed**.

4. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcement plates from same material as frames.

D. Custom Hollow Metal Doors
1. General: Provide doors not less than 1-3/4 inches (44.5 mm) thick, of seamless hollow construction unless otherwise indicated. Construct doors with smooth surfaces without visible joints or seams on exposed faces. Comply with ANSI/NAAMM-HMMA 861.
2. Exterior Door Face Sheets: Fabricated from metallic-coated steel sheet, minimum 0.053 inch (1.3 mm) thick.
3. Interior Door Face Sheets: Fabricated from cold-rolled steel sheet unless metallic-coated sheet is indicated, minimum 0.042 inch (1.0 mm) thick.
4. Core Construction: Provide thermal-resistance-rated cores for exterior doors and interior doors where indicated, **as directed**.
   a. Steel-Stiffened Core: 0.026-inch- (0.7-mm-) thick, steel vertical stiffeners of same material as face sheets extending full-door height, with vertical webs spaced not more than 6 inches (152 mm) apart, spot welded to face sheets a maximum of 5 inches (127 mm) o.c. Spaces filled between stiffeners with glass- or mineral-fiber insulation.
      1) Fire Door Core: As required to provide fire-protection and temperature-rise ratings indicated.
      2) Thermal-Rated (Insulated) Doors: Where indicated, provide doors fabricated with thermal-resistance value (R-value) of not less than 4.0 deg F x h x sq. ft./Btu (0.704 K x sq. m/W) **OR** 6.0 deg F x h x sq. ft./Btu (1.057 K x sq. m/W), **as directed,** when tested according to ASTM C 1363.
5. Vertical Edges for Single-Acting Doors: Beveled 1/8 inch in 2 inches (3 mm in 50 mm).
6. Vertical Edges for Double-Acting Doors: Round vertical edges with 2-1/8-inch (54-mm) radius.
7. Top and Bottom Channels: Closed with continuous channels, minimum 0.053 inch (1.3 mm) thick, of same material as face sheets and spot welded to both face sheets.
8. Hardware Reinforcement: Fabricate according to ANSI/NAAMM-HMMA 861 with reinforcing plates from same material as door face sheets.

E. Custom Hollow Metal Frames
1. General: Fabricate frames of construction indicated. Close contact edges of corner joints tight with faces mitered and stops butted or mitered. Continuously weld faces and soffits and finish faces smooth. Comply with ANSI/NAAMM-HMMA 861.
   a. Door Frames for Openings 48 Inches (1219 mm) Wide or Less: Fabricated from 0.053-inch- (1.3-mm-) thick steel sheet.
   b. Door Frames for Openings More Than 48 Inches (1219 mm) Wide: Fabricated from 0.067-inch- (1.7-mm-) thick steel sheet.
   c. Sidelight and Transom Frames: Fabricated from same thickness material as adjacent door frame.
   d. Borrowed-Light Frames: Fabricated from 0.053-inch- (1.3-mm-) thick steel sheet.
2. Exterior Frames: Formed from metallic-coated steel sheet.
3. Interior Frames: Fabricated from cold-rolled steel sheet unless metallic-coated sheet is indicated.
4. Hardware Reinforcement: Fabricate according to ANSI/NAAMM-HMMA 861 with reinforcing plates from same material as frame.

5. Head Reinforcement: Provide minimum 0.093-inch- (2.3-mm-) thick, steel channel or angle stiffener for opening widths more than 48 inches (1219 mm).

F. Frame Anchors
   1. Jamb Anchors:
      a. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch (1.0 mm) thick, with corrugated or perforated straps not less than 2 inches (50 mm) wide by 10 inches (250 mm) long; or wire anchors not less than 0.177 inch (4.5 mm) thick.
      b. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch (1.0 mm) thick.
      c. Compression Type for Drywall Slip-on Frames: Adjustable compression anchors.
      d. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch- (9.5-mm-) diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.
   2. Floor Anchors: Formed from same material as frames, not less than 0.042 inch (1.0 mm) thick, and as follows:
      a. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
      b. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch (50-mm) height adjustment. Terminate bottom of frames at finish floor surface.

G. Hollow Metal Panels
   1. Provide hollow metal panels of same materials, construction, and finish as specified for adjoining hollow metal work.

H. Stops And Moldings
   1. Moldings for Glazed Lites in Doors: Minimum 0.032 inch (0.8 mm) thick, fabricated from same material as door face sheet in which they are installed.
   2. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch (16 mm) high unless otherwise indicated.
   3. Loose Stops for Glazed Lites in Frames: Minimum 0.032 inch (0.8 mm) thick, fabricated from same material as frames in which they are installed.
   4. Terminated Stops: Where indicated on interior door frames, terminate stops 6 inches (152 mm) above finish floor with a 45-degree **OR** 90-degree, **as directed**, angle cut, and close open end of stop with steel sheet closure. Cover opening in extension of frame with welded-steel filler plate, with welds ground smooth and flush with frame.

I. Louvers
   1. Provide louvers for interior doors, where indicated, that comply with SDI 111C, with blades or baffles formed of 0.020-inch- (0.5-mm-) thick, cold-rolled steel sheet set into 0.032-inch- (0.8-mm-) thick steel frame.
      a. Sightproof Louver: Stationary louvers constructed with inverted V-shaped or Y-shaped blades.
      b. Lightproof Louver: Stationary louvers constructed with baffles to prevent light from passing from one side to the other, any angle.
      c. Fire-Rated Automatic Louvers: Louvers constructed with movable blades closed by actuating fusible link, and listed and labeled for use in fire-rated door assemblies of type and fire-resistance rating indicated by same testing and inspecting agency that established fire-resistance rating of door assembly.

J. Accessories
   1. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.
   2. Ceiling Struts: Minimum 1/4-inch-thick by 1-inch- (6.4-mm-thick by 25.4-mm-) wide steel.
   3. Grout Guards: Formed from same material as frames, not less than 0.016 inch (0.4 mm) thick.

K. Fabrication
1. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
2. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117 **OR** ANSI/NAAMM-HMMA 861, **as directed**.
3. Hollow Metal Doors:
   a. Exterior Doors: Provide weep-hole openings in bottom of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
   b. Glazed Lites: Factory cut openings in doors.
   c. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch (19 mm) beyond edge of door on which astragal is mounted.
4. Hollow Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
   a. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
   b. Sidelight and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
   c. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
   d. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
   e. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
   f. Jamb Anchors: Provide number and spacing of anchors as follows:
      1) Masonry Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:
         a) Two anchors per jamb up to 60 inches (1524 mm) high.
         b) Three anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
         c) Four anchors per jamb from 90 to 120 inches (2286 to 3048 mm) high.
         d) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 120 inches (3048 mm) high.
      2) Stud-Wall Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:
         a) Three anchors per jamb up to 60 inches (1524 mm) high.
         b) Four anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
         c) Five anchors per jamb from 90 to 96 inches (2286 to 2438 mm) high.
         d) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 96 inches (2438 mm) high.
         e) Two anchors per head for frames above 42 inches (1066 mm) wide and mounted in metal-stud partitions.
      3) Compression Type: Not less than two anchors in each jamb.
      4) Postinstalled Expansion Type: Locate anchors not more than 6 inches (152 mm) from top and bottom of frame. Space anchors not more than 26 inches (660 mm) o.c.
   g. Door Silencers: Except on weather-stripped doors, drill stops to receive door silencers as follows. Keep holes clear during construction.
      1) Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
      2) Double-Door Frames: Drill stop in head jamb to receive two door silencers.

5. Fabricate concealed stiffeners, edge channels, and hardware reinforcement from either cold- or hot-rolled steel sheet.
6. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware".
   a. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8 **OR** ANSI/NAAMM-HMMA 861.
   b. Reinforce doors and frames to receive nontemplated, mortised and surface-mounted door hardware.
   c. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
   d. Coordinate locations of conduit and wiring boxes for electrical connections with Division 16.
7. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.
   a. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow metal work.
   b. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
   c. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
   d. Provide loose stops and moldings on inside of hollow metal work.
   e. Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.

L. Steel Finishes
1. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.
   a. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.
2. Factory-Applied Paint Finish: Manufacturer's standard, complying with ANSI/SDI A250.3 for performance and acceptance criteria.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.

1.3 EXECUTION

A. Installation
1. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.
2. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11 **OR** HMMA 840, **as directed**.
   a. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
      1) At fire-protection-rated openings, install frames according to NFPA 80.
      2) Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
      3) Install frames with removable glazing stops located on secure side of opening.
      4) Install door silencers in frames before grouting.
      5) Remove temporary braces necessary for installation only after frames have been properly set and secured.
      6) Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.

7) Field apply bituminous coating to backs of frames that are filled with grout containing antifreezing agents.

b. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
   1) Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

c. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.

d. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.

e. Concrete Walls: Solidly fill space between frames and concrete with grout. Take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.

f. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.

g. In-Place Gypsum Board Partitions: Secure frames in place with postinstalled expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.

h. Ceiling Struts: Extend struts vertically from top of frame at each jamb to overhead structural supports or substrates above frame unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction. Provide adjustable wedged or bolted anchorage to frame jamb members.

i. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
   1) Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
   2) Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
   3) Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
   4) Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.

3. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.
   a. Non-Fire-Rated Standard Steel Doors:
      1) Jambs and Head: 1/8 inch (3 mm) plus or minus 1/16 inch (1.6 mm).
      2) Between Edges of Pairs of Doors: 1/8 inch (3 mm) plus or minus 1/16 inch (1.6 mm).
      3) Between Bottom of Door and Top of Threshold: Maximum 3/8 inch (9.5 mm).
      4) Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch (19 mm).
   b. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
   c. Smoke-Control Doors: Install doors according to NFPA 105 **OR** UBC Standard 7-2, **as directed**.
4. Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with hollow metal manufacturer's written instructions.
   a. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches (230 mm) o.c. and not more than 2 inches (50 mm) o.c. from each corner.

B. Adjusting And Cleaning
1. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.
2. Remove grout and other bonding material from hollow metal work immediately after installation.

3. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
4. Metallic-Coated Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION 08110

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SECTION 08110a - STAINLESS STEEL DOORS AND FRAMES

1.1 GENERAL

A. Description
1. This specification covers the furnishing and installation of stainless steel doors and frames. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Stainless-steel, hollow-metal doors and panels.
   b. Stainless-steel, hollow-metal frames.

C. Submittals
1. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, fire-resistance rating, temperature-rise ratings, and finishes.
2. Shop Drawings: Include the following:
   a. Elevations of each door design.
   b. Details of doors, including vertical and horizontal edge details and metal thicknesses.
   c. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
   d. Locations of reinforcement and preparations for hardware.
   e. Details of each different wall opening condition.
   f. Details of anchorages, joints, field splices, and connections.
   g. Details of accessories.
   h. Details of moldings, removable stops, and glazing.
   i. Details of conduit and preparations for power, signal, and control systems.
3. Samples:
   a. Finishes: For each type of exposed finish required, prepared on Samples of not less than 3 by 5 inches (75 by 125 mm).
   b. Doors: Include section of vertical-edge, top, and bottom construction; core construction; glazing; and hinge and other applied hardware reinforcement.
   c. Frames: Show profile, corner joint, floor and wall anchors, and silencers. Include separate section showing fixed hollow-metal panels and glazing if applicable.
4. Schedule: Provide a schedule of stainless-steel, hollow-metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with a door hardware schedule.
5. Oversize Construction Certification: For assemblies required to be fire rated and exceeding limitations of labeled assemblies.
6. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of stainless-steel, hollow-metal door and frame assembly.

D. Quality Assurance
1. Source Limitations: Obtain stainless-steel, hollow-metal work from single source from single manufacturer.
2. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
   a. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
   b. Temperature-Rise Limit: Where indicated **OR** At vertical exit enclosures and exit passageways, **as directed**, provide doors that have a maximum transmitted temperature

end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.

3. Smoke- and Draft-Control Door Assemblies: Where indicated **OR** At corridors, smoke barriers, and smoke partitions, **as directed**, provide assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
   a. Air Leakage Rate: Maximum air leakage of 0.3 cfm/sq. ft. (3 cu. m per minute/sq. m) at the tested pressure differential of 0.3-inch wg (75 Pa) of water.
4. Fire-Rated, Borrowed-Light Frame Assemblies: Assemblies that are listed and labeled, by a testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9. Label each individual glazed lite. Install in compliance with NFPA 80.
5. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
1. Deliver doors and frames palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
2. Shipping Spreaders: Deliver welded frames with two removable spreader bars across bottom of frames, tack welded or mechanically attached to jambs and mullions.
3. Store doors and frames under cover at Project site. Place units in a vertical position with heads up, spaced by blocking, on minimum 4-inch- (100-mm-) high wood blocking. Avoid using nonvented plastic or canvas shelters that could create a humidity chamber.
   a. If wrappers on doors become wet, remove cartons immediately. Provide minimum 1/4-inch (6-mm) space between each stacked door to permit air circulation.

F. Project Conditions
1. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

G. Coordination
1. Coordinate installation of anchorages for stainless-steel frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

1.2 PRODUCTS

A. Stainless-Steel Doors
1. Description: Stainless-steel doors, not less than 1-3/4 inches (44 mm) thick, of seamed **OR** seamless, **as directed**, hollow-metal construction. Construct doors with smooth, flush surfaces without visible joints or seams on faces.
   a. Face Sheets: Fabricate from 0.050-inch- (1.27-mm-) **OR** 0.062-inch- (1.59-mm-) **OR** 0.078-inch- (1.98-mm-), **as directed**, thick, stainless-steel sheet.
   b. Core Construction: Fabricate doors with core indicated.
      1) Welded Steel-Stiffened Core: 0.031-inch- (0.79-mm-) thick, stainless-steel **OR** 0.030-inch- (0.76-mm-) nominal thickness uncoated steel **OR** 0.034-inch- (0.86-mm-) nominal thickness metallic-coated steel, **as directed**, vertical stiffeners extending full-door height, spaced not more than 6 inches (152 mm) apart, spot welded to face sheets a maximum of 5 inches (127 mm) o.c. Fill spaces between stiffeners with mineral-fiber insulation.
      2) Laminated Core: Honeycomb of resin-impregnated kraft paper with maximum 1-inch (25.4-mm) cells or foam-plastic insulation fastened to face sheets with waterproof adhesive.
         a) Foam-Plastic Insulated Doors: Thermal-resistance value (R-value) of not less than 4.0 deg F x h x sq. ft./Btu (0.704 K x sq. m/W) **OR** 6.0 deg F x h x sq.

ft./Btu (1.057 K x sq. m/W) **OR** 12.3 deg F x h x sq. ft./Btu (2.166 K x sq. m/W), **as directed**, when tested according to ASTM C 1363.

i. Locations: Exterior doors and interior doors, where indicated.

3) Laminated Steel-Stiffened Core: 0.031-inch- (0.79-mm-) thick, stainless-steel **OR** 0.030-inch- (0.76-mm-) nominal thickness uncoated steel **OR** 0.034-inch- (0.86-mm-) nominal thickness metallic-coated steel, **as directed**, vertical stiffeners extending full-door height, spaced not more than 6 inches (152 mm) apart, fastened to face sheets with waterproof adhesive. Fill spaces between stiffeners with mineral-fiber insulation.

4) Fire-Rated Door Core: As required to provide fire-protection and temperature-rise ratings indicated.

c. Vertical Edges for Single-Acting Doors: Beveled 1/8 inch in 2 inches (3 mm in 50 mm).

d. Vertical Edges for Double-Acting Doors: Round vertical edges with 2-1/8-inch (54-mm) radius.

e. Moldings for Glazed Lites in Doors: 0.038-inch- (0.95-mm-) thick stainless steel.

f. Loose Stops for Glazed Lites in Doors: 0.038-inch- (0.95-mm-) thick stainless steel.

g. Top and Bottom Channels: Closed with continuous channels, 0.062-inch- (1.59-mm-) thick stainless steel **OR** 0.060-inch- (1.52-mm-) nominal thickness uncoated steel **OR** 0.064-inch- (1.63-mm-) nominal thickness metallic-coated steel, **as directed**.

1) Spot welded to both face sheets.

OR

Securely fastened using adhesive.

h. Hardware Reinforcement: Fabricate according to ANSI/NAAMM-HMMA 866 with reinforcing plates from stainless **OR** uncoated **OR** metallic-coated, **as directed**, steel.

i. Electrical Hardware Enclosures: Provide enclosures and junction boxes within doors for electrically operated door hardware, interconnected with UL-approved, 1/2-inch- (12.7-mm-) diameter conduit and connectors.

1) Where indicated for installation of wiring, provide access plates to junction boxes, fabricate from same material and thickness as face sheet and fasten with at least four security fasteners spaced not more than 6 inches (152 mm) o.c.

2. Performance: Level A, ANSI A250.4.

3. Materials:

a. Stainless-Steel Sheet: ASTM A 240/A 240M, austenitic stainless steel, Type 304 **OR** Type 316, **as directed**.

b. Steel Sheet: ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, Commercial Steel (CS), Type B.

c. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

d. Foam-Plastic Insulation: Manufacturer's standard polystyrene **OR** urethane, **as directed**, board insulation with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84. Enclose insulation completely within door.

e. Mineral-Fiber Insulation: Insulation composed of rock-wool fibers, slag-wool fibers, or glass fibers.

4. Stainless-Steel Finishes:

a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

b. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1) Run grain of directional finishes with long dimension of each piece.

2) When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

3) Directional Satin Finish: No. 4.

4) Dull Satin Finish: No. 6.

5) Mirrorlike Reflective, Nondirectional Polish: No. 8.

c. Bright, Cold-Rolled, Unpolished Finish: No. 2B. Factory primed for field finish, **as directed**.

B. Stainless-Steel Panels
   1. Provide stainless-steel panels of same construction, materials, and finish as specified for adjoining stainless-steel doors.

C. Stainless-Steel Frames
   1. Description: Fabricate stainless-steel frames of construction indicated, with faces of corners mitered and contact edges closed tight.
      a. Door Frames: Machine mitered, faces only welded **OR** Saw mitered and full (continuously) welded **OR** Machine mitered and full welded **OR** Knock down **OR** Slip on **OR** As indicated, **as directed**.
         1) Weld frames according to HMMA 820.
      b. Sidelight, Transom and Borrowed-Light Frames: Machine mitered, faces only welded **OR** Saw mitered and full (continuously) welded **OR** Machine mitered and full welded, **as directed**.
      c. Door Frames for Openings 48 Inches (1219 mm) Wide or Less: Fabricate from 0.062-inch- (1.59-mm-) **OR** 0.078-inch- (1.98-mm-) **OR** 0.109-inch- (2.78-mm-), **as directed**, thick, stainless-steel sheet.
      d. Door Frames for Openings More Than 48 Inches (1219 mm) Wide: Fabricate from 0.078-inch- (1.98-mm-) **OR** 0.109-inch- (2.78-mm-), **as directed**, thick, stainless-steel sheet.
      e. Borrowed-Light Frames: Fabricate from 0.062-inch- (1.59-mm-) **OR** 0.078-inch- (1.98-mm-) **OR** 0.109-inch- (2.78-mm-), **as directed**, thick, stainless-steel sheet.
      f. Sidelight and Transom Frames: Fabricate from stainless-steel sheet of same thickness as adjacent door frame.
      g. Glazing and Panel Stops: Formed integral with stainless-steel frames, minimum 5/8 inch (16 mm) high, unless otherwise indicated.
      h. Loose Stops for Glazed Lites and Panels: 0.038-inch- (0.95-mm-) thick stainless steel.
      i. Hardware Reinforcement: Fabricate according to ANSI/NAAMM-HMMA 866 with reinforcing plates from stainless **OR** uncoated **OR** metallic-coated, **as directed**, steel.
      j. Head Reinforcement: 0.109-inch- (2.78-mm-) thick, stainless-steel channel or angle stiffener for openings widths more than 48 inches (1219 mm).
      k. Jamb Anchors:
         1) Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.062-inch- (1.59-mm-) thick stainless steel **OR** 0.060-inch- (1.52-mm-) nominal thickness uncoated steel **OR** 0.064-inch- (1.63-mm-) nominal thickness metallic-coated steel, **as directed**, with corrugated or perforated straps not less than 2 inches (50 mm) wide by 10 inches (250 mm) long; or wire anchors not less than 0.156 inch (4.0 mm) thick.
         2) Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.050-inch- (1.27-mm-) thick stainless steel **OR** 0.048-inch- (1.21-mm-) nominal thickness uncoated steel **OR** 0.052-inch- (1.32-mm-) nominal thickness metallic-coated steel, **as directed**.
         3) Compression Type for Slip-on Frames: Fabricate adjustable compression anchors from stainless **OR** uncoated **OR** metallic-coated, **as directed**, steel.
         4) Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch- (9.5-mm-) diameter, stainless-steel **OR** uncoated steel **OR** metallic-coated steel, **as directed**, bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.
      l. Floor Anchors: Not less than 0.078-inch- (1.98-mm-) thick stainless steel **OR** 0.075-inch- (1.90-mm-) nominal thickness uncoated steel **OR** 0.079-inch- (2.01-mm-) nominal thickness metallic-coated steel, **as directed**, and as follows:
         1) Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
         2) Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch (50-mm) height adjustment. Terminate bottom of frames at finish floor surface.

m. Ceiling Struts: Minimum 3/8-inch-thick by 2-inch- (9.5-mm-thick by 50-mm-) wide from stainless **OR** uncoated **OR** metallic-coated, **as directed**, steel.

n. Plaster Guards: Not less than 0.019-inch- (0.48-mm-) thick stainless steel **OR** 0.018-inch- (0.46-mm-) nominal thickness uncoated steel **OR** 0.022-inch- (0.56-mm-) nominal thickness metallic-coated steel, **as directed**.

2. Performance: Level A, ANSI A250.4.

3. Materials:

a. Stainless-Steel Sheet: ASTM A 240/A 240M, austenitic stainless steel, Type 304 **OR** Type 316, **as directed**.

b. Steel Sheet: ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, Commercial Steel (CS), Type B.

c. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

d. Frame Anchors: Stainless-steel sheet. Same type as door face.

OR

Frame Anchors: Steel sheet **OR** Metallic-coated steel sheet, **as directed**, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

e. Inserts, Bolts, and Anchor Fasteners: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Alloy Group 1 or 4) for bolts and nuts.

OR

Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

4. Finishes:

a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

b. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1) Run grain of directional finishes with long dimension of each piece.

2) When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

3) Directional Satin Finish: No. 4.

4) Dull Satin Finish: No. 6.

5) Mirrorlike Reflective, Nondirectional Polish: No. 8.

c. Bright, Cold-Rolled, Unpolished Finish: No. 2B. Factory primed for field finish, **as directed**.

D. Accessories

1. Glazing: Comply with requirements in Division 08 Section "Glazing".

2. Grout: Comply with ASTM C 476, with a slump of not more than 4 inches (102 mm) as measured according to ASTM C 143/C 143M.

3. Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

4. Mineral Fiber Insulation: Insulation composed of rock-wool fibers, slag-wool fibers, or glass fibers.

E. Fabrication

1. Stainless-Steel Door Fabrication: Stainless-steel doors to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal.

a. Seamed Edge Construction: Both vertical door edges joined by visible, continuous interlocking seam (lock seam) full height of door.

OR

Seamed Edge Construction: Both vertical door edges joined by visible seam that is projection, spot, or tack welded on inside edges of door at minimum 6 inches (152 mm) o.c.

b. Seamless Edge Construction: Door face sheets joined at vertical edges by continuous weld extending full height of door; with edges ground and polished, providing smooth, flush surfaces with no visible seams.
c. Exterior Doors: Close top edges flush and seal joints against water penetration. Provide weep-hole openings in bottom of exterior doors to permit moisture to escape.
d. Stops and Moldings: Factory cut openings in doors. Provide stops and moldings around glazed lites. Form corners of stops and moldings with butted or mitered hairline joints.
   1) Glazed Lites: Provide fixed stops and moldings welded on secure side of door.
   2) Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.
e. Hardware Preparation: Factory prepare stainless-steel doors to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping, according to the Door Hardware Schedule and templates furnished as specified in Division 8 Section "Door Hardware".
   1) Reinforce doors to receive nontemplated mortised and surface-mounted door hardware.
f. Locate hardware as indicated, or if not indicated, according to HMMA 831, "Recommended Hardware Locations for Custom Hollow Metal Doors and Frames."
g. Tolerances: Fabricate doors to tolerances indicated in ANSI/NAAMM-HMMA 866.

2. Stainless-Steel Frame Fabrication: Fabricate stainless-steel frames to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
   a. Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible. Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated from same thickness metal as frames.
   b. Mullions, Rails and Transom Bars: Provide closed tubular members with no visible face seams or joints. Fasten members at crossings and to jambs by butt welding according to joint designs in HMMA 820.
      1) Provide false head member to receive lower ceiling where frames extend to finish ceilings of different heights.
   c. Provide countersunk, flat-, or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
   d. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
   e. Jamb Anchors: Provide number and spacing of anchors as follows:
      1) Masonry Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:
         a) Two anchors per jamb up to 60 inches (1524 mm) in height.
         b) Three anchors per jamb from 60 to 90 inches (1524 to 2286 mm) in height.
         c) Four anchors per jamb from 90 to 96 inches (2286 to 2438 mm) in height.
         d) Four anchors per jamb plus one additional anchor per jamb for each 24 inches (610 mm) or fraction thereof more than 96 inches (2438 mm) in height.
      2) Stud-Wall Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:
         a) Three anchors per jamb up to 60 inches (1524 mm) in height.
         b) Four anchors per jamb from 60 to 90 inches (1524 to 2286 mm) in height.
         c) Five anchors per jamb from 90 to 96 inches (2286 to 2438 mm) in height.
         d) Five anchors per jamb plus one additional anchor per jamb for each 24 inches (610 mm) or fraction thereof more than 96 inches (2438 mm) in height.
         e) Two anchors per head for frames more than 42 inches (1066 mm) wide and mounted in metal-stud partitions.

3) Compression Type: Not less than two anchors in each jamb.
4) Postinstalled Expansion Type: Locate anchors not more than 6 inches (152 mm) from top and bottom of frame. Space anchors not more than 26 inches (660 mm) o.c.

f. Head Reinforcement: For frames more than 48 inches (1219 mm) wide, provide continuous head reinforcement for full width of opening, welded to back of frame at head.

g. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Provide plastic plugs to keep holes clear during construction.
1) Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
2) Double-Door Frames: Drill stop in head jamb to receive two door silencers.

h. Stops and Moldings: Provide stops and moldings around glazed lites and solid panels where indicated. Form corners of stops and moldings with butted or mitered hairline joints.
1) Single Glazed Lites: Provide fixed stops and moldings welded on secure side of door or frame.
2) Multiple Glazed Lites: Provide fixed and removable stops and moldings such that each lite is capable of being removed independently.
3) Coordinate rabbet width between fixed and removable stops with type of glazing or panel and type of installation indicated.
4) Terminated Stops: Where indicated for interior door frames, terminate stops 6 inches (152 mm) above finish floor with a 45 **OR** 90, **as directed**,-degree angle cut, and close open end of stop with stainless-steel sheet closure. Cover opening in extension of frame with welded-stainless-steel filler plate, with welds ground smooth and flush with frame.

i. Hardware Preparation: Factory prepare stainless-steel frames to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping, according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware (scheduled By Describing Products)".
1) Reinforce frames to receive nontemplated mortised and surface-mounted door hardware.
2) Locate hardware as indicated, or if not indicated, according to HMMA 831, "Recommended Hardware Locations for Custom Hollow Metal Doors and Frames."

j. Plaster Guards: Weld guards to frame at back of hardware mortises and mounting holes in frames to be grouted.

k. Tolerances: Fabricate frames to tolerances indicated in ANSI/NAAMM-HMMA 866.

1.3 EXECUTION

A. Examination
1. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of stainless-steel doors and frames.
2. Examine roughing-in for embedded and built-in anchors to verify actual locations of stainless-steel, door-frame connections before frame installation.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
2. Prior to installation and with installation spreaders in place, adjust and securely brace stainless-steel door frames for squareness, alignment, twist, and plumb to the following tolerances:
a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.

c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a perpendicular line from head to floor.

3. Drill and tap doors and frames to receive nontemplated mortised and surface-mounted door hardware.

C. Installation

1. General: Install stainless-steel doors and frames plumb, rigid, properly aligned, and securely fastened in place; comply with ANSI/NAAMM-HMMA 866 and manufacturer's written instructions.
2. Stainless-Steel Frames: Install stainless-steel frames of size and profile indicated.
   a. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
      1) At fire-protection-rated openings, install frames according to NFPA 80.
      2) Where frames are fabricated in sections due to shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
      3) Install frames with removable glazing stops located on secure side of opening.
      4) Install door silencers in frames before grouting.
      5) Remove temporary braces necessary for installation only after frames have been properly set and secured.
      6) Check plumb, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
      7) Apply corrosion-resistant coating to backs of grout-filled frames.
   b. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor and secure with postinstalled expansion anchors.
      1) Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors, if so indicated and approved on Shop Drawings.
   c. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.
   d. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
   e. In-Place Gypsum Board Partitions: Secure frames in place with postinstalled expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
   f. Ceiling Struts: Extend struts vertically from top of frame at each jamb to supporting construction above, unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction above. Provide adjustable wedged or bolted anchorage to frame jamb members.
   g. Grouted Frames: Solidly fill space between frames and substrate with grout. Take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.
   h. Installation Tolerances: Adjust stainless-steel frames for squareness, alignment, twist, and plumb to the following tolerances:
      1) Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
      2) Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
      3) Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
      4) Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.
3. Stainless-Steel Doors: Fit non-fire-rated doors accurately in frames with the following clearances:
   a. Non-Fire-Rated Doors:

1) Jambs and Head: 1/8 inch (3 mm) plus or minus 1/16 inch (1.6 mm).
2) Between Edges of Pairs of Doors: 1/8 inch (3 mm) plus or minus 1/16 inch (1.6 mm).
3) Between Bottom of Door and Top of Threshold: Maximum 3/8 inch (9.5 mm).
4) Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch (19 mm).

b. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
c. Smoke-Control Doors: Install doors according to NFPA 105.

4. Glazing: Install glazing in sidelights, transoms, and borrowed lights to comply with installation requirements in Division 08 Section "Glazing".
   a. Secure stops with countersunk, flat-, or oval-head machine screws spaced uniformly not more than 9 inches (230 mm) o.c., and not more than 2 inches (50 mm) o.c. from each corner.

D. Adjusting And Cleaning
1. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work including stainless-steel doors or frames that are warped, bowed, or otherwise unacceptable.
2. Clean grout and other bonding material off stainless-steel doors and frames immediately after installation.
3. Stainless-Steel Touchup: Immediately after erection, smooth any abraded areas of stainless steel and polish to match undamaged finish.

END OF SECTION 08110a

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Task	Specification	Specification Description
08110	08354	Sound Control Doors

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SECTION 08210 - FLUSH WOOD DOORS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for flush wood doors. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Solid-core doors and transom panels with wood-veneer, medium-density-overlay, hardboard or MDF, and plastic-laminate faces.
   b. Hollow-core doors with wood-veneer, hardboard or MDF, and plastic-laminate faces.
   c. Shop priming and Factory finishing flush wood doors.
   d. Factory fitting flush wood doors to frames and factory machining for hardware.

C. Submittals
1. Product Data: For each type of door indicated. Include factory-finishing specifications.
2. LEED Submittals:
   a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that flush wood doors comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
      1) Include statement indicating costs for each certified wood product.
   b. Product Data for Credit EQ 4.4: For adhesives and composite wood products, documentation indicating that product contains no urea formaldehyde.
3. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; location and extent of hardware blocking; and other pertinent data.
   a. Indicate dimensions and locations of mortises and holes for hardware.
   b. Indicate dimensions and locations of cutouts.
   c. Indicate requirements for veneer matching.
   d. Indicate doors to be factory finished and finish requirements.
   e. Indicate fire-protection ratings for fire-rated doors.
4. Samples: For plastic-laminate door faces and factory-finished doors.

D. Quality Assurance
1. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
2. Quality Standard: In addition to requirements specified, comply with AWI's "Architectural Woodwork Quality Standards Illustrated" **OR** WDMA I.S.1-A, "Architectural Wood Flush Doors" **OR** WI's "Manual of Millwork", **as directed**.
3. Forest Certification: Provide doors made with cores **OR** veneers **OR** not less than 70 percent of wood products **OR** all wood products, **as directed**, obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
4. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure **OR** as close to neutral pressure as possible, **as directed**, according to NFPA 252 **OR** UBC Standard 7-2 **OR** UL 10B **OR** UL 10C, **as directed**.
   a. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

b. Temperature-Rise Limit: Where indicated **OR** At vertical exit enclosures and exit passageways, **as directed**, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.

5. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
1. Comply with requirements of referenced standard and manufacturer's written instructions.
2. Package doors individually in plastic bags or cardboard cartons **OR** cardboard cartons and wrap bundles of doors in plastic sheeting, **as directed**.
3. Mark each door on bottom **OR** top and bottom, **as directed**, rail with opening number used on Shop Drawings.

F. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
a. Warranty Period for Solid-Core Exterior Doors: Two **OR** Five, **as directed**, years from date of Substantial Completion.
b. Warranty Period for Solid-Core Interior Doors: Life of installation.
c. Warranty Period for Hollow-Core Interior Doors: One **OR** Two, **as directed**, year(s) from date of Substantial Completion.

1.2 PRODUCTS

A. Door Construction, General
1. Low-Emitting Materials: Provide doors made with adhesives and composite wood products that do not contain urea formaldehyde.
2. WDMA I.S.1-A Performance Grade:
a. Heavy Duty unless otherwise indicated.
b. Extra Heavy Duty: Classrooms, public toilets, janitor's closets, assembly spaces, exits, patient rooms, and where indicated.
c. Standard Duty: Closets (not including janitor's closets), private toilets, and where indicated.
3. Particleboard-Core Doors:
a. Particleboard:
1) ANSI A208.1, Grade LD-1 **OR** Grade LD-2, **as directed**, made with binder containing no urea-formaldehyde resin, **as directed**.
OR
Straw-based particleboard complying with ANSI A208.1, Grade LD-2 or M-2, except for density.
b. Blocking: Provide wood blocking in particleboard-core doors as needed to eliminate through-bolting hardware.
c. Provide doors with glued-wood-stave **OR** structural-composite-lumber, **as directed**, cores instead of particleboard cores for doors indicated to receive exit devices.
4. Structural-Composite-Lumber-Core Doors:
a. Structural Composite Lumber: WDMA I.S.10.
1) Screw Withdrawal, Face: 700 lbf (3100 N).
2) Screw Withdrawal, Edge: 400 lbf (1780 N).
5. Fire-Protection-Rated Doors: Provide core specified or mineral core as needed to provide fire-protection rating indicated.
a. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.

b. Pairs: Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals, **as directed**. Comply with specified requirements for exposed edges.
OR
Pairs: Provide formed-steel edges and astragals with intumescent seals, **as directed**.
1) Finish steel edges and astragals with baked enamel same color as doors, **as directed**.
OR
Finish steel edges and astragals to match door hardware (locksets or exit devices).

6. Mineral-Core Doors:
   a. Core: Noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating indicated.
   b. Blocking: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated as needed to eliminate through-bolting hardware.
   c. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.
7. Hollow-Core Doors:
   a. Construction: Institutional **OR** Standard, **as directed**, hollow core.

B. Veneered-Faced Doors For Transparent Finish
1. Exterior Solid-Core Doors:
   a. Grade: Premium, with Grade AA faces **OR** Premium, with Grade A faces **OR** Custom (Grade A faces) **OR** Economy (Grade B faces), **as directed**.
   b. Species: Anigre **OR** Select white ash **OR** Figured select white ash **OR** Select white birch **OR** Cherry **OR** Select red gum **OR** Figured select red gum **OR** Select white maple **OR** Red oak **OR** Persimmon **OR** Sapele **OR** Sycamore **OR** Walnut **OR** White oak **OR** Ucuuba (Virola Duckei) **OR** Cupiuba (Goupia glabra), **as directed**.
   c. Cut: Rotary cut **OR** Plain sliced (flat sliced) **OR** Quarter sliced **OR** Rift cut, **as directed**.
   d. Match between Veneer Leaves: Book **OR** Slip **OR** Pleasing, **as directed**, match.
   e. Assembly of Veneer Leaves on Door Faces: Center-balance **OR** Balance **OR** Running, **as directed**, match.
   f. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions, **as directed**.
   g. Exposed Vertical **OR** Vertical and Top, **as directed**, Edges: Same species as faces or a compatible species **OR** Same species as faces **OR** Applied wood-veneer edges of same species as faces and covering edges of faces **OR** Applied wood edges of same species as faces and covering edges of crossbands, **as directed**.
   h. Core: Particleboard **OR** Glued wood stave **OR** Structural composite lumber**, as directed**.
   i. Construction: Five **OR** Five or seven, **as directed**, plies. Stiles and rails are bonded to core, then entire unit abrasive planed before veneering. Faces are bonded to core using a hot press, **as directed**.
   j. Adhesives: Type I per WDMA TM-6.
2. Interior Solid-Core Doors:
   a. Grade: Premium, with Grade AA faces **OR** Premium, with Grade A faces **OR** Custom (Grade A faces) **OR** Economy (Grade B faces), **as directed**.
   b. Species: Anigre **OR** Select white ash **OR** Figured select white ash **OR** Select white birch **OR** Cherry **OR** Select red gum **OR** Figured select red gum **OR** Select white maple **OR** Red oak **OR** Persimmon **OR** Sapele **OR** Sycamore **OR** Walnut **OR** White oak **OR** Ucuuba (Virola Duckei) **OR** Cupiuba (Goupia glabra), **as directed**.
   c. Cut: Rotary cut **OR** Plain sliced (flat sliced) **OR** Quarter sliced **OR** Rift cut, **as directed**.
   d. Match between Veneer Leaves: Book **OR** Slip **OR** Pleasing, **as directed**, match.
   e. Assembly of Veneer Leaves on Door Faces: Center-balance **OR** Balance **OR** Running, **as directed**, match.

f. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions, **as directed**.
g. Room Match:
1) Match door faces within each separate room or area of building. Corridor-door faces do not need to match where they are separated by 10 feet (3 m) **OR** 20 feet (6 m), **as directed**, or more.
OR
Provide door faces of compatible color and grain within each separate room or area of building.
h. Transom Match: Continuous match **OR** End match **OR** As indicated, **as directed**.
i. Blueprint Match: Where indicated, provide doors with faces produced from same flitches as adjacent wood paneling and arranged to provide blueprint match with wood paneling. Comply with requirements in Division 06 Section(s) "Interior Architectural Woodwork" OR "Paneling", **as directed**.
j. Exposed Vertical **OR** Vertical and Top, **as directed**, Edges: Same species as faces or a compatible species **OR** Same species as faces **OR** Applied wood-veneer edges of same species as faces and covering edges of faces **OR** Applied wood edges of same species as faces and covering edges of crossbands, **as directed**.
k. Core: Particleboard **OR** Glued wood stave **OR** Nonglued wood stave **OR** Structural composite lumber**, as directed**.
l. Construction:
1) Five **OR** Five or seven, **as directed**, plies. Stiles and rails are bonded to core, then entire unit abrasive planed before veneering. Faces are bonded to core using a hot press, **as directed**.
OR
Seven plies, either bonded or nonbonded construction.

3. Interior Hollow-Core Doors:
a. Grade: Premium, with Grade AA faces **OR** Premium, with Grade A faces **OR** Custom (Grade A faces) **OR** Economy (Grade B faces), **as directed**.
b. Species: Anigre **OR** Select white ash **OR** Figured select white ash **OR** Select white birch **OR** Cherry **OR** Select red gum **OR** Figured select red gum **OR** Select white maple **OR** Red oak **OR** Persimmon **OR** Sapele **OR** Sycamore **OR** Walnut **OR** White oak **OR** Ucuuba (Virola Duckei) **OR** Cupiuba (Goupia glabra), **as directed**.
c. Cut: Rotary cut **OR** Plain sliced (flat sliced) **OR** Quarter sliced **OR** Rift cut, **as directed**.
d. Match between Veneer Leaves: Book **OR** Slip **OR** Pleasing, **as directed**, match.
e. Assembly of Veneer Leaves on Door Faces: Center-balance **OR** Balance **OR** Running, **as directed**, match.
f. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions, **as directed**.
g. Exposed Vertical **OR** Vertical and Top, **as directed**, Edges: Same species as faces or a compatible species **OR** Same species as faces **OR** Applied wood-veneer edges of same species as faces and covering edges of faces **OR** Applied wood edges of same species as faces and covering edges of crossbands, **as directed**.
h. Construction: Seven plies.

C. Doors For Opaque Finish
1. Exterior Solid-Core Doors:
a. Grade: Premium **OR** Custom **OR** Economy, **as directed**.
b. Faces: Medium-density overlay **OR** Any closed-grain hardwood of mill option, **as directed**.
1) Apply medium-density overlay to standard-thickness, closed-grain, hardwood face veneers **OR** directly to high-density hardboard crossbands, **as directed**.
c. Exposed Vertical **OR** Vertical and Top, **as directed**, Edges: Any closed-grain hardwood.
d. Core: Particleboard **OR** Glued wood stave **OR** Structural composite lumber, **as directed**.

e. Construction: Five **OR** Five or seven, **as directed**, plies. Stiles and rails are bonded to core, then entire unit abrasive planed before veneering. Faces are bonded to core using a hot press, **as directed**.
f. Adhesives: Type I per WDMA TM-6.

2. Interior Solid-Core Doors:
   a. Grade: Premium **OR** Custom **OR** Economy, **as directed**.
   b. Faces: Medium-density overlay **OR** Any closed-grain hardwood of mill option **OR** Hardboard or MDF, **as directed**.
      1) Apply medium-density overlay to standard-thickness, closed-grain, hardwood face veneers **OR** directly to high-density hardboard crossbands, **as directed**.
      2) Hardboard Faces: AHA A135.4, Class 1 (tempered) or Class 2 (standard).
      3) MDF Faces: ANSI A208.2, Grade 150 or 160.
   c. Exposed Vertical **OR** Vertical and Top, **as directed**, Edges: Any closed-grain hardwood.
   d. Core: Particleboard **OR** Glued wood stave **OR** Nonglued wood stave **OR** Structural composite lumber, **as directed**.
   e. Construction:
      1) Three **OR** Five **OR** Five or seven, **as directed**, plies. Stiles and rails are bonded to core, then entire unit abrasive planed before veneering. Faces are bonded to core using a hot press, **as directed**.
         OR
         Three **OR** Seven, **as directed**, plies, either bonded or nonbonded construction.

3. Interior Hollow-Core Doors:
   a. Grade: Premium **OR** Custom **OR** Economy, **as directed**.
   b. Faces: Medium-density overlay **OR** Any closed-grain hardwood of mill option **OR** Hardboard or MDF, **as directed**.
      1) Hardboard Faces: AHA A135.4, Class 1 (tempered) or Class 2 (standard).
      2) MDF Faces: ANSI A208.2, Grade 150 or 160.
   c. Exposed Vertical **OR** Vertical and Top, **as directed**, Edges: Any closed-grain hardwood.
   d. Construction: Three **OR** Seven, **as directed**, plies.

D. Plastic-Laminate-Faced Doors

1. Interior Solid-Core Doors:
   a. Grade: Premium **OR** Custom **OR** Economy, **as directed**.
   b. Plastic-Laminate Faces: High-pressure decorative laminates complying with NEMA LD 3, Grade HGS **OR** Grade HSH, **as directed**.
   c. Colors, Patterns, and Finishes: As indicated **OR** As selected from laminate manufacturer's full range of products, **as directed**.
   d. Exposed Vertical **OR** Vertical and Top, **as directed**, Edges: Hardwood edges for staining to match faces **OR** Hardwood edges for painting **OR** Plastic laminate that matches faces, applied before faces **OR** Impact-resistant polymer edging, applied after faces, **as directed**.
      1) Polymer Edging Color: Beige **OR** Brown **OR** Same color as faces, **as directed**.
   e. Core: Particleboard **OR** Glued wood stave **OR** Structural composite lumber, **as directed**.
   f. Construction:
      1) Three plies. Stiles and rails are bonded to core, then entire unit abrasive planed before faces are applied. Faces are bonded to core using a hot press, **as directed**.
         OR
         Five plies. Stiles and rails are bonded to core, then entire unit abrasive planed before faces and crossbands are applied. Faces are bonded to core using a hot press, **as directed**.

2. Interior Hollow-Core Doors:
   a. Grade: Premium **OR** Custom **OR** Economy, **as directed**.
   b. Plastic-Laminate Faces: High-pressure decorative laminates complying with NEMA LD 3, Grade HGS **OR** Grade HSH, **as directed**.
   c. Colors, Patterns, and Finishes: As indicated **OR** As selected from laminate manufacturer's full range of products, **as directed**.

d. Exposed Vertical **OR** Vertical and Top, **as directed**, Edges: Hardwood edges for staining to match faces **OR** Hardwood edges for painting **OR** Plastic laminate that matches faces, applied before faces **OR** Impact-resistant polymer edging, applied after faces, **as directed**.
   1) Polymer Edging Color: Beige **OR** Brown **OR** Same color as faces, **as directed**.
e. Construction: Plastic-laminate faces glued directly to core.

E. Louvers And Light Frames
1. Wood Louvers: Door manufacturer's standard solid-wood louvers unless otherwise indicated.
   a. Wood Species: Same species as door faces **OR** Species compatible with door faces **OR** Any closed-grain hardwood, **as directed**.
2. Metal Louvers:
   a. Blade Type: Vision-proof, inverted V **OR** Vision-proof, inverted Y **OR** Darkroom-type, double inverted V, **as directed**.
   b. Metal and Finish:
      1) Hot-dip galvanized steel, 0.040 inch (1.0 mm) thick, factory primed for paint finish **OR** with baked-enamel- or powder-coated finish, **as directed**.
         OR
         Extruded aluminum with Class II, clear anodic finish, AA-M12C22A31.
         OR
         Extruded aluminum with light bronze **OR** medium bronze **OR** dark bronze **OR** black, **as directed**, Class II, color anodic finish, AA-M12C22A32/A34.
3. Louvers for Fire-Rated Doors: Metal louvers with fusible link and closing device, listed and labeled for use in doors with fire-protection rating of 1-1/2 hours and less.
   a. Metal and Finish: Hot-dip galvanized steel, 0.040 inch (1.0 mm) thick, factory primed for paint finish **OR** with baked-enamel- or powder-coated finish, **as directed**.
4. Wood Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads as follows unless otherwise indicated.
   a. Wood Species: Same species as door faces **OR** Species compatible with door faces **OR** Any closed-grain hardwood, **as directed**.
   b. Profile: Flush rectangular beads **OR** Recessed tapered beads **OR** Recessed tapered beads with exposed banding **OR** Lipped tapered beads **OR** Manufacturer's standard shape, **as directed**.
   c. At wood-core doors with 20-minute fire-protection ratings, provide wood beads and metal glazing clips approved for such use.
5. Wood-Veneered Beads for Light Openings in Fire-Rated Doors: Manufacturer's standard wood-veneered noncombustible beads matching veneer species of door faces and approved for use in doors of fire-protection rating indicated. Include concealed metal glazing clips where required for opening size and fire-protection rating indicated.
6. Metal Frames for Light Openings in Fire-Rated Doors: Manufacturer's standard frame formed of 0.048-inch- (1.2-mm-) thick, cold-rolled steel sheet; factory primed for paint finish **OR** with baked-enamel- or powder-coated finish, **as directed**; and approved for use in doors of fire-protection rating indicated.

F. Fabrication
1. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
   a. Comply with requirements in NFPA 80 for fire-rated doors.
2. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W series standards, and hardware templates.
   a. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.
   b. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.

3. Transom and Side Panels: Fabricate matching panels with same construction, exposed surfaces, and finish as specified for associated doors. Finish bottom edges of transoms and top edges of rabbeted doors same as door stiles.
   a. Fabricate door and transom panels with full-width, solid-lumber, rabbeted, **as directed**, meeting rails. Provide factory-installed spring bolts for concealed attachment into jambs of metal door frames.
4. Openings: Cut and trim openings through doors in factory.
   a. Light Openings: Trim openings with moldings of material and profile indicated.
   b. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Division 08 Section "Glazing".
   c. Louvers: Factory install louvers in prepared openings.
5. Exterior Doors: Factory treat exterior doors with water repellent after fabrication has been completed but before shop priming **OR** factory finishing, **as directed**.
   a. Flash top of outswinging doors (with manufacturer's standard metal flashing).

G. Shop Priming
1. Doors for Opaque Finish: Shop prime doors with one coat of wood primer specified in Division 09 Section(s) "Exterior Painting" OR "Interior Painting", **as directed**. Seal all four edges, edges of cutouts, and mortises with primer.
2. Doors for Transparent Finish: Shop prime doors with stain (if required), other required pretreatments, and first coat of finish as specified in Division 09 Section(s) "Exterior Painting" OR "Interior Painting" OR "Wood Stains And Transparent Finishes", **as directed**. Seal all four edges, edges of cutouts, and mortises with first coat of finish.

H. Factory Finishing
1. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
   a. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on bottom **OR** top and bottom, **as directed**, edges, edges of cutouts, and mortises.
2. Finish doors at factory.
   OR
   Finish doors at factory that are indicated to receive transparent finish. Field finish doors indicated to receive opaque finish.
   OR
   Finish doors at factory where indicated in schedules or on Drawings as factory finished.
3. Transparent Finish:
   a. Grade: Premium **OR** Custom, **as directed**.
   b. Finish:
      1) AWI conversion varnish **OR** catalyzed polyurethane, **as directed**, system.
         OR
         WDMA TR-4 conversion varnish **OR** TR-6 catalyzed polyurethane, **as directed**.
         OR
         WI System 4 clear conversion varnish **OR** 5 catalyzed polyurethane **OR** 8 UV-curable coating, **as directed**.
   c. Staining: Match sample **OR** As selected from manufacturer's full range **OR** None required, **as directed**.
   d. Effect: Open-grain finish **OR** Filled finish **OR** Semifilled finish, produced by applying an additional finish coat to partially fill the wood pores, **as directed**.
   e. Sheen: Satin **OR** Semigloss, **as directed**.
4. Opaque Finish:
   a. Grade: Premium **OR** Custom, **as directed**.
   b. Finish:
      1) AWI conversion varnish **OR** catalyzed polyurethane, **as directed**, system.
         OR
         WDMA OP-4 conversion varnish **OR** OP-6 catalyzed polyurethane, **as directed**.

OR

WI System 4 conversion varnish **OR** 5 catalyzed polyurethane **OR** 8 UV-curable coating, **as directed**.

c. Color: Match sample **OR** As selected from manufacturer's full range, **as directed**.

d. Sheen: Satin **OR** Semigloss **OR** Gloss, **as directed**.

1.3 EXECUTION

A. Installation

1. Hardware: For installation, see Division 08 Section "Door Hardware".
2. Installation Instructions: Install doors to comply with manufacturer's written instructions and the referenced quality standard, and as indicated.
   a. Install fire-rated doors in corresponding fire-rated frames according to NFPA 80.
3. Job-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors. Machine doors for hardware. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.
   a. Clearances: Provide 1/8 inch (3.2 mm) at heads, jambs, and between pairs of doors. Provide 1/8 inch (3.2 mm) from bottom of door to top of decorative floor finish or covering unless otherwise indicated. Where threshold is shown or scheduled, provide 1/4 inch (6.4 mm) from bottom of door to top of threshold unless otherwise indicated.
      1) Comply with NFPA 80 for fire-rated doors.
   b. Bevel non-fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) at lock and hinge edges.
   c. Bevel fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) at lock edge; trim stiles and rails only to extent permitted by labeling agency.
4. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
5. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

B. Adjusting

1. Operation: Rehang or replace doors that do not swing or operate freely.
2. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 08210

SECTION 08210a - STILE AND RAIL WOOD DOORS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for stile and rail wood doors. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Exterior stile and rail wood doors and sidelites.
b. Interior stile and rail wood doors.
c. Interior fire-rated, stile and rail wood doors.
d. Interior fire-rated, wood door and sidelite frames.
e. Priming and Finishing stile and rail wood doors.
f. Fitting stile and rail wood doors to frames and machining for hardware.
g. Prehanging doors in frames.

C. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that wood used for stile and rail wood doors complies with forest certification requirements.
1) Include statement indicating costs for each certified wood product.
b. Product Data for Credit EQ 4.4: For adhesives and composite wood materials, documentation indicating that products contain no urea formaldehyde.
3. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; and other pertinent data.
4. Samples: Representing typical range of color and grain for each species of veneer and solid lumber required. Finish Sample with same materials proposed for factory-finished doors.

D. Quality Assurance
1. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
2. Forest Certification: Provide doors made with veneers **OR** not less than 70 percent of wood products **OR** all wood products, **as directed**, obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
3. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure **OR** as close to neutral pressure as possible, **as directed**, according to NFPA 252 **OR** UBC Standard 7-2 **OR** UL 10B **OR** UL 10C, **as directed**.
a. Temperature-Rise Limit: Where indicated **OR** At vertical exit enclosures and exit passageways, **as directed**, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.
4. Safety Glass: Provide products complying with testing requirements in 16 CFR 1201, for Category II materials, unless those of Category I are expressly indicated and permitted.

E. Delivery, Storage, And Handling
1. Comply with manufacturer's written instructions and requirements of quality standard referenced in Part 1.2.

2. Package doors individually in opaque plastic bags or cardboard cartons.
3. Mark each door on top and bottom edge with opening number used on Shop Drawings.

F. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship, or have warped (bow, cup, or twist) more than 1/4 inch (6.4 mm) in a 42-by-84-inch (1067-by-2134-mm) section.
   a. Warranty shall be in effect during the following period of time from date of Substantial Completion:
      1) Exterior Doors: None **OR** One year **OR** Two years **OR** Five years, **as directed**.
      2) Interior Doors: One year **OR** Five years **OR** Life of installation, **as directed**.
      3) Insulated **OR** Insulating Leaded, **as directed**, Glass Vision Panels: Three **OR** Five, **as directed**, years.

1.2 PRODUCTS

A. Materials
1. General: Use only materials that comply with referenced standards and other requirements specified.
   a. Assemble exterior doors and sidelites, including components, with wet-use adhesives complying with ASTM D 5572 for finger joints and with ASTM D 5751 for joints other than finger joints.
   b. Assemble interior doors, frames, and sidelites, including components, with either dry-use or wet-use adhesives complying with ASTM D 5572 for finger joints and with ASTM D 5751 for joints other than finger joints.
2. Low-Emitting Materials: Provide doors made with adhesives and composite wood products that do not contain urea-formaldehyde resins.
3. Panel Products: Any of the following:
   a. Particleboard made from wood particles, with binder containing no urea-formaldehyde resin, complying with ANSI A208.1, Grade M-2.
      OR
      Particleboard made from straw, complying with ANSI A208.1, Grade M-2, except for density.
   b. Medium-density fiberboard made from wood fiber, with binder containing no urea-formaldehyde resin, complying with ANSI A208.2, Grade 130.
   c. Hardboard, complying with AHA A135.4.
   d. Veneer core plywood, made with adhesive containing no urea-formaldehyde resin.

B. Exterior Stile And Rail Wood Doors
1. Exterior Stile and Rail Wood Doors: Stock exterior doors complying with WDMA I.S.6, "Industry Standard for Wood Stile and Rail Doors," and with other requirements specified.
   a. Finish and Grade: Transparent and Premium or Select **OR** Opaque and Standard, **as directed**.
   b. Wood Species: Idaho white, lodgepole, ponderosa, or sugar pine **OR** Manufacturer's standard softwood species and cut, **as directed**.
   c. Stile and Rail Construction: Edge-glued solid lumber **OR** veneered, structural composite lumber **OR** veneered edge- and end-glued lumber, **as directed**.
   d. Panel Construction: Edge-glued solid lumber **OR** veneered panel product, **as directed**.
   e. Raised-Panel Thickness: Manufacturer's standard, but not less than that required by WDMA I.S.6 for design group indicated **OR** As indicated, **as directed**.
   f. Molding Profile (Sticking): Manufacturer's standard **OR** As selected from manufacturer's full range, **as directed**.
   g. Glass: Uncoated, clear, fully tempered float glass, 5.0 mm thick **OR** laminated glass made from two lites of 3.0-mm-thick annealed glass **OR** insulating-glass units made from two

lites of 3.0-mm-thick, fully tempered glass with 1/4-inch (6.4-mm) interspace, **as directed**, complying with Division 08 Section "Glazing".

h. WDMA Design Group: 1-3/4 Front Entrance Doors (Exterior) **OR** 1-3/4 Thermal (Insulated-Glass) Doors (Exterior) **OR** 8'-0" High Doors **OR** Side Lights **OR** 1-3/4 and 1-3/8 Entrance Doors (Exterior) **OR** Combination Doors **OR** Screen Doors, **as directed**.

i. Mark, label, or otherwise identify stile and rail wood doors as complying with WDMA I.S.6 and grade specified. Include panel design number if applicable.

2. Exterior Stile and Rail Wood Doors: Stock **OR** Custom, **as directed**, exterior doors complying with AWI's "Architectural Woodwork Quality Standards," **OR** WI's "Manual of Millwork," **OR** WDMA I.S.6A, "Industry Standard for Architectural Stile and Rail Doors," **as directed**, and with other requirements specified.

a. Panel Designs: Indicated by Drawings. Do not modify intended aesthetic effects, as judged solely by the Owner, except with the Owner's approval. If modifications are proposed, submit comprehensive explanatory data to the Owner for review.

b. Grade: Premium **OR** Custom, **as directed**.

c. Finish: Transparent **OR** Opaque, **as directed**.

d. Wood Species and Cut for Transparent Finish: Idaho white, lodgepole, ponderosa, or sugar pine, plain sawed/sliced **OR** Douglas fir or western hemlock, quarter sawed/sliced (vertical grain) **OR** Red oak, quarter sawed/sliced stiles and rails, plain sawed/sliced panels **OR** Species indicated in schedule, plain sawed/sliced, **as directed**.

e. Door Construction for Transparent Finish:

1) Stile and Rail Construction:

a) Clear lumber; may be edge glued for width. Select lumber for similarity of grain and color, and arrange for optimum match between adjacent pieces.

OR

Veneered, structural composite lumber or veneered, edge- and end-glued clear lumber, **as directed**. Select veneers for similarity of grain and color, and arrange for optimum match between adjacent pieces. Use veneers not less than 1/16 inch (1.6 mm) thick, **as directed**.

2) Raised-Panel Construction:

a) Clear lumber; edge glued for width. Select lumber for similarity of grain and color, and arrange for optimum match between adjacent pieces.

OR

Edge-glued, clear lumber; glued to both sides of a wood-based panel product. Select lumber for similarity of grain and color, and arrange for optimum match between adjacent pieces.

OR

Veneered, wood-based panel product with mitered, raised rims made from matching clear lumber.

OR

Veneered, shaped, wood-based panel product with veneer conforming to raised-panel shape.

f. Door Construction for Opaque Finish:

1) Stile and Rail Construction: Clear softwood; may be edge glued for width and finger jointed.

OR

Stile and Rail Construction: Veneered, structural composite lumber or veneered edge- and end-glued lumber, **as directed**.

2) Raised-Panel Construction: Clear softwood lumber; edge glued for width.

OR

Raised-Panel Construction: Veneered, wood-based panel product.

g. Stile and Rail Widths: As indicated **OR** Manufacturer's standard, but not less than the following, **as directed**:

1) Stiles, Top and Intermediate Rails: 5-3/8 inches (137 mm).

2) Bottom Rails: 11-3/8 inches (289 mm).

h. Raised-Panel Thickness: As indicated **OR** 1-3/4 inches (44 mm) **OR** 1-3/8 inches (35 mm) **OR** Manufacturer's standard, but not less than 1-1/8 inches (29 mm), **as directed**.
i. Molding Profile (Sticking): Bead and cove **OR** Ogee **OR** Ovalo **OR** Recessed bevel **OR** Recessed square **OR** Manufacturer's standard **OR** As selected from manufacturer's full range, **as directed**.
j. Glass: Uncoated, clear, fully tempered float glass, 5.0 mm thick **OR** laminated glass made from two lites of 3.0-mm-thick annealed glass **OR** insulating-glass units made from two lites of 3.0-mm-thick, fully tempered glass with 1/4-inch (6.4-mm) interspace, **as directed**, complying with Division 08 Section "Glazing".
k. Provide AWI Quality Certification Labels or an AWI letter of licensing for Project indicating that doors comply with requirements of grades specified.
OR
Provide WI-Certified Compliance Certificate indicating that doors comply with requirements of grades specified.
l. Mark, label, or otherwise identify stile and rail wood doors as complying with WDMA I.S.6A and grade specified.

C. Interior Stile And Rail Wood Doors
1. Interior Stile and Rail Wood Doors: Stock interior doors complying with WDMA I.S.6, "Industry Standard for Wood Stile and Rail Doors," and with other requirements specified.
a. Finish and Grade: Transparent and Premium or Select **OR** Opaque and Standard, **as directed**.
b. Wood Species: Idaho white, lodgepole, ponderosa, or sugar pine **OR** Douglas fir or western hemlock, vertical sawed/sliced **OR** Red oak, quarter sawed/sliced **OR** Manufacturer's standard softwood species and cut, **as directed**.
c. Stile and Rail Construction: Edge-glued solid lumber **OR** veneered, structural composite lumber **OR** veneered edge- and end-glued lumber, **as directed**.
d. Raised-Panel Construction: Edge-glued solid lumber **OR** Veneered panel product **OR** shaped, medium-density fiberboard, **as directed**.
e. Flat-Panel Construction: Veneered panel product **OR** hardboard or medium-density fiberboard, **as directed**.
f. Raised-Panel Thickness: Manufacturer's standard, but not less than that required by WDMA I.S.6 for design group indicated **OR** As indicated, **as directed**.
g. Flat-Panel Thickness: Manufacturer's standard, but not less than that required by WDMA I.S.6 for design group indicated **OR** As indicated, **as directed**.
h. Molding Profile (Sticking): Manufacturer's standard **OR** As selected from manufacturer's full range, **as directed**.
i. Glass: Uncoated, clear, fully tempered float glass, 5.0 mm thick **OR** laminated glass made from two lites of 3.0-mm-thick annealed glass, **as directed**, complying with Division 08 Section "Glazing".
j. WDMA Design Group: 1-3/8 Interior Panel Doors **OR** French Doors **OR** 8'-0" High Doors **OR** Bifold Doors, **as directed**.
k. Mark, label, or otherwise identify stile and rail wood doors as complying with WDMA I.S.6 and grade specified. Include panel design number if applicable.
2. Interior Stile and Rail Wood Doors: Stock **OR** Custom, **as directed**, interior doors complying with AWI's "Architectural Woodwork Quality Standards," **OR** WI's "Manual of Millwork," **OR** WDMA I.S.6A, "Industry Standard for Architectural Stile and Rail Doors," **as directed**, and with other requirements specified.
a. Panel Designs: Indicated by Drawings. Do not modify intended aesthetic effects, as judged solely by the Owner, except with the Owner's approval. If modifications are proposed, submit comprehensive explanatory data to the Owner for review.
b. Grade: Premium **OR** Custom, **as directed**.
c. Finish: Transparent **OR** Opaque, **as directed**.
d. Wood Species and Cut for Transparent Finish: Idaho white, lodgepole, ponderosa, or sugar pine, plain sawed/sliced **OR** Douglas fir or western hemlock, quarter sawed/sliced

(vertical grain) **OR** Red oak, quarter sawed/sliced stiles and rails, plain sawed/sliced panels **OR** Species indicated in schedule, plain sawed/sliced, **as directed**.

e. Door Construction for Transparent Finish:
   1) Stile and Rail Construction: Clear lumber; may be edge glued for width. Select lumber for similarity of grain and color, and arrange for optimum match between adjacent pieces.
      OR
      Stile and Rail Construction: Veneered, structural composite lumber **OR** veneered, edge- and end-glued clear lumber, **as directed**. Select veneers for similarity of grain and color, and arrange for optimum match between adjacent pieces. Use veneers not less than 1/16 inch (1.6 mm) thick, **as directed**.
   2) Raised-Panel Construction: Clear lumber; edge glued for width. Select lumber for similarity of grain and color, and arrange for optimum match between adjacent pieces.
      OR
      Raised-Panel Construction: Edge-glued, clear lumber; glued to both sides of a wood-based panel product. Select lumber for similarity of grain and color, and arrange for optimum match between adjacent pieces.
      OR
      Raised-Panel Construction: Veneered, wood-based panel product with mitered, raised rims made from matching clear lumber.
      OR
      Raised-Panel Construction: Veneered, shaped, wood-based panel product with veneer conforming to raised-panel shape.
   3) Flat-Panel Construction: Veneered, wood-based panel product.

f. Door Construction for Opaque Finish:
   1) Stile and Rail Construction: Clear softwood; may be edge glued for width and finger jointed.
      OR
      Stile and Rail Construction: Veneered, structural composite lumber **OR** veneered edge- and end-glued lumber, **as directed**.
   2) Raised-Panel Construction: Clear softwood lumber; edge glued for width.
      OR
      Raised-Panel Construction: Shaped, medium-density fiberboard.
   3) Flat-Panel Construction: Veneered, wood-based panel product **OR** Medium-density fiberboard, **as directed**.

g. Stile and Rail Widths: As indicated **OR** Manufacturer's standard, but not less than the following, **as directed**:
   1) Stiles, Top and Intermediate Rails: 4-1/2 inches (114 mm).
   2) Bottom Rails: 9 inches (229 mm).

h. Raised-Panel Thickness: As indicated **OR** 1-3/4 inches (44 mm) **OR** 1-3/8 inches (35 mm) **OR** Manufacturer's standard, but not less than 1-1/8 inches (29 mm) **OR** Manufacturer's standard, but not less than 3/4 inch (19 mm), **as directed**.

i. Flat-Panel Thickness: As indicated **OR** 1/2 inch (13 mm) **OR** 3/8 inch (10 mm) **OR** 1/4 inch (6.4 mm), **as directed**.

j. Molding Profile (Sticking): Bead and cove **OR** Ogee **OR** Ovalo **OR** Recessed bevel **OR** Recessed square **OR** Manufacturer's standard **OR** As selected from manufacturer's full range, **as directed**.

k. Glass: Uncoated, clear, fully tempered float glass, 5.0 mm thick **OR** laminated glass made from two lites of 3.0-mm-thick annealed glass, **as directed**, complying with Division 08 Section "Glazing".

l. Provide AWI Quality Certification Labels or an AWI letter of licensing for Project indicating that doors comply with requirements of grades specified.
   OR
   Provide WI-Certified Compliance Certificate indicating that doors comply with requirements of grades specified.

m. Mark, label, or otherwise identify stile and rail wood doors as complying with WDMA I.S.6A and grade specified.

3. Interior Stile and Rail Wood Doors: Fire-rated (20-minute rating) doors complying with AWI's "Architectural Woodwork Quality Standards," **OR** WI's "Manual of Millwork," **OR** WDMA I.S.6A, "Industry Standard for Architectural Stile and Rail Doors," **as directed**, and with other requirements specified.
   a. Panel Designs: Indicated by Drawings. Do not modify intended aesthetic effects, as judged solely by the Owner, except with the Owner's approval. If modifications are proposed, submit comprehensive explanatory data to the Owner for review.
   b. Grade: Premium **OR** Custom, **as directed**.
   c. Finish: Transparent **OR** Opaque, **as directed**.
   d. Wood Species and Cut for Transparent Finish: Idaho white, lodgepole, ponderosa, or sugar pine, plain sawed/sliced **OR** Douglas fir or western hemlock, quarter sawed/sliced (vertical grain) **OR** Red oak, quarter sawed/sliced stiles and rails, plain sawed/sliced panels **OR** Species indicated in schedule, plain sawed/sliced, **as directed**.
   e. Door Construction for Transparent Finish: 1-3/4-inch- (44-mm-) thick stiles and rails and veneered flat panels not less than 5/8 inch (16 mm) thick **OR** raised panels not less than 1-1/8 inches (29 mm) thick, **as directed**.
      1) Stile and Rail Construction: Veneered, structural composite lumber **OR** veneered, edge- and end-glued clear lumber, **as directed**. Select veneers for similarity of grain and color, and arrange for optimum match between adjacent pieces. Use veneers not less than 1/16 inch (1.6 mm) thick, **as directed**.
      2) Raised-Panel Construction: Veneered, shaped, wood-based panel product with veneer conforming to raised-panel shape.
      3) Flat-Panel Construction: Veneered, wood-based panel product.
   f. Door Construction for Opaque Finish: 1-3/4-inch- (44-mm-) thick stiles and rails and veneered flat panels not less than 5/8 inch (16 mm) thick **OR** raised panels not less than 1-1/8 inches (29 mm) thick, **as directed**.
      1) Stile and Rail Construction: Veneered, structural composite lumber **OR** veneered edge- and end-glued lumber, **as directed**.
      2) Raised-Panel Construction: Shaped, medium-density fiberboard.
      3) Flat-Panel Construction: Veneered, wood-based panel product **OR** Medium-density fiberboard, **as directed**.
   g. Stile and Rail Widths: As indicated **OR** Manufacturer's standard, but not less than the following, **as directed**:
      1) Stiles, Top and Intermediate Rails: 4-1/2 inches (114 mm).
      2) Bottom Rails: 9 inches (229 mm).
   h. Molding Profile (Sticking): Bead and cove **OR** Ogee **OR** Ovalo **OR** Recessed bevel **OR** Recessed square **OR** Manufacturer's standard **OR** As selected from manufacturer's full range, **as directed**.
   i. Provide AWI Quality Certification Labels or an AWI letter of licensing for Project indicating that doors comply with requirements of grades specified.
      OR
      Provide WI-Certified Compliance Certificate indicating that doors comply with requirements of grades specified.
   j. Mark, label, or otherwise identify stile and rail wood doors as complying with WDMA I.S.6A and grade specified.

4. Interior Stile and Rail Wood Doors: Fire-rated (45-minute rating) doors complying with AWI's "Architectural Woodwork Quality Standards," **OR** WI's "Manual of Millwork," **as directed**, and with other requirements specified.
   a. Panel Designs: Indicate by Drawings. Do not modify intended aesthetic effects, as judged solely by the Owner, except with the Owner's approval. If modifications are proposed, submit comprehensive explanatory data to the Owner for review.
   b. Grade: Premium **OR** Custom, **as directed**.
   c. Finish: Transparent **OR** Opaque, **as directed**.

d. Wood Species and Cut for Transparent Finish: Idaho white, lodgepole, ponderosa, or sugar pine, plain sawed/sliced **OR** Douglas fir or western hemlock, quarter sawed/sliced (vertical grain) **OR** Red oak, quarter sawed/sliced stiles and rails, plain sawed/sliced panels **OR** Species indicated in schedule, plain sawed/sliced, **as directed**.

e. Interior Fire-Rated Door Construction: 1-3/4-inch- (44-mm-) thick, edged and veneered mineral-core stiles and rails and 1-1/8-inch- (29-mm-) thick, veneered mineral-core raised panels.

f. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.
   1) Screw-Holding Capability: 550 lbf (2440 N) **OR** 475 lbf (2110 N) **OR** 400 lbf (1780 N), **as directed**, per NWWDA T.M.-10.

g. Stile and Rail Widths: As indicated **OR** Manufacturer's standard, but not less than the following, **as directed**:
   1) Stiles, Top and Intermediate Rails: 4-1/2 inches (114 mm).
   2) Bottom Rails: 9 inches (229 mm).

h. Molding Profile (Sticking): Bead and cove **OR** Ogee **OR** Ovalo **OR** Recessed bevel **OR** Recessed square **OR** Manufacturer's standard **OR** As selected from manufacturer's full range, **as directed**.

i. Provide AWI Quality Certification Labels or an AWI letter of licensing for Project indicating that doors comply with requirements of grades specified.
   OR
   Provide WI-Certified Compliance Certificate indicating that doors comply with requirements of grades specified.

D. Interior Fire-Rated Wood Door Frames
1. Interior Fire-Rated Wood Door Frames: Frames, complete with casings **OR** sidelite frames and casings, **as directed**, fabricated from solid fire-retardant-treated wood or from veneered fire-retardant particleboard, fire-retardant medium-density fiberboard, or mineral board.
2. Species: Red oak **OR** White oak **OR** White maple **OR** Cherry, **as directed**.

E. Stile And Rail Wood Door Fabrication
1. Fabricate stile and rail wood doors in sizes indicated for field fitting.
2. Factory fit doors to suit frame-opening sizes indicated, with the following uniform clearances and bevels unless otherwise indicated:
   a. Clearances: Provide 1/8 inch (3 mm) at heads, jambs, and between pairs of doors. Provide 1/2 inch (13 mm) from bottom of door to top of decorative floor finish or covering. Where threshold is shown or scheduled, provide not more than 3/8 inch (10 mm) from bottom of door to top of threshold.
      1) Comply with NFPA 80 for fire-rated doors.
   b. Bevel non-fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) at lock and hinge edges.
   c. Bevel fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) on lock edge; trim stiles and rails only to extent permitted by labeling agency.
3. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W Series standards, and hardware templates.
4. Glazed Openings: Trim openings indicated for glazing with solid wood moldings, with one side removable. Miter wood moldings at corner joints.
   OR
   Glazed Openings: Glaze doors at factory with glass of type and thickness indicated, complying with Division 08 Section "Glazing". Install glass using manufacturer's standard elastomeric glazing sealant complying with ASTM C 920. Secure glass in place with removable wood moldings. Miter wood moldings at corner joints.
5. Transom and Side Panels: Fabricate panels to match adjoining doors in materials, finish, and quality of construction.

6. Exterior Doors: Factory treat exterior doors after fabrication with water-repellent preservative to comply with WDMA I.S.4. Flash top of outswinging doors with manufacturer's standard metal flashing.
7. Prehung Doors: Provide stile and rail doors as prehung units including doors, frames, weather stripping, **as directed**, and hardware.
   a. Provide wood door frames, other than fire-rated wood door frames, that comply with Division 06 Section(s) "Interior Finish Carpentry" OR "Interior Architectural Woodwork", **as directed**.
   b. Provide hardware, including weather stripping and thresholds, that complies with Division 08 Section "Door Hardware".

F. Shop Priming
1. Doors for Opaque Finish: Shop prime doors with one coat of wood primer specified in Division 09 Section(s) "Exterior Painting" OR "Interior Painting", **as directed**. Seal all four edges, edges of cutouts, and mortises with primer.
2. Doors for Transparent Finish: Shop prime doors with stain (if required), other required pretreatments, and first coat of finish as specified in Division 09 Section "Wood Stains And Transparent Finishes". Seal all four edges, edges of cutouts, and mortises with first coat of finish.

G. Finishing
1. Finish wood doors at factory **OR** woodworking shop, **as directed**.
   OR
   Finish wood doors at factory **OR** woodworking shop, **as directed**, that are indicated to receive transparent finish. Wood doors that are indicated to receive opaque finish may be field finished.
   OR
   Finish wood doors at factory **OR** woodworking shop, **as directed**, where indicated in schedules or on Drawings. Wood doors that are not indicated to be factory **OR** shop, **as directed**, finished may be field finished.
2. For doors indicated to be factory **OR** shop, **as directed**, finished, comply with AWI's "Architectural Woodwork Quality Standards," **OR** WI's "Manual of Millwork," **OR** WDMA I.S.6A, "Industry Standard for Architectural Stile and Rail Doors," **as directed**, and with other requirements specified.
   a. Finish faces and all four edges of doors, including mortises and cutouts. Stains and fillers may be omitted on bottom **OR** top and bottom, **as directed**, edges, edges of cutouts, and mortises.
3. Transparent Finish:
   a. Grade: Premium **OR** Custom, **as directed**.
   b. Finish: AWI conversion varnish **OR** AWI catalyzed polyurethane, **as directed**, system.
      OR
      Finish: WDMA TR-4 conversion varnish **OR** WDMA TR-6 catalyzed polyurethane, **as directed**.
      OR
      Finish: WI System 4 clear conversion varnish **OR** WI System 5 catalyzed polyurethane **OR** WI System 8 UV-curable coating, **as directed**.
   c. Staining: Match sample **OR** As selected from manufacturer's full range **OR** None required, **as directed**.
   d. Effect: Open-grain finish **OR** Filled finish **OR** Semifilled finish, produced by applying an additional finish coat to partially fill the wood pores, **as directed**.
   e. Sheen: Satin **OR** Semigloss, **as directed**.
4. Opaque Finish:
   a. Grade: Premium **OR** Custom, **as directed**.
   b. Finish: AWI conversion varnish **OR** AWI catalyzed polyurethane, **as directed**, system.
      OR
      Finish: WDMA OP-4 conversion varnish **OR** WDMA OP-6 catalyzed polyurethane, **as directed**.

OR

Finish: WI System 4 conversion varnish **OR** WI System 5 catalyzed polyurethane **OR** WI System 8 UV-curable coating, **as directed**.

c. Color: Match sample **OR** As selected from manufacturer's full range, **as directed**.

d. Sheen: Satin **OR** Semigloss **OR** Gloss, **as directed**.

1.3 EXECUTION

A. Installation

1. Install fire-rated wood door frames level, plumb, true, and aligned with adjacent materials. Use concealed shims where necessary for alignment.
   a. Countersink fasteners, fill surface flush, and sand smooth.
2. Hardware: For installation, see Division 08 Section "Door Hardware".
3. Install wood doors to comply with manufacturer's written instructions, WDMA I.S.6, "Industry Standard for Wood Stile and Rail Doors," **OR** AWI's "Architectural Woodwork Quality Standards," **OR** WI's "Manual of Millwork," **OR** WDMA I.S.6A, "Industry Standard for Architectural Stile and Rail Doors," **as directed**, and other requirements specified.
   a. Provide WI-Certified Compliance Certificate for Installation.
   b. Install fire-rated doors in corresponding fire-rated frames according to NFPA 80.
4. Field-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted with fire-rated doors. Machine doors for hardware. Seal cut surfaces after fitting and machining.
   a. Clearances: Provide 1/8 inch (3 mm) at heads, jambs, and between pairs of doors. Provide 1/8 inch (3 mm) **OR** 1/4 inch (6 mm) **OR** 3/8 inch (10 mm) **OR** 1/2 inch (13 mm), **as directed**, from bottom of door to top of decorative floor finish or covering. Where threshold is shown or scheduled, provide 1/4 inch (6 mm) **OR** 3/8 inch (10 mm), **as directed**, from bottom of door to top of threshold.
      1) Comply with NFPA 80 for fire-rated doors.
   b. Bevel non-fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) at lock and hinge edges.
   c. Bevel fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) on lock edge; trim stiles and rails only to extent permitted by labeling agency.
5. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
6. Factory-Finished **OR** Shop-Finished, **as directed**, Doors: Restore finish before installation if fitting or machining is required at Project site.

B. Adjusting

1. Operation: Rehang or replace doors that do not swing or operate freely.
2. Finished Doors: Replace doors that are damaged or do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 08210a

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Task	Specification	Specification Description
08210	01352	No Specification Required

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SECTION 08301 - ACCESS DOORS AND FRAMES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for access doors and frames. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Access doors and frames for walls and ceilings.
b. Floor access doors and frames.

C. Submittals
1. Product Data: For each type of access door and frame indicated.
2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
3. Samples: For each door face material in specified finish.
4. Schedule: Types, locations, sizes, latching or locking provisions, and other data pertinent to installation.

D. Quality Assurance
1. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 that are identical to access door and frame assemblies tested for fire-test-response characteristics per the following test method and that are listed and labeled by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
a. NFPA 252 or UL 10B for vertical access doors and frames.
b. ASTM E 119 or UL 263 for horizontal access doors and frames.

1.2 PRODUCTS

A. Steel Materials
1. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
a. ASTM A 123/A 123M, for galvanizing steel and iron products.
b. ASTM A 153/A 153M, for galvanizing steel and iron hardware.
2. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.
a. ASTM A 123/A 123M, for galvanizing steel and iron products
b. ASTM A 153/A 153M, for galvanizing steel and iron hardware.
3. Steel Sheet: Uncoated or electrolytic zinc-coated, ASTM A 591/A 591M with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.
4. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS) with A60 (ZF180) zinc-iron-alloy (galvannealed) coating or G60 (Z180) mill-phosphatized zinc coating.
5. Steel Finishes: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
a. Surface Preparation for Steel Sheet: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
b. Surface Preparation for Metallic-Coated Steel Sheet: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds,

mechanical connections, and abraded areas, and apply galvanizing repair paint specified below to comply with ASTM A 780.

1) Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

c. Factory-Primed Finish: Apply shop primer immediately after cleaning and pretreating.

d. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat. Comply with paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils (0.05 mm).

e. Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils (0.04 mm). Prepare, treat, and coat metal to comply with resin manufacturer's written instructions.

6. Drywall Beads: Edge trim formed from 0.0299-inch (0.76-mm) zinc-coated steel sheet formed to receive joint compound and in size to suit thickness of gypsum board.

7. Plaster Beads: Casing bead formed from 0.0299-inch (0.76-mm) zinc-coated steel sheet with flange formed out of expanded metal lath and in size to suit thickness of plaster.

B. Stainless-Steel Materials

1. Rolled-Stainless-Steel Floor Plate: ASTM A 793, manufacturer's standard finish.

2. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304 **OR** 316, **as directed**. Remove tool and die marks and stretch lines or blend into finish.

a. Finish: Directional Satin Finish, No. 4 **OR** Manufacturer's standard, **as directed**.

C. Aluminum Materials

1. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T6, mill finish.

2. Aluminum-Alloy Rolled Tread Plate: ASTM B 632/B 632M, Alloy 6061-T6, mill finish.

3. Aluminum Sheet: ASTM B 209 (ASTM B 209M).

a. Mill Finish: AA-M10 (Mechanical Finish: as fabricated, unspecified).

b. Anodic Finish: Class II, clear anodic coating complying with AAMA 611 **OR** Class I, clear anodic coating complying with AAMA 611, **as directed**.

c. Baked-Enamel Finish: Manufacturer's standard.

D. Access Doors And Frames For Walls And Ceilings

1. Flush Access Doors and Frames with Exposed Trim: Fabricated from steel **OR** metallic-coated steel **OR** stainless-steel, **as directed**, sheet.

a. Locations: Wall **OR** Ceiling **OR** Wall and ceiling, **as directed**, surfaces.

b. Door: Minimum 0.060-inch- (1.5-mm-), **as directed,** thick sheet metal, set flush with exposed face flange of frame.

c. Frame: Minimum 0.060-inch- (1.5-mm-), **as directed**, thick sheet metal with 1-inch- (25-mm-) **OR** 1-1/4-inch- (32-mm-), **as directed**, wide, surface-mounted trim.

d. Hinges: Spring-loaded, concealed-pin type **OR** Continuous piano, **as directed**.

e. Latch: Cam latch **OR** Slam latch **OR** Self-latching bolt, **as directed**, operated by screwdriver **OR** knurled knob **OR** hex head wrench **OR** pinned hex head wrench **OR** spanner head wrench **OR** flush key **OR** ring turn, **as directed**, with interior release.

f. Lock: Cylinder **OR** Mortise cylinder, **as directed**.

1) Lock Preparation: Prepare door panel to accept cylinder specified in Division 08 Section "Door Hardware".

2. Flush Access Doors and Trimless Frames: Fabricated from steel **OR** metallic-coated steel **OR** stainless-steel, **as directed**, sheet.

a. Locations: Wall **OR** Ceiling **OR** Wall and ceiling, **as directed**, surfaces.

b. Door: Minimum 0.060-inch- (1.5-mm-), **as directed**, thick sheet metal, set flush with surrounding finish surfaces.

c. Frame: Minimum 0.060-inch- (1.5-mm-), **as directed**, thick sheet metal with drywall **OR** plaster, **as directed**, bead flange.

d. Hinges: Spring-loaded, concealed-pin type **OR** Continuous piano, **as directed**.
e. Latch: Cam latch **OR** Slam latch **OR** Self-latching bolt, **as directed**, operated by screwdriver **OR** knurled knob **OR** hex head wrench **OR** pinned hex head wrench **OR** spanner head wrench **OR** flush key **OR** ring turn, **as directed**, with interior release.
f. Lock: Cylinder **OR** Mortise cylinder, **as directed**.
1) Lock Preparation: Prepare door panel to accept cylinder specified in Division 08 Section "Door Hardware".

3. Recessed Access Doors and Trimless Frames: Fabricated from steel **OR** metallic-coated steel **OR** stainless-steel, **as directed**, sheet.
a. Locations: Wall **OR** Ceiling **OR** Wall and ceiling, **as directed**, surfaces.
b. Door: Minimum 0.060-inch- (1.5-mm-), **as directed,** thick sheet metal in the form of a pan recessed 5/8 inch (16 mm) **OR** 1 inch (25 mm), **as directed**, for gypsum board **OR** plaster **OR** acoustical tile, **as directed**, infill.
c. Frame: Minimum 0.060-inch- (1.5-mm-), **as directed**, thick sheet metal with drywall bead for gypsum board surfaces **OR** with plaster bead for plaster surfaces **OR** designed for insertion into acoustical tile ceiling, **as directed**.
d. Hinges: Spring-loaded, concealed-pin type **OR** Concealed pivoting rod hinge, **as directed**.
e. Latch: Cam latch **OR** Slam latch **OR** Self-latching bolt, **as directed**, operated by screwdriver **OR** knurled knob **OR** hex head wrench **OR** pinned hex head wrench **OR** spanner head wrench **OR** flush key **OR** ring turn, **as directed**, with interior release.
f. Lock: Cylinder **OR** Mortise cylinder, **as directed**.
1) Lock Preparation: Prepare door panel to accept cylinder specified in Division 08 Section "Door Hardware".

4. Aluminum Flush Access Doors and Frames with Exposed Trim: Fabricated from aluminum sheet and extruded-aluminum shapes.
a. Locations: Wall **OR** Ceiling **OR** Wall and ceiling, **as directed**, surfaces.
b. Door: Minimum 0.080-inch- (2.0-mm-), **as directed**, thick aluminum sheet.
c. Frame: Minimum 0.060-inch- (1.5-mm-), **as directed**, thick extruded aluminum with 1-1/4-inch- (32-mm-) wide rolled flange.
d. Hinges: Concealed continuous aluminum.
e. Latch: Screwdriver-operated cam latch.

5. Lightweight Flush Access Doors and Frames with Exposed Trim: Fabricated from lightweight metal.
a. Locations: Wall **OR** Ceiling **OR** Wall and ceiling, **as directed**, surfaces.
b. Door: Minimum 0.018-inch- (0.45-mm-) thick steel sheet.
c. Frame: Minimum 0.045-inch- (1.1-mm-) thick extruded aluminum with 1-1/4-inch- (32-mm-) wide rolled flange.
d. Hinges: Continuous piano.
e. Latch: Screwdriver-operated cam latch.

6. Plastic Flush Access Doors and Frames with Exposed Trim: Fabricated from 1/8-inch- (3.2-mm-) thick high-impact plastic with UV stabilizer.
a. Locations: Wall **OR** Ceiling **OR** Wall and ceiling, **as directed**, surfaces.
b. Door: Flush to frame with rounded corners.
c. Frame: 1 piece, 3/4 inch (19 mm) deep.
d. Latch: Snap latch.
e. Finish: White with textured exposed surfaces.

7. Exterior Flush Access Doors and Frames with Exposed Trim: Weatherproof with extruded door gasket.
a. Locations: Wall **OR** Ceiling **OR** Wall and ceiling, **as directed**, surfaces.
b. Door: Minimum 0.040-inch- (1.0-mm-), **as directed**, thick, metallic-coated steel sheet; flush panel construction with manufacturer's standard 2-inch- (50-mm-) thick fiberglass insulation.
c. Frame: Minimum 0.060-inch- (1.5-mm-), **as directed**, thick extruded aluminum.
d. Hinges: Continuous piano, zinc plated.
e. Lock: Dual-action handles with key lock.

8. Fire-Rated, Insulated, Flush Access Doors and Frames with Exposed Trim: Fabricated from steel **OR** metallic-coated steel **OR** stainless-steel, **as directed**, sheet.
   a. Locations: Wall **OR** Ceiling **OR** Wall and ceiling, **as directed**, surfaces.
   b. Fire-Resistance Rating: Not less than that indicated **OR** that of adjacent construction **OR** 45 minutes **OR** 1 hour **OR** 1-1/2 hours **OR** 2 hours **OR** 3 hours, **as directed**.
   c. Temperature Rise Rating: 250 deg F (139 deg C) at the end of 30 minutes.
   d. Door: Flush panel with a core of mineral-fiber insulation enclosed in sheet metal with a minimum thickness of 0.036 inch (0.9 mm), **as directed**.
   e. Frame: Minimum 0.060-inch- (1.5-mm-), **as directed**, thick sheet metal with 1-inch- (25-mm-), **as directed,** wide, surface-mounted trim.
   f. Hinges: Concealed-pin type **OR** Continuous piano, **as directed**.
   g. Automatic Closer: Spring type.
   h. Latch: Self-latching device operated by knurled knob **OR** flush key **OR** ring turn, **as directed**, with interior release.
   i. Lock: Self-latching device with cylinder **OR** mortise cylinder, **as directed**, lock.
      1) Lock Preparation: Prepare door panel to accept cylinder specified in Division 08 Section "Door Hardware".
9. Fire-Rated, Insulated, Flush Access Doors and Trimless Frames: Fabricated from steel **OR** metallic-coated steel **OR** stainless-steel, **as directed**, sheet.
   a. Locations: Wall **OR** Ceiling **OR** Wall and ceiling, **as directed**, surfaces.
   b. Fire-Resistance Rating: Not less than that indicated **OR** that of adjacent construction **OR** 45 minutes **OR** 1 hour **OR** 1-1/2 hours **OR** 2 hours **OR** 3 hours, **as directed**.
   c. Temperature Rise Rating: 250 deg F (139 deg C) at the end of 30 minutes.
   d. Door: Flush panel with a core of mineral-fiber insulation enclosed in sheet metal with a minimum thickness of 0.036 inch (0.9 mm), **as directed**.
   e. Frame: Minimum 0.060-inch- (1.5-mm-), **as directed**, thick sheet metal with drywall **OR** plaster, **as directed**, bead.
   f. Hinges: Concealed-pin type **OR** Continuous piano, **as directed**.
   g. Automatic Closer: Spring type.
   h. Latch: Self-latching device operated by knurled knob **OR** flush key **OR** ring turn, **as directed**, with interior release.
   i. Lock: Self-latching device with cylinder **OR** mortise cylinder, **as directed**, lock.
      1) Lock Preparation: Prepare door panel to accept cylinder specified in Division 08 Section "Door Hardware".
10. Fire Rated, Uninsulated, Flush Access Doors and Frames with Exposed Trim: Fabricated from steel **OR** metallic-coated steel **OR** stainless-steel, **as directed**, sheet.
   a. Locations: Wall surfaces.
   b. Fire-Resistance Rating: Not less than that indicated **OR** that of adjacent construction **OR** 45 minutes **OR** 1 hour **OR** 1-1/2 hours **OR** 2 hours **OR** 3 hours, **as directed**.
   c. Door: Minimum 0.060-inch- (1.5-mm-), **as directed**, thick sheet metal, flush construction.
   d. Frame: Minimum 0.060-inch- (1.5-mm-), **as directed**, thick sheet metal with 1-inch- (25-mm-) **OR** 1-1/4-inch- (32-mm-), **as directed**, wide, surface-mounted trim.
   e. Hinges: Concealed-pin type **OR** Continuous piano, **as directed**.
   f. Automatic Closer: Spring type.
   g. Latch: Self-latching device operated by knurled knob **OR** flush key **OR** ring turn, **as directed**, with interior release.
   h. Lock: Self-latching device with cylinder **OR** mortise cylinder, **as directed**, lock.
      1) Lock Preparation: Prepare door panel to accept cylinder specified in Division 08 Section "Door Hardware".
11. Medium-Security, Flush Access Doors and Frames with Exposed Trim: Fabricated from steel **OR** metallic-coated steel **OR** stainless-steel, **as directed**, sheet.
   a. Locations: Wall **OR** Ceiling **OR** Wall and ceiling, **as directed**, surfaces.
   b. Door: Minimum 0.105-inch- (2.7-mm-) thick sheet metal, flush construction.
   c. Frame: Minimum 0.105-inch- (2.7-mm-) thick sheet metal with 1-inch- (25-mm-) **OR** 1-1/4-inch- (32-mm-), **as directed**, wide, surface-mounted trim.

d. Hinges: Concealed continuous piano.
e. Lock: Detention.
1) Lock Preparation: Prepare door panel to accept cylinder specified in Division 08 Section "Door Hardware".

12. Medium-Security, Flush Access Doors with Trimless Frames: Fabricated from steel **OR** metallic-coated steel **OR** stainless-steel, **as directed**, sheet.
a. Locations: Wall **OR** Ceiling **OR** Wall and ceiling, **as directed**, surfaces.
b. Door: Minimum 0.105-inch- (2.7-mm-) thick sheet metal, flush construction.
c. Frame: Minimum 0.105-inch- (2.7-mm-) thick sheet metal with drywall **OR** plaster, **as directed**, bead.
d. Hinges: Concealed continuous piano.
e. Lock: Detention.
1) Lock Preparation: Prepare door panel to accept cylinder specified in Division 08 Section "Door Hardware".

13. High-Security, Flush Access Doors and Frames with Exposed Trim: Fabricated from steel **OR** metallic-coated steel **OR** stainless-steel, **as directed,** sheet and angles.
a. Locations: Wall **OR** Ceiling **OR** Wall and ceiling, **as directed,** surfaces.
b. Door: Minimum 0.135-inch- (3.4-mm-) thick sheet metal, flush construction.
c. Frame: Minimum 3/16-by-2-by-2-inch (4.7-by-50-by-50-mm) angle welded with joints ground smooth.
d. Hinges: Heavy-duty steel welded to door and frame.
e. Lock: Heavy-duty, detention deadbolt.
1) Lock Preparation: Prepare door panel to accept cylinder specified in Division 08 Section "Door Hardware".

14. Maximum-Security, Flush Access Doors and Frames with Exposed Trim: Fabricated from steel **OR** metallic-coated steel **OR** stainless-steel, **as directed**, sheet and angles.
a. Locations: Wall **OR** Ceiling **OR** Wall and ceiling, **as directed,** surfaces.
b. Door: Minimum 0.180-inch- (4.55-mm-) thick sheet metal, flush construction.
c. Frame: Minimum 3/16-by-2-by-2-by-3-inch (4.7-by-50-by-50-by-76-mm) angle welded with joints ground smooth.
d. Hinges: Heavy-duty steel welded to door and frame.
e. Lock: Heavy-duty detention deadbolt.
1) Lock Preparation: Prepare door panel to accept cylinder specified in Division 08 Section "Door Hardware".

15. Fire-Rated, Insulated, Medium-Security, Flush Access Doors and Frames with Exposed Trim: Fabricated from steel **OR** metallic-coated steel **OR** stainless-steel, **as directed,** sheet.
a. Locations: Wall surfaces.
b. Fire-Resistance Rating: Not less than that indicated **OR** that of adjacent construction **OR** 45 minutes **OR** 1 hour **OR** 1-1/2 hours **OR** 2 hours **OR** 3 hours, **as directed**.
c. Temperature Rise Rating: 250 deg F (139 deg C) at the end of 30 minutes.
d. Door: Flush panel with a core of 2-inch- (50-mm-) thick, mineral-fiber insulation enclosed in sheet metal with a minimum thickness of 0.075 inch (1.9 mm).
e. Frame: Minimum 0.060-inch- (1.5-mm-) thick sheet metal with 1-inch- (25-mm-) **OR** 1-1/4-inch- (32-mm-), **as directed**, wide, surface-mounted trim.
f. Hinges: Concealed-pin type **OR** Continuous piano, **as directed**.
g. Automatic Closer: Spring type.
h. Lock: Self-latching device with detention lock.
1) Lock Preparation: Prepare door panel to accept cylinder specified in Division 08 Section "Door Hardware".

16. Fire-Rated, Insulated, Medium-Security, Flush Access Doors with Trimless Frames: Fabricated from steel **OR** metallic-coated steel **OR** stainless-steel, **as directed,** sheet.
a. Locations: Wall surfaces.
b. Fire-Resistance Rating: Not less than that indicated **OR** that of adjacent construction **OR** 45 minutes **OR** 1 hour **OR** 1-1/2 hours **OR** 2 hours **OR** 3 hours, **as directed**.
c. Temperature Rise Rating: 250 deg F (139 deg C) at the end of 30 minutes.

d. Door: Flush panel with a core of 2-inch- (50-mm-) thick, mineral-fiber insulation enclosed in sheet metal with a minimum thickness of 0.075 inch (1.9 mm).
e. Frame: Minimum 0.060-inch- (1.5-mm-) thick sheet metal with drywall **OR** plaster, **as directed**, bead.
f. Hinges: Concealed-pin type **OR** Continuous piano, **as directed**.
g. Automatic Closer: Spring type.
h. Lock: Self-latching device with detention lock.
1) Lock Preparation: Prepare door panel to accept cylinder specified in Division 08 Section "Door Hardware".

E. Floor Access Doors And Frames
1. Floor Doors, General: Equip each door with adjustable counterbalancing springs, heavy-duty hold-open arm that automatically locks door open at 90 degrees, release handle with red vinyl grip that allows for one-handed closure, and recessed lift handle.
2. Aluminum Floor Door: Single **OR** Double, **as directed,**-leaf opening. Extruded-aluminum angle frame with 1/4-inch- (6.4-mm-) thick, diamond-pattern, aluminum tread plate door; nonwatertight; loading capacity to support 150-lbf/sq. ft. (7.2-kN/sq. m) pedestrian live load **OR** 300-lbf/sq. ft. (14.4-kN/sq. m) pedestrian live load **OR** AASHTO H20 concentrated wheel load, without impact, **as directed**.
3. Watertight Aluminum Floor Door: Single **OR** Double, **as directed,**-leaf opening. Extruded-aluminum gutter frame with NPS 1-1/2 (DN 40) drainage coupling and 1/4-inch- (6.4-mm-) thick, diamond-pattern, aluminum tread plate door; watertight; loading capacity to support 150-lbf/sq. ft. (7.2-kN/sq. m) pedestrian live load **OR** 300-lbf/sq. ft. (14.4-kN/sq. m) pedestrian live load **OR** AASHTO H20 concentrated wheel load, without impact, **as directed**.
4. Steel Angle-Frame Floor Door: Single **OR** Double, **as directed,**-leaf opening. Prime-painted structural **OR** Galvanized structural **OR** Stainless, **as directed**,-steel frame with 3/16- or 1/4-inch- (4.8- or 6.4-mm-) **OR** 3/16-inch- (4.8-mm-) **OR** 1/4-inch- (6.4-mm-), **as directed**, thick, diamond-pattern, prime-painted structural **OR** galvanized structural **OR** stainless, **as directed,**-steel tread plate door; nonwatertight; loading capacity to support 150-lbf/sq. ft. (7.2-kN/sq. m) pedestrian live **OR** 300-lbf/sq. ft. (14.4-kN/sq. m) pedestrian live **OR** AASHTO H20 concentrated wheel, **as directed**, load.
a. Fire-Resistance Rating: Not less than that indicated **OR** that of adjacent construction **OR** 45 minutes **OR** 1 hour **OR** 1-1/2 hours **OR** 2 hours **OR** 3 hours, **as directed**.
b. Finish painted in yellow with wording "FIRE DOOR - DO NOT STORE MATERIALS ON SURFACE."
5. Watertight Steel Gutter-Frame Floor Door: Single **OR** Double, **as directed**,-leaf opening. Prime-painted structural **OR** Galvanized structural **OR** Stainless, **as directed**,-steel channel frame forming gutter with NPS 1-1/2 (DN 40) drainage coupling and 3/16- or 1/4-inch- (4.8- or 6.4-mm-) **OR** 3/16-inch- (4.8-mm-) **OR** 1/4-inch- (6.4-mm-), **as directed**, thick, diamond-pattern, prime-painted structural **OR** galvanized structural **OR** stainless, **as directed**,-steel tread plate door; watertight; loading capacity to support 150-lbf/sq. ft. (7.2-kN/sq. m) pedestrian live **OR** 300-lbf/sq. ft. (14.4-kN/sq. m) pedestrian live **OR** AASHTO H20 concentrated wheel, **as directed**, load.
a. Fire-Resistance Rating: Not less than that indicated **OR** that of adjacent construction **OR** 45 minutes **OR** 1 hour **OR** 1-1/2 hours **OR** 2 hours **OR** 3 hours, **as directed**.
b. Finish painted in yellow with wording "FIRE DOOR - DO NOT STORE MATERIALS ON SURFACE."
6. Hardware: Provide the following:
a. Hinges: Heavy-duty, zinc-coated steel **OR** aluminum **OR** stainless-steel **OR** brass, **as directed**, butt hinges with stainless-steel pins.
b. Latch: Stainless-steel slam latch.
c. Lock: Staple for a padlock **OR** Recessed hasp **OR** Keyed deadlock bolt **OR** Hasp and staple, **as directed**.
d. Hardware Material: Manufacturer's standard **OR** Stainless steel, including latch and lifting mechanism assemblies, hold-open arms, and all brackets, hinges, pins, and fasteners, **as directed**.

7. Insulation: Fiberglass **OR** Urethane, **as directed**, with liner pan.
8. Safety Accessories: Safety chains **OR** net **OR** railing, **as directed**.

F. Fabrication
1. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
2. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
3. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of supports indicated.
4. Recessed Access Doors: Form face of panel to provide recess for application of applied finish. Reinforce panel as required to prevent buckling.
5. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.
   a. For cylinder lock, furnish two keys per lock and key all locks alike.
   b. For recessed panel doors, provide access sleeves for each locking device. Furnish plastic grommets and install in holes cut through finish.
6. Extruded Aluminum: After fabrication, apply manufacturer's standard protective coating on aluminum that will come in contact with concrete.

1.3 EXECUTION

A. Installation
1. Comply with manufacturer's written instructions for installing access doors and frames.
2. Set frames accurately in position and attach securely to supports with plane of face panels aligned with adjacent finish surfaces.
3. Install doors flush with adjacent finish surfaces or recessed to receive finish material.

B. Adjusting And Cleaning
1. Adjust doors and hardware after installation for proper operation.
2. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION 08301

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Task	Specification	Specification Description
08305	08301	Access Doors And Frames

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SECTION 08310 - SLIDING METAL FIRE DOORS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for sliding metal fire doors. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Single-leaf, power-operated and manually operated sliding door with or without pass door.
b. Biparting, power-operated and manually operated sliding door with or without pass door.
c. Multiple-leaf, power-operated and manually operated sliding door with or without pass door.

C. Performance Requirements
1. Structural Performance: Provide horizontal sliding doors capable of withstanding the effects of gravity loads and the following loads and stresses without evidencing permanent deformation of door components:
a. Wind Load: Uniform pressure (velocity pressure) of 20 lbf/sq. ft. (960 Pa), **unless required otherwise by the location of the work**, acting inward or outward.

D. Submittals
1. Product Data: For each type of product indicated.
a. Fire-Rated Doors: Include description of fire-release system including testing and resetting instructions.
2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
3. Product Certificates: For sliding metal fire doors, signed by product manufacturer.
4. Oversize Construction Certification: For door assemblies required to be fire rated and that exceed size limitations of labeled assemblies, signed by authorized representative of testing agency.
5. Operation and Maintenance Data: For sliding metal fire doors to include in emergency, operation, and maintenance manuals.

E. Quality Assurance
1. Fire-Rated Sliding Door Assemblies: Provide assemblies complying with NFPA 80 that are identical to door assemblies tested for fire-test-response characteristics according to NFPA 252 or UL 10B, and that are listed and labeled for fire ratings indicated by UL, FMG, ITS, or another testing agency acceptable to authorities having jurisdiction.
a. Test Pressure: Test at as close to neutral pressure as possible.
b. Oversize Fire-Rated Sliding Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a testing agency acceptable to authorities having jurisdiction that doors comply with all standard construction requirements of tested and labeled fire-rated door assemblies except for size.
c. Provide units with labels showing 250 deg F (139 deg C) **OR** 450 deg F (250 deg C) **OR** 650 deg F (361 deg C), **as directed**, temperature-rise ratings.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.2 PRODUCTS

A. Materials
1. Cold-Rolled Steel Sheets: ASTM A 1008/A 1008M, Commercial Steel (CS), or Drawing Steel (DS), Type B, exposed, matte finish.
2. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B, with A60 (ZF180) **OR** A90 (ZF275), **as directed**, zinc-iron-alloy (galvannealed) coating or G90 (Z275) **OR** G60 (Z180), **as directed**, zinc coating; restricted flatness.
3. Stainless-Steel Sheets: ASTM A 240/A 240M, Type 304 **OR** 316, **as directed**; stretcher-leveled standard of flatness; No. 4 satin **OR** 6 dull, **as directed**, finish.
4. Hardware and Fasteners: Manufacturer's standard units **OR** Hot-dip galvanize per ASTM A 153/A 153M where items are used on galvanized steel exterior doors **OR** Stainless steel **OR** Stainless steel where indicated, **as directed**.

B. Sliding Metal Fire Doors
1. Overhead-Supported Doors: Provide composite **OR** hollow-metal **OR** tubular-frame, **as directed**,-type construction fire door assemblies with wall-mounted overhead track support and the following fire-protection rating and panel facing sheet material and thickness:
2. Bottom-Support Doors: Provide bottom-support, tubular-frame-type construction fire door assemblies with floor track, top guides, and the following fire-protection rating, temperature-rise rating, and face sheet material and thickness:
    a. Fire-Protection Rating: 4 hours **OR** 3 hours **OR** 1-1/2 hours **OR** 3/4 hour **OR** As indicated, **as directed**.
    b. Panel Facing:
        1) Steel: 0.033-inch (0.8-mm) **OR** 0.043-inch (1.1-mm) **OR** 0.053-inch (1.35-mm) **OR** 0.067-inch (1.7-mm), **as directed**, minimum thickness.
        2) Metallic-Coated Steel: 0.040-inch (1.0-mm) **OR** 0.052-inch (1.3-mm) **OR** 0.064-inch (1.6-mm) **OR** 0.079-inch (2.0-mm), **as directed**, nominal thickness.
        3) Stainless Steel: 0.038-inch (0.96-mm) **OR** 0.050-inch (1.3-mm) **OR** 0.062-inch (1.57-mm) **OR** 0.078-inch (1.98-mm), **as directed**, nominal thickness.
3. Operating Hardware: Manufacturer's standard, labeled, automatic-closing-type, sliding fire door assemblies complete with track, adjustable roller guides, binders, floor stops, cables, sheaves, counterweights, and fusible links. Furnish necessary hangers, fittings, and fasteners required for attaching hardware to door and for door sliding operation, including latch or handle for manual operation. Provide hot-dip galvanized steel **OR** electrogalvanized steel **OR** factory-prime-painted steel **OR** stainless-steel, **as directed**, hardware.
4. Weight Boxes: 0.064-inch- (1.6-mm-) thick, metallic-coated steel counterweight boxes or guards; size as required for counterweights and clearance.
5. Crush Plates: 3/16-inch-thick by 6-inch-wide (4.8-mm-thick by 150-mm-wide), continuous steel plates on hollow concrete masonry walls.
6. Track Hood: Formed, metallic-coated steel sheet **OR** stainless-steel, **as directed**; size as required for clearance and to protect tracks on exterior installations.
7. Weather Stripping: UL-classified, brush-style weather stripping with attachments for mounting at head, jambs, and bottom surface of door.
8. Motorized Operator: UL-approved, high-starting torque, reversing motor and adjustable speed operator with thermal-overload protection. Include fusible-link release to disengage operator and to allow door to close automatically.
    a. Design operator for current characteristics of electrical service supplied. Provide UL-listed, 1/2-hp, 208- to 230-V ac, single-phase **OR** 208-V ac, 3-phase **OR** 220-V ac, 3-phase **OR** 480-V ac, 3-phase, **as directed**, 60-cycle motor with NEMA 250, Type 1 enclosure and 24-V ac, secondary control voltage.
    b. Equip door for completely automatic operation with clutch, speed reducer, brake, limit switches, electric reverse edge, brackets, bolts, and release for manual operation. Control equipment includes two pull cords **OR** two 3-button control stations with push buttons labeled "OPEN," "CLOSE," and "STOP" **OR** two motion detectors **OR** two loop detectors

OR two photoelectric obstruction detectors **OR** time delay for closing, **as directed**, and electric interlock for pass door.

9. Interconnecting Device: Device for connecting fusible links for doors on both sides of wall.
10. Door Release Devices: Electromagnetic release devices compatible with smoke detectors or building's fire alarm system.
11. Fire Detection: Provide early warning, photoelectric smoke detectors or ionization detectors to be coupled to electromagnetic door release devices.
12. Pass Door: UL-listed swing door and frame.
13. Pass Door Hardware: Factory installed with one and one-half pairs of mortise spring hinges **OR** butt hinges and closer, **as directed**, and mortise latchset **OR** mortise lock **OR** exit device **OR** panic device, **as directed**.
    a. Provide hardware complying with Division 08 Section "Door Hardware".
14. Vision Panels: Factory fabricated in door with integral removable glass stops. Provide UL-approved, wired glass panels or other fire-resistive glazing product acceptable to authorities having jurisdiction; do not exceed area allowed for door rating.

C. Fabrication
1. Composite-Type Doors: Fabricate in modular panels. Bond face materials to both sides of core and reinforce perimeter with minimum 0.043-inch- (1.1-mm-) thick, internal steel channel. Encase panel edges with minimum 0.067-inch- (1.7-mm-) thick, steel channel. Back joints in face sheets with minimum 0.043-inch- (1.1-mm-) thick, steel H column. Connect panels with H column and cover plate. Attach armor edges and astragals to doors.
2. Hollow-Metal Doors: Bond face materials to both sides of core and reinforce perimeter with minimum 0.043-inch- (1.1-mm-) thick, internal steel channel. Back joints in face sheets with minimum 0.043-inch- (1.1-mm-) thick, steel H column. Weld and fill joints and grind exposed welds smooth. Attach armor edges and astragals to doors.
3. Tubular-Frame Doors: Fabricate perimeter frame and internal stiffeners of minimum 0.043-inch-(1.1-mm-) thick steel tubes. Miter corner joints in frame and weld frame and stiffener joints. Locate joints in face sheets over stiffeners. Weld and fill joints and grind exposed welds smooth. Attach armor edges and astragals to doors.
4. Core Construction: Provide core materials complying with fire-protection-rating and temperature-rise requirements.
    a. Resin-impregnated honeycomb.
    b. Mineral-fiber board.
    c. Urethane.
    d. Fiberglass.
    e. Calcium silicate
    f. Inorganic mineral.
    g. Manufacturer's standard.

D. Steel Finishes
1. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Preparation for Shop Priming: After galvanizing, thoroughly clean metal of grease, dirt, oil, flux, and other foreign matter, and treat with metallic-phosphate pretreatment.
3. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of sliding metal fire doors:
    a. Exteriors (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
    b. Interiors (SSPC Zone 1A): SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."
4. Prime Finish: Immediately after cleaning and pretreating, apply manufacturer's standard rust-inhibiting primer on **OR** zinc-rich primer on metallic-coated, **as directed**, steel doors for field painting.
5. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat. Comply with

paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils (0.05 mm).

a. Color and Gloss: As selected from manufacturer's full range.

1.3 EXECUTION

A. Installation

1. Install sliding metal fire doors according to NFPA 80 and manufacturer's written instructions for type of door operation indicated and fire-protection rating required.
   a. Interface fire-detection devices with building's fire alarm system.
2. Drill necessary holes cleanly, with no broken areas or spalls, for installation of fasteners in concrete or masonry. Remove and replace damaged masonry as directed.

B. Adjusting And Cleaning

1. Operate sliding metal fire doors on completion of installation to ensure satisfactory operation. Check moving parts for proper alignment and lubrication. Make adjustments for smooth, easy operation.
   a. Test door closing when activated by detector or alarm-connected, fire-release system. Reset door-closing mechanism after successful test.
2. Clean surfaces and refinish abraded or damaged surfaces to match factory finish.

END OF SECTION 08310

Task	Specification	Specification Description
08316	08301	Access Doors And Frames
08325	01352	No Specification Required

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SECTION 08330 - OVERHEAD COILING DOORS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for overhead coiling doors. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Service doors with integral pass doors.
b. Insulated service doors with integral pass doors.
c. Counter doors.
d. Fire-rated service doors with integral pass doors.
e. Fire-rated, insulated service doors with integral pass doors.
f. Fire-rated counter doors.

C. Performance Requirements
1. Delegated Design: Design overhead coiling doors, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Structural Performance, Exterior Doors: Exterior overhead coiling doors shall withstand the wind loads, the effects of gravity loads, and loads and stresses within limits and under conditions indicated according to SEI/ASCE 7.
a. Wind Loads: As indicated on Drawings **OR** Uniform pressure (velocity pressure) of 20 lbf/sq. ft. (960 Pa), acting inward and outward, **as directed**.
1) Basic Wind Speed: 85 mph (38 m/s) **OR** 90 mph (40 m/s) **OR** 100 mph (44 m/s) **OR** 110 mph (49 m/s), **as directed**.
2) Importance Factor: <**Insert factor**>.
3) Exposure Category: A **OR** B **OR** C **OR** D, **as directed**.
b. Deflection Limits: Design overhead coiling doors to withstand design wind load without evidencing permanent deformation or disengagement of door components.
3. Operability under Wind Load: Design overhead coiling doors to remain operable under design **OR** uniform pressure (velocity pressure) of 20 lbf/sq. ft. (960 Pa), **as directed**, wind load, acting inward and outward.
4. Windborne-Debris-Impact-Resistance Performance: Provide glazed and impact-protective overhead coiling doors that pass missile-impact and cyclic-pressure tests when tested according to ASTM E 1886 and ASTM E 1996.
a. Large Missile Test: For overhead coiling doors located within 30 feet (9.144 m) of grade.
b. Small Missile Test: For overhead coiling doors located more than 30 feet (9.144 m) above grade.
5. Seismic Performance: Overhead coiling doors shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
6. Operation Cycles: Provide overhead coiling door components and operators capable of operating for not less than number of cycles indicated for each door. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.

D. Submittals
1. Product Data: For each type and size of overhead coiling door and accessory.

2. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data. Include plans, elevations, sections, details, and attachments to other work.
   a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   b. Show locations of replaceable fusible links.
   c. Wiring Diagrams: For power, signal, and control wiring.
3. Samples: For each exposed product and for each color and texture specified.
4. Delegated-Design Submittal: For overhead coiling doors indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
5. Qualification Data: For qualified Installer.
6. Seismic Qualification Certificates: For overhead coiling doors**,** accessories, and components, from manufacturer.
7. Oversize Construction Certification: For door assemblies required to be fire-rated and that exceed size limitations of labeled assemblies.
8. Maintenance Data.

E. Quality Assurance
1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project.
2. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at as close to neutral pressure as possible according to NFPA 252 **OR** UBC Standard 7-2 **OR** UL 10B, **as directed**.
   a. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
   b. Temperature-Rise Limit: Where indicated **OR** At vertical exit enclosures and exit passageways, **as directed**, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.
   c. Smoke Control: Where indicated **OR** In corridors and smoke barriers, **as directed**, provide doors that are listed and labeled with the letter "S" on the fire-rating label by a qualified testing agency for smoke- and draft-control based on testing according to UBC Standard 7-2 **OR** UL 1784, **as directed**; with maximum air-leakage rate of 3.0 cfm/sq. ft. (0.01524 cu. m/s x sq. m) of door opening at 0.10 inch wg (24.9 Pa) for both ambient and elevated temperature tests.
3. Sound-Control Doors: Assemblies that have been fabricated and tested to control the passage of sound and have minimum certified STC rating according to ASTM E 413.
4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
5. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines **OR** ICC/ANSI A117.1, **as directed**.

1.2 PRODUCTS

A. Door Curtain Materials And Construction
1. Door Curtains: Fabricate overhead coiling-door curtain of interlocking metal slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:

a. Steel Door Curtain Slats: Zinc-coated (galvanized), cold-rolled structural steel sheet; complying with ASTM A 653/A 653M, with G90 (Z275) zinc coating; nominal sheet thickness (coated) of 0.028 inch (0.71 mm) and as required to meet requirements.
b. Stainless-Steel Door Curtain Slats: ASTM A 666, Type 304; sheet thickness of 0.025 inch (0.64 mm) and as required to meet requirements.
c. Aluminum Door Curtain Slats: ASTM B 209 (ASTM B 209M) sheet or ASTM B 221 (ASTM B 221M) extrusions, alloy and temper standard with manufacturer for type of use and finish indicated; thickness of 0.050 inch (1.27 mm) and as required to meet requirements.
d. Vision-Panel Glazing: Manufacturer's standard clear glazing, fabricated from transparent acrylic sheet or fire-protection rated glass as required for type of door; set in glazing channel secured to curtain slats.
e. Insulation: Fill slats for insulated doors with manufacturer's standard thermal insulation complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84. Enclose insulation completely within slat faces.
f. Metal Interior Curtain-Slat Facing: Match metal of exterior curtain-slat face.
g. Plastic Interior Curtain-Slat Facing: Extruded PVC plastic with maximum flame-spread index of 25 **OR** 75 **OR** 200, **as directed**, and smoke-developed index of 450, according to ASTM E 84.
h. Gasket Seal: Provide insulated slats with manufacturer's standard interior-to-exterior thermal break or with continuous gaskets between slats.

2. Endlocks and Windlocks for Service Doors: Malleable-iron casings galvanized after fabrication, secured to curtain slats with galvanized rivets or high-strength nylon. Provide locks on not less than alternate curtain slats for curtain alignment and resistance against lateral movement.
3. Endlocks for Counter Doors: Manufacturer's standard locks on not less than alternate curtain slats for curtain alignment and resistance against lateral movement.
4. Bottom Bar for Service Doors: Consisting of two angles, each not less than 1-1/2 by 1-1/2 by 1/8 inch (38 by 38 by 3 mm) thick; fabricated from manufacturer's standard hot-dip galvanized steel, stainless steel, or aluminum extrusions to match curtain slats and finish.
5. Bottom Bar for Counter Doors: Manufacturer's standard continuous channel or tubular shape, fabricated from manufacturer's standard hot-dip galvanized steel, stainless steel, or aluminum extrusions to match curtain slats and finish.
6. Astragal for Interior Doors: Equip each door bottom bar with a replaceable, adjustable, continuous, compressible gasket of flexible vinyl, rubber, or neoprene as a cushion bumper.
7. Curtain Jamb Guides: Manufacturer's standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain, and a continuous bar for holding windlocks.
   a. Removable Posts and Jamb Guides for Counter Doors: Manufacturer's standard.
8. Pass Door(s): Door and frame assembly constructed integrally with the coiling-door assembly and bearing the same fire rating. Complying with egress and accessibility requirements of authorities having jurisdiction.
   a. Door Frame and Integral Jamb Guide: Fabricate of angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading.
   b. Hinged Frame: Hinged pass door and frame that swings out of the way, as a unit, to allow use of the full coiling-door opening width. One jamb of the pass-door frame is hinged and the other jamb includes a guide for the lower, narrower part of the coiling-door curtain.
   c. Rigid Frame: Rigid pass door and frame that are built into the rigid, lower part of the door curtain and that raise with the curtain.
   d. Locking Hardware:
      1) Lockset **OR** Exit Hardware: As specified in Division 08 Section "Door Hardware" **OR** As selected from manufacturer's full range, **as directed**.

2) Lock Cylinders: Provide cylinders specified in Division 08 Section "Door Hardware" **OR** standard with manufacturer, **as directed**, and keyed to building keying system, **as directed**.
3) Keys: Two **OR** Three, **as directed**, for each cylinder.

e. Thresholds: Equip pass doors with integral thresholds that comply with egress and accessibility requirements of authorities having jurisdiction.

B. Hood
1. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.
a. Galvanized Steel: Nominal 0.028-inch- (0.71-mm-) thick, hot-dip galvanized steel sheet with G90 (Z275) zinc coating, complying with ASTM A 653/A 653M.
b. Stainless Steel: 0.025-inch- (0.64-mm-) thick stainless-steel sheet, Type 304, complying with ASTM A 666.
c. Aluminum: 0.040-inch- (1.02-mm-) thick aluminum sheet complying with ASTM B 209 (ASTM B 209M), of alloy and temper recommended by manufacturer and finisher for type of use and finish indicated.
d. Include automatic drop baffle on fire-rated doors to guard against passage of smoke or flame.
e. Exterior-Mounted Doors: Fabricate hood to act as weather protection and with a perimeter sealant-joint-bead profile for applying joint sealant.

C. Counter Doors
1. Integral Frame, Hood, and Fascia for Counter Door: Welded sheet metal assembly of the following sheet metal:
a. Galvanized Steel: Nominal 0.064-inch- (1.63-mm-) thick, hot-dip galvanized steel sheet with G90 (Z275) zinc coating, complying with ASTM A 653/A 653M.
b. Stainless Steel: 0.062-inch- (1.59-mm-) thick stainless-steel sheet, Type 304, complying with ASTM A 666.
2. Integral Metal Sill for Counter Door: Fabricate sills as integral part of frame assembly of Type 304 stainless steel in manufacturer's standard thickness with No. 4 finish.
3. Fire-Rated, Laminate Counter: Fire-door manufacturer's high-pressure decorative laminate-covered countertop, UL or ITS tested and labeled for 1-1/2-hour fire rating for approved use with fire-door assembly.

D. Locking Devices
1. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on both left and right jamb sides, operable from coil side.
2. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.
a. Lock Cylinders: Provide cylinders specified in Division 08 Section "Door Hardware" **OR** standard with manufacturer, **as directed**, and keyed to building keying system, **as directed**.
b. Keys: Provide Two **OR** Three, **as directed**, for each cylinder.
3. Chain Lock Keeper: Suitable for padlock.
4. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

E. Curtain Accessories
1. Smoke Seals: Equip each fire-rated door with smoke-seal perimeter gaskets for smoke and draft control as required for door listing and labeling by a qualified testing agency.

2. Weatherseals: Equip each exterior door with weather-stripping gaskets fitted to entire perimeter of door for a weathertight installation, unless otherwise indicated.
   a. At door head, use 1/8-inch- (3-mm-) thick, replaceable, continuous sheet secured to inside of hood.
   b. At door jambs, use replaceable, adjustable, continuous, flexible, 1/8-inch- (3-mm-) thick seals of flexible vinyl, rubber, or neoprene.
3. Push/Pull Handles: Equip each push-up-operated or emergency-operated door with lifting handles on each side of door, finished to match door.
   a. Provide pull-down straps or pole hooks for doors more than 84 inches (2130 mm) high.
4. Automatic-Closing Device for Fire-Rated Doors: Equip each fire-rated door with an automatic-closing device that is inoperative during normal door operations and that has a governor unit complying with NFPA 80 and an easily tested and reset release mechanism designed to be activated by the following:
   a. Replaceable fusible links with temperature rise and melting point of 165 deg F (74 deg C) interconnected and mounted on both sides of door opening.
   b. Manufacturer's standard UL-labeled smoke detector and door-holder-release devices.
   c. Manufacturer's standard UL-labeled heat detector and door-holder-release devices.
   d. Building fire-detection and -alarm systems and manufacturer's standard door-holder-release devices.

F. Counterbalancing Mechanism
1. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.
2. Counterbalance Barrel: Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, welded or seamless carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 0.03 in./ft. (2.5 mm/m) of span under full load.
3. Spring Balance: One or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.
4. Torsion Rod for Counterbalance Shaft: Fabricate of manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.
5. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

G. Manual Door Operators
1. Equip door with manufacturer's recommended manual door operator unless another type of door operator is indicated.
2. Push-up Door Operation: Design counterbalance mechanism so required lift or pull for door operation does not exceed 25 lbf (111 N).
3. Chain-Hoist Operator: Consisting of endless steel hand chain, chain-pocket wheel and guard, and gear-reduction unit with a maximum 25 lbf (111 N) **OR** 30 lbf (133 N), **as directed**, force for door operation. Provide alloy-steel hand chain with chain holder secured to operator guide.
4. Crank Operator: Consisting of crank and crank gearbox, steel crank drive shaft, and gear-reduction unit, of type indicated. Size gears to require not more than 25 lbf (111 N) **OR** 30 lbf (133 N), **as directed**, force to turn crank. Fabricate gearbox to be oil tight and to completely enclose operating mechanism. Provide manufacturer's standard crank-locking device.

H. Electric Door Operators
1. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and operation-cycles requirement specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, remote-control stations, control devices, integral gearing for locking door, and accessories required for proper operation.
   a. Comply with NFPA 70.

b. Provide control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24 V, ac or dc.

2. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.
3. Door Operator Location(s): Operator location indicated for each door.
   a. Top-of-Hood Mounted: Operator is mounted to the right or left door head plate with the operator on top of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Headroom is required for this type of mounting.
   b. Front-of-Hood Mounted: Operator is mounted to the right or left door head plate with the operator on coil side of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Front clearance is required for this type of mounting.
   c. Wall Mounted: Operator is mounted to the inside front wall on the left or right side of door and connected to door drive shaft with drive chain and sprockets. Side room is required for this type of mounting. Wall mounted operator can also be mounted above or below shaft; if above shaft, headroom is required.
   d. Bench Mounted: Operator is mounted to the right or left door head plate and connected to the door drive shaft with drive chain and sprockets. Side room is required for this type of mounting.
   e. Through-Wall Mounted: Operator is mounted on other side of wall from coil side of door.
4. Electric Motors: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 11 Section "Common Motor Requirements For Equipment", unless otherwise indicated.
   a. Electrical Characteristics:
      1) Phase: Single phase **OR** Polyphase, **as directed**.
      2) Volts: 115 **OR** 208 **OR** 230 **OR** 460, **as directed**, V.
      3) Hertz: 60.
   b. Motor Type and Controller: Reversible motor and controller (disconnect switch) for motor exposure indicated.
   c. Motor Size: Minimum size as indicated. If not indicated, large enough to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. (203 mm/s) and not more than 12 in./sec. (305 mm/s), without exceeding nameplate ratings or service factor.
   d. Operating Controls, Controllers (Disconnect Switches), Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
   e. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.
5. Limit Switches: Equip each motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.
6. Obstruction Detection Device: Equip motorized door with indicated external automatic safety sensor capable of protecting full width of door opening. For non-fire-rated doors, activation of device immediately stops and reverses downward door travel. For fire-rated doors, activation delays closing.
   a. Photoelectric Sensor: Manufacturer's standard system designed to detect an obstruction in door opening without contact between door and obstruction.
      1) Self-Monitoring Type: Designed to interface with door operator control circuit to detect damage to or disconnection of sensing device. When self-monitoring feature is activated, door closes only with sustained pressure on close button.
   b. Sensor Edge: Automatic safety sensor edge, located within astragal or weather stripping mounted to bottom bar. Contact with sensor activates device. Connect to control circuit using manufacturer's standard take-up reel or self-coiling cable.
      1) Self-Monitoring Type: Four-wire configured device designed to interface with door operator control circuit to detect damage to or disconnection of sensor edge.
7. Remote-Control Station: Momentary-contact, three-button control station with push-button controls labeled "Open," "Close," and "Stop."

a. Interior units, full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.
b. Exterior units, full-guarded, standard-duty, surface-mounted, weatherproof type, NEMA ICS 6, Type 4 enclosure, key operated.

8. Emergency Manual Operation: Equip each electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed 25 lbf (111 N) **OR** 30 lbf (133 N), **as directed**.
9. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.
10. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.
11. Audible and Visual Signals: Audible alarm and visual indicator lights in compliance with regulatory requirements for accessibility.
12. Radio-Control System: Consisting of the following:
    a. Three-channel universal coaxial receiver to open, close, and stop door; one **OR** two, **as directed**, per operator.
    b. Multifunction remote control.
    c. Remote-antenna mounting kit.

I. Door Assembly

1. Service **OR** Insulated Service **OR** Counter, **as directed**, Door: Overhead coiling door formed with curtain of interlocking metal slats.
2. Operation Cycles: Not less than 10,000 **OR** 20,000 **OR** 50,000 **OR** 100,000, **as directed**.
    a. Include tamperproof cycle counter.
3. STC Rating: 26.
4. Curtain R-Value: 4.5 deg F x h x sq. ft./Btu (0.792 K x sq. m/W) **OR** 5.0 deg F x h x sq. ft./Btu (0.881 K x sq. m/W) **OR** 6.0 deg F x h x sq. ft./Btu (1.057 K x sq. m/W), **as directed**.
5. Door Curtain Material: Galvanized steel **OR** Stainless steel **OR** Aluminum, **as directed**.
6. Door Curtain Slats: Curved **OR** Flat, **as directed**, profile slats of 1-1/4-inch (32-mm) **OR** 1-1/2-inch (38-mm) **OR** 1-7/8-inch (48-mm) **OR** 2-5/8-inch (67-mm) **OR** 3-1/4-inch (83-mm), **as directed**, center-to-center height.
    a. Perforated Slats: Approximately 1/16-inch (1.6-mm) pinholes **OR** 3/32-inch (2.4-mm) pinholes **OR** 7/8-inch- (22-mm-) wide by 3/8-inch- (10-mm-) high slots, **as directed**.
    b. Fenestrated Slats: Approximately 3- by 5/8-inch (76- by 16-mm) **OR** 4- by 5/8-inch (102- by 16-mm) **OR** 10- by 1-5/8-inch (254- by 41-mm), **as directed**, openings spaced approximately 1-1/2 inches (38 mm) apart and beginning 12 inches (305 mm) from jamb guides.
    c. Vision Panels: Approximately 10- by 1-5/8-inch (254- by 41-mm) openings spaced approximately 2 inches (51 mm) apart and beginning 12 inches (305 mm) from end guides; in two **OR** three, **as directed**, rows of slats at height indicated on Drawings; installed with insulated, **as directed**, vision-panel glazing.
    d. Insulated-Slat Interior Facing: Metal **OR** Plastic, **as directed**.
7. Curtain Jamb Guides: Galvanized steel **OR** Stainless steel **OR** Aluminum, **as directed**, with exposed finish matching curtain slats. Provide continuous integral wear strips to prevent metal-to-metal contact and to minimize operational noise. Provide removable post(s) and jamb guides where shown on Drawings.
8. Pass Door(s): Hinged **OR** Rigid, **as directed**, frame with lockset **OR** exit hardware, **as directed**.
9. Hood: Match curtain material and finish **OR** Galvanized steel **OR** Stainless steel **OR** Aluminum, **as directed**.
    a. Shape: Round **OR** Square **OR** As shown on Drawings, **as directed**.
    b. Mounting: Face of wall **OR** Between jambs **OR** As shown on Drawings, **as directed**.
10. Integral Frame, Hood, and Fascia for Counter Door: Galvanized steel **OR** Stainless steel, **as directed**.

a. Mounting: Face of wall **OR** Between jambs **OR** As shown on Drawings, **as directed**.

11. Sill Configuration for Counter Door: No sill **OR** Integral metal sill, **as directed**.
12. Locking Devices: Equip door with slide bolt for padlock **OR** locking device assembly, **as directed**, and chain lock keeper, **as directed**.
    a. Locking Device Assembly: Single-jamb side **OR** Cremone type, both jamb sides, **as directed**, locking bars, operable from inside with thumb turn **OR** outside with cylinder **OR** outside only, with cylinder **OR** inside and outside with cylinders, **as directed**.
13. Manual Door Operator: Push-up operation **OR** Chain-hoist operator **OR** Manufacturer's standard crank operator **OR** Awning-crank operator **OR** Wall-crank operator, **as directed**.
    a. Provide operator with through-wall shaft operation.
    b. Provide operator with manufacturer's standard removable operating arm.
14. Electric Door Operator:
    a. Usage Classification: Heavy duty, 60 to 90 cycles per hour **OR** Standard duty, up to 60 cycles per hour **OR** Medium duty, up to 15 cycles per hour **OR** Light duty, up to 10 cycles per hour, **as directed**.
    b. Operator Location: Top of hood **OR** Front of hood **OR** Wall **OR** Bench **OR** Through wall **OR** As shown on Drawings, **as directed**.
    c. Motor Exposure: Interior **OR** Exterior, wet, and humid, **as directed**.
    d. Emergency Manual Operation: Push-up **OR** Chain **OR** Crank, **as directed**, type.
    e. Obstruction-Detection Device: Automatic photoelectric sensor **OR** electric sensor edge on bottom bar **OR** pneumatic sensor edge on bottom bar, **as directed**; self-monitoring type, **as directed**.
        1) Sensor Edge Bulb Color: Black **OR** As selected from manufacturer's full range, **as directed**.
    f. Remote-Control Station: Interior **OR** Exterior **OR** Where shown on Drawings, **as directed**.
    g. Other Equipment: Audible and visual signals **OR** Radio-control system, **as directed**.
15. Door Finish:
    a. Aluminum Finish: Mill **OR** Clear anodized **OR** Light bronze anodized **OR** Medium bronze anodized **OR** Dark bronze anodized **OR** Black anodized **OR** Anodized color matching sample **OR** Anodized color as selected from full range of industry colors and color densities, **as directed**.
    b. Baked-Enamel or Powder-Coated Finish: Color as indicated by manufacturer's designations **OR** Color matching sample **OR** Color as selected from manufacturer's full range, **as directed**.
    c. Factory Prime Finish: Manufacturer's standard color.
    d. Stainless-Steel Finish: No. 2B (bright, cold rolled) **OR** No. 4 (polished directional satin), **as directed**.
    e. Interior Curtain-Slat Facing: Match finish of exterior curtain-slat face **OR** PVC plastic, **as directed**.

J. Fire-Rated Door Assembly
1. Fire-Rated Service **OR** Insulated Service **OR** Counter, **as directed**, Door: Overhead fire-rated coiling door formed with curtain of interlocking metal slats.
2. Operation Cycles: Not less than 10,000 **OR** 20,000 **OR** 50,000 **OR** 100,000, **as directed**.
    a. Include tamperproof cycle counter.
3. Fire Rating: 3/4 hour **OR** 1 hour **OR** 1-1/2 hours **OR** 3 hours **OR** 4 hours, **as directed**, with temperature-rise limit, **as directed**, and with smoke control, **as directed**.
4. STC Rating: 27.
5. Curtain R-Value: 4.5 deg F x h x sq. ft./Btu (0.792 K x sq. m/W) **OR** 5.0 deg F x h x sq. ft./Btu (0.881 K x sq. m/W) **OR** 6.0 deg F x h x sq. ft./Btu (1.057 K x sq. m/W), **as directed**.
6. Door Curtain Material: Galvanized steel **OR** Stainless steel, **as directed**.
7. Door Curtain Slats: Curved **OR** Flat, **as directed**, profile slats of 1-1/4-inch (32-mm) **OR** 1-1/2-inch (38-mm) **OR** 1-7/8-inch (48-mm) **OR** 2-5/8-inch (67-mm) **OR** 3-1/4-inch (83-mm), **as directed**, center-to-center height.

a. Vision Panels: Approximately 10- by 1-5/8-inch (254- by 41-mm) openings spaced approximately 2 inches (51 mm) apart and beginning 12 inches (305 mm) from end guides; in two **OR** three, **as directed**, rows of slats at height indicated on Drawings; installed with fire-rated vision-panel glazing.
b. Insulated-Slat Interior Facing: Metal.

8. Curtain Jamb Guides: Galvanized steel **OR** Stainless steel, **as directed**, with exposed finish matching curtain slats.
9. Pass Door(s): Hinged **OR** Rigid, **as directed**, frame with lockset **OR** exit hardware, **as directed**.
10. Hood: Match curtain material and finish **OR** Galvanized steel **OR** Stainless steel, **as directed**.
    a. Shape: Round **OR** Square **OR** As shown on Drawings, **as directed**.
    b. Mounting: Face of wall **OR** Between jambs **OR** As shown on Drawings, **as directed**.
11. Integral Frame, Hood, and Fascia for Counter Door: Galvanized steel **OR** Stainless steel, **as directed**.
    a. Mounting: Face of wall **OR** Between jambs **OR** As shown on Drawings, **as directed**.
12. Sill Configuration for Fire-Rated Counter Door: No sill **OR** Integral metal sill **OR** Fire-rated, laminate counter, **as directed**.
    a. High-Pressure Decorative Laminate: Match color, pattern, and finish as indicated by manufacturer's designations **OR** of sample **OR** as selected from manufacturer's full range, **as directed**.
13. Locking Devices: Equip door with slide bolt for padlock **OR** locking device assembly, **as directed**, and chain lock keeper, **as directed**.
    a. Locking Device Assembly: Single-jamb side **OR** Cremone type, both jamb sides, **as directed**, locking bars, operable from inside with thumbturn **OR** outside with cylinder **OR** outside only, with cylinder **OR** inside and outside with cylinders, **as directed**.
14. Manual Door Operator: Push-up operation **OR** Chain-hoist operator **OR** Manufacturer's standard crank operator **OR** Awning-crank operator **OR** Wall-crank operator, **as directed**.
    a. Provide operator with through-wall shaft operation.
    b. Provide operator with manufacturer's standard removable operating arm.
15. Electric Door Operator:
    a. Usage Classification: Heavy duty, 60 to 90 cycles per hour **OR** Standard duty, up to 60 cycles per hour **OR** Medium duty, up to 15 cycles per hour **OR** Light duty, up to 10 cycles per hour, **as directed**.
    b. Operator Location: Top of hood **OR** Front of hood **OR** Wall **OR** Bench **OR** Through wall **OR** As shown on Drawings, **as directed**.
    c. Motor Exposure: Interior **OR** Exterior, wet, and humid, **as directed**.
    d. Emergency Manual Operation: Push-up **OR** Chain **OR** Crank, **as directed**, type.
    e. Obstruction Detection Device: Automatic photoelectric sensor **OR** electric sensor edge on bottom bar **OR** pneumatic sensor edge on bottom bar, **as directed**; self-monitoring type, **as directed**.
        1) Sensor Edge Bulb Color: Black **OR** As selected from manufacturer's full range, **as directed**.
    f. Remote-Control Station: Interior **OR** Exterior **OR** Where shown on Drawings, **as directed**.
    g. Other Equipment: Audible and visual signals **OR** Radio-control system, **as directed**.
16. Door Finish:
    a. Baked-Enamel or Powder-Coated Finish: Color as indicated by manufacturer's designations **OR** Color matching sample **OR** Color as selected from manufacturer's full range, **as directed**.
    b. Factory Prime Finish: Manufacturer's standard color.
    c. Stainless-Steel Finish: No. 2B (bright, cold rolled) **OR** No. 4 (polished directional satin), **as directed**.
    d. Interior Curtain-Slat Facing: Match finish of exterior curtain-slat face.

K. General Finish Requirements
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

2. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

L. Aluminum Finishes
1. Mill Finish: Manufacturer's standard.
2. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
3. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
4. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, application, and baking.

M. Steel And Galvanized-Steel Finishes
1. Factory Prime Finish: Manufacturer's standard primer, compatible with field-applied finish. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.
2. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

N. Stainless-Steel Finishes
1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
   a. Run grain of directional finishes with long dimension of each piece.
   b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
   c. Directional Satin Finish: No. 4.
3. Bright, Cold-Rolled, Unpolished Finish: No. 2B.

1.3 EXECUTION

A. Installation
1. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.
2. Install overhead coiling doors, hoods, and operators at the mounting locations indicated for each door.
3. Accessibility: Install overhead coiling doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility.
4. Fire-Rated Doors: Install according to NFPA 80.
5. Smoke-Control Doors: Install according to NFPA 80 and NFPA 105.

B. Startup Service
1. Engage a factory-authorized service representative to perform startup service.
   a. Perform installation and startup checks according to manufacturer's written instructions.
   b. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   c. Test door closing when activated by detector or alarm-connected fire-release system. Reset door-closing mechanism after successful test.

C. Adjusting
1. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.

2. Lubricate bearings and sliding parts as recommended by manufacturer.
3. Adjust seals to provide weathertight fit around entire perimeter.

END OF SECTION 08330

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SECTION 08340 - DETENTION DOORS AND FRAMES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for detention doors and frames. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Swinging detention doors.
   b. Sliding detention doors.
   c. Detention panels.
   d. Detention frames.

C. Definitions
1. Minimum-Thickness Steel: Indicated as the specified minimum thicknesses for base metal without coatings, according to HMMA 803.
2. Nominal-Thickness Stainless Steel: Indicated as the specified thicknesses for which over- and under-thickness tolerances apply, according to ASTM A 480/A 480M.
3. Nominal Surface of Floor Covering: Top surface of floor; for resilient tile and carpet, nominal surface of floor covering is defined as top of concrete slab.

D. Performance Requirements
1. Detention Doors and Frame Assemblies: Provide detention doors and frames that comply with the following, based on testing manufacturer's standard units in assemblies similar to those indicated for this Project:
   a. Security Grade: Comply with Grade 1 **OR** Grade 2 **OR** Grade 3 **OR** Grade 4, **as directed**, according to ASTM F 1450.
   b. Bullet Resistance: Comply with Level 3 rating when tested according to UL 752.
      1) Listed and labeled, by a testing agency acceptable to authorities having jurisdiction, as bullet resisting.
   c. Tool-Attack Resistance: Comply with small-tool-attack-resistance rating when tested according to UL 437 and UL 1034.
2. Detention Frames: Provide sidelight and borrowed-light detention frames that comply with ASTM F 1592 and removable stop test according to HMMA 863, based on testing manufacturer's standard units in assemblies similar to those indicated for this Project.

E. Submittals
1. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, label compliance, fire-resistance rating, and temperature-rise ratings, and finishes for each type of detention doors and frames specified.
2. Shop Drawings: In addition to requirements below, provide a schedule using same reference numbers for details and openings as those on Drawings:
   a. Elevations of each door design.
   b. Direction of swing **OR** slide, **as directed**.
   c. Inmate and non-inmate sides.
   d. Details of doors, including vertical and horizontal edge details, and metal thicknesses.
   e. Details of frames, including dimensioned profiles, and metal thicknesses.
   f. Locations of reinforcement and preparations for hardware.
   g. Details of each different wall opening condition.
   h. Details of anchorages, joints, field splices, and connections.

i. Details of food-pass openings, louvers, speaking apertures, and gun ports.
j. Details of moldings, removable stops, and glazing.
k. Details of conduit, junction boxes, and preparations for electrified and pneumatic door hardware.

3. Samples:
   a. For each type of exposed finish required.
   b. For the following items to demonstrate compliance with requirements for quality of materials and construction:
      1) Detention Doors: Show vertical-edge, top, and bottom construction; insulation; face stiffeners; and hinge and other applied hardware reinforcement. Include separate section showing glazing if applicable.
      2) Detention Frames: Show profile, welded corner joint, welded hinge reinforcement, grout-cover boxes, floor and wall anchors, and silencers. Include separate section showing fixed steel panels and glazing if applicable.
4. Coordination Drawings: Drawings of each detention door and frame, drawn to scale, on which connections and interface with electrified and pneumatic control systems are shown.
5. Oversize Construction Certification: For assemblies required to be fire rated and exceeding limitations of labeled assemblies.
6. Welding certificates.
7. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency for detention doors and frames. Indicate metal thickness of each component of tested assembly and describe construction methods.
8. Field quality-control reports documenting inspections of installed products.

F. Quality Assurance
1. Welding Qualifications: Qualify procedures and personnel according to the following:
   a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   b. AWS D1.3, "Structural Welding Code - Sheet Steel."
   c. AWS D1.6, "Structural Welding Code - Stainless Steel."
2. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure **OR** as close to neutral pressure as possible, **as directed**, according to NFPA 252 **OR** UBC Standard 7-2 **OR** UL 10B **OR** UL 10C, **as directed**.
   a. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
   b. Temperature-Rise Limit: Where indicated **OR** At vertical exit enclosures and exit passageways, **as directed**, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.
3. Fire-Rated Detention Sidelight and Borrow-Light Frames: Assemblies complying with NFPA 80 that are listed and labeled, by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 257.
4. Smoke-Control Detention Door Assemblies: Comply with NFPA 105.

G. Delivery, Storage, And Handling
1. Deliver detention doors and frames palleted, wrapped, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
2. Deliver detention frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
3. Inspect units, on delivery, for damage. Minor damage may be repaired provided refinished items match new work and are approved by Architect; otherwise, remove and replace damaged items as directed.

4. Store detention doors and frames under cover at building site. Place units in a vertical position with heads up, spaced by blocking, on minimum 4-inch- (102-mm-) high wood blocking. Avoid using nonvented plastic or canvas shelters that could create a humidity chamber.
   a. Provide minimum 1/4-inch (6-mm) space between each stacked unit to permit air circulation.

H. Maintenance Tools
1. Tool Kit: Provide six sets of tools for use with security fasteners, each packaged in a compartmented kit configured for easy handling and storage.

1.2 PRODUCTS

A. Materials
1. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, CS (Commercial Steel), Type B; free of scale, pitting, or surface defects; pickled and oiled.
2. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, CS (Commercial Steel), Type B.
3. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, CS (Commercial Steel), Type B; with G60 (Z180) zinc (galvanized) or A60 (ZF180) zinc-iron-alloy (galvannealed) coating designation.
4. Stainless-Steel Sheet: ASTM A 240/A 240M, austenitic stainless steel, Type 304.
5. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
6. Concealed Bolts: ASTM A 307, Grade A unless otherwise indicated.
7. Masonry Anchors: Fabricated from same steel sheet as door face.
8. Embedded Anchors: Fabricated from mild steel shapes and plates, hot-dip galvanized according to ASTM A 153/A 153M.
9. Postinstalled Expansion Anchors: With capability to sustain, without failure, a load equal to 4 times the load imposed, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
   a. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition (mild).
   b. Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Alloy Group 1 or 4) for bolts and nuts; ASTM A 276 or ASTM A 666, Type 304 or 316, for anchors.
   c. Corrosion Protection: Components fabricated from nickel-copper-alloy rods complying with ASTM B 164 for UNS No. N04400 alloy.
10. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
11. Glazing: Comply with Division 08 Section "Security Glazing".
12. Grout: Comply with ASTM C 476, with a slump of not more than 4 inches (102 mm) as measured according to ASTM C 143/C 143M.
13. Insulation: Slag-wool-fiber/rock-wool-fiber or glass-fiber blanket insulation. ASTM C 665, Type I (unfaced); with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics. Minimum 1.5-lb/cu. ft. (24-kg/cu. m) density.
14. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

B. Detention Doors
1. General: Provide flush-design detention doors of seamless hollow construction, 2 inches (51 mm) thick unless otherwise indicated. Construct detention doors with smooth, flush surfaces without visible joints or seams on exposed faces or stile edges.
   a. For single-acting swinging detention doors, bevel both vertical edges 1/8 inch in 2 inches (3 mm in 51 mm).
   b. For sliding detention doors, square both vertical edges.
2. Core Construction: Provide the following core construction of same material as detention door face sheets, welded to both detention door faces:

a. Steel-Stiffened Core: 0.042-inch- (1.0-mm-) thick, steel vertical stiffeners extending full-door height, with vertical webs spaced not more than 4 inches (102 mm) apart, spot welded to face sheets a maximum of 3 inches (76 mm) o.c. Fill spaces between stiffeners with insulation.
b. Truss-Stiffened Core: 0.013-inch- (0.3-mm-) thick, steel, truncated triangular stiffeners extending between face sheets and for full height and width of door; with stiffeners welded to face sheets not more than 3 inches (76 mm) o.c. vertically and 2-3/4 inches (70 mm) horizontally. Fill spaces between stiffeners with insulation.

3. Vertical Edge Channels: 0.123-inch- (3.1-mm-) thick, continuous channel of same material as detention door face sheets, extending full-door height at each vertical edge; welded to top and bottom channels to create a fully welded perimeter channel. Noncontiguous channel is permitted to accommodate lock-edge hardware only if lock reinforcement is welded to and made integral with channel.
4. Top and Bottom Channels: 0.123-inch- (3.1-mm-) thick metal channel of same material as detention door face sheets, spot welded, not more than 4 inches (102 mm) o.c., to face sheets.
   a. Reinforce top edge of detention door with 0.053-inch- (1.3-mm-) thick closing channel, inverted and nesting in top channel; welded so channel web is flush with top door edges.
5. Hardware Reinforcement: Fabricate reinforcing plates from same material as detention door face sheets to comply with the following minimum thicknesses:
   a. Full-Mortise Hinges and Pivots: 0.187 inch (4.7 mm) thick.
   b. Maximum-Security Surface Hinges: 0.250 inch (6.3 mm) thick.
   c. Strike Reinforcements: 0.187 inch (4.7 mm) thick.
   d. Slide-Device Hanger Attachments: As recommended by device manufacturer.
   e. Lock Fronts, Concealed Holders, and Surface-Mounted Closers: 0.093 inch (2.3 mm) thick.
   f. All Other Surface-Mounted Hardware: 0.093 inch (2.3 mm) thick.
   g. Lock Pockets: 0.123 inch (3.1 mm) thick at non-inmate side, welded to face sheet.
6. Hardware Enclosures: Provide enclosures and junction boxes for electrically operated detention door hardware of same material as detention door face sheets, interconnected with UL-approved, 1/2-inch- (13-mm-) diameter conduit and connectors.
   a. Where indicated for installation of wiring, provide access plates to junction boxes, fabricated from same material and thickness as face sheet and fastened with at least 4 security fasteners spaced not more than 6 inches (152 mm) o.c.
7. Interior Detention Door Face Sheets: Fabricated from cold-rolled steel sheets **OR** metallic-coated steel sheets **OR** stainless-steel sheets, **as directed**.
   a. Security Grade 1: 0.093-inch- (2.3-mm-) minimum-thickness steel **OR** 0.109-inch (2.8-mm) nominal-thickness stainless steel, **as directed**.
   b. Security Grade 2: 0.093-inch- (2.3-mm-) minimum-thickness steel **OR** 0.109-inch (2.8-mm) nominal-thickness stainless steel, **as directed**.
   c. Security Grade 3: 0.067-inch- (1.7-mm-) minimum-thickness steel **OR** 0.078-inch (2.0-mm) nominal-thickness stainless steel, **as directed**.
   d. Security Grade 4: 0.067-inch- (1.7-mm-) minimum-thickness steel **OR** 0.078-inch (2.0-mm) nominal-thickness stainless steel, **as directed**.
8. Exterior Detention Door Face Sheets: Fabricated from metallic-coated steel sheets **OR** stainless-steel sheets, **as directed**.
   a. Security Grade 1: 0.093-inch- (2.3-mm-) minimum-thickness steel **OR** 0.109-inch (2.8-mm) nominal-thickness stainless steel, **as directed**.
   b. Security Grade 2: 0.093-inch- (2.3-mm-) minimum-thickness steel **OR** 0.109-inch (2.8-mm) nominal-thickness stainless steel, **as directed**.
   c. Security Grade 3: 0.067-inch- (1.7-mm-) minimum-thickness steel **OR** 0.078-inch (2.0-mm) nominal-thickness stainless steel, **as directed**.
   d. Security Grade 4: 0.067-inch- (1.7-mm-) minimum-thickness steel **OR** 0.078-inch (2.0-mm) nominal-thickness stainless steel, **as directed**.

C. Detention Panels

1. Provide fixed detention panels of same materials, construction, and finish as specified for adjoining detention frame.

D. Detention Frames
1. General: Provide fully welded detention frames with integral stops, of seamless construction without visible joints or seams. Fabricate detention frames with contact edges closed tight and corners mitered, reinforced, and continuously welded full depth and width of detention frame.
2. Provide two temporary steel spreaders spot welded to bottom of jambs to act as bracing during shipping and storage. Remove prior to installation.
3. Stop Height: Provide minimum stop height of 0.625 inch (16 mm) **OR** 0.750 inch (19 mm), **as directed,** for detention door openings and minimum stop height of 1-1/4 inches (32 mm) in security glazing or detention panel openings unless otherwise indicated.
4. Interior Detention Frames: Fabricated from cold-rolled steel sheets **OR** metallic-coated steel sheets where indicated **OR** stainless-steel sheets for stainless-steel detention doors, **as directed**.
   a. Security Grade 1: 0.093-inch- (2.3-mm-) minimum-thickness steel **OR** 0.109-inch (2.8-mm) nominal-thickness stainless steel, **as directed**.
   b. Security Grade 2: 0.093-inch- (2.3-mm-) minimum-thickness steel **OR** 0.109-inch (2.8-mm) nominal-thickness stainless steel, **as directed**.
   c. Security Grade 3: 0.067-inch- (1.7-mm-) minimum-thickness steel **OR** 0.078-inch (2.0-mm) nominal-thickness stainless steel, **as directed**.
   d. Security Grade 4: 0.067-inch- (1.7-mm-) minimum-thickness steel **OR** 0.078-inch (2.0-mm) nominal-thickness stainless steel, **as directed**.
5. Exterior Detention Frames: Fabricated from metallic-coated steel sheets **OR** stainless-steel sheets for stainless-steel detention doors, **as directed**.
   a. Security Grade 1: 0.093-inch- (2.3-mm-) minimum-thickness steel **OR** 0.109-inch (2.8-mm) nominal-thickness stainless steel, **as directed**.
   b. Security Grade 2: 0.093-inch- (2.3-mm-) minimum-thickness steel **OR** 0.109-inch (2.8-mm) nominal-thickness stainless steel, **as directed**.
   c. Security Grade 3: 0.067-inch- (1.7-mm-) minimum-thickness steel **OR** 0.078-inch (2.0-mm) nominal-thickness stainless steel, **as directed**.
   d. Security Grade 4: 0.067-inch- (1.7-mm-) minimum-thickness steel **OR** 0.078-inch (2.0-mm) nominal-thickness stainless steel, **as directed**.
6. Hardware Reinforcement: Fabricate reinforcing plates from same material as detention frame to comply with the following minimum thicknesses:
   a. Hinges and Pivots: 0.187 inch (4.7 mm) thick by 1-1/2 inches (38 mm) wide by 10 inches (254 mm) long.
   b. Strikes, Flush Bolts, and Closers: 0.187 inch (4.7 mm) thick.
   c. Surface-Mounted Hardware: 0.093 inch (2.3 mm) thick.
   d. Lock Pockets: 0.123 inch (3.1 mm) thick at non-inmate side, welded to face sheet. Provide 0.123-inch- (3.1-mm-) thick, lock protection plate for attachment to lock pocket with security fasteners.
7. Hardware Enclosures: Provide enclosures and junction boxes for electrically operated detention door hardware, interconnected with UL-approved, 1/2-inch- (13-mm-) diameter conduit and connectors.
   a. Where indicated for installation of wiring, provide access plates to junction boxes, fabricated from same material and thickness as face sheet and fastened with at least 4 security fasteners spaced not more than 6 inches (152 mm) o.c.
8. Mullions and Transom Bars: Provide closed or tubular mullions and transom bars where indicated. Fasten mullions and transom bars at crossings and to jambs by butt welding. Reinforce joints between detention frame members with concealed clip angles or sleeves of same metal and thickness as detention frame.
9. Jamb Anchors: Weld jamb anchors to detention frames near hinges and directly opposite on strike jamb or as required to secure detention frames to adjacent construction.
   a. Number of Anchors: Provide two anchors per jamb plus the following:
      1) Detention Door Frames: One additional anchor for each 18 inches (457 mm), or fraction thereof, above 54 inches (1372 mm) in height.

2) Detention Frames with Security Glazing or Detention Panels: One additional anchor for each 18 inches (457 mm), or fraction thereof, above 36 inches (914 mm) in height.

b. Masonry Anchors: Adjustable, corrugated or perforated, strap-and-stirrup anchors to suit detention frame size; formed of same material and thickness as detention frame; with strap not less than 2 inches (51 mm) wide by 10 inches (254 mm) long.

c. Embedded Anchors: Provide detention frames with removable faces at jambs where embedded anchors are indicated. Anchors consist of three parts:

1) Embedded Plates: Steel plates, 0.188 inch thick by 4 inches wide by 6 inches (4.7 mm thick by 102 mm wide by 152 mm) long. Continuously weld 2 steel bars, 1/2 inch (13 mm) in diameter and 10 inches (254 mm) long with 2-inch (51-mm) 90-degree turndown on ends, to the embedded end of each plate. Weld steel angles, 0.188 inch thick by 2 by 2 by 4 inches (4.7 mm thick by 51 by 51 by 102 mm) long, to the exposed end of each plate. Embed at locations to match frame angles.

2) Frame Angles: Steel angles, 0.188 inch thick by 2 by 2 by 4 inches (4.7 mm thick by 51 by 51 by 102 mm) long, welded to detention frames with 1-inch- (25-mm-) long welds at each end of angle.

3) Connector Angles: Steel angles, of size required, to connect frame angles and embedded plates.

d. Postinstalled Expansion Anchors: Minimum 1/2-inch- (13-mm-) diameter concealed bolts with expansion shields or inserts. Provide conduit spacer from detention frame to wall, welded to detention frame. Reinforce detention frames at anchor locations.

10. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, formed of same material and thickness as detention frame, and as follows:

a. Monolithic Concrete Slabs: Clip anchors, with two holes to receive fasteners, welded to bottom of jambs and mullions with at least four spot welds per anchor.

b. Separate Topping Concrete Slabs: Adjustable anchors with extension clips, allowing not less than 2-inch (51-mm) height adjustment, welded to jambs and mullions with at least 4 spot welds per anchor. Terminate bottom of detention frames at finish floor surface.

11. Rubber Door Silencers: Except on weather-stripped detention doors, drill stops in strike jambs to receive three silencers on single-detention-door frames and drill head jamb stop to receive two silencers on double-detention-door frames. Keep holes clear during construction.

12. Grout Guards: Provide factory-installed grout guards of same material as detention frame, welded to detention frame at back of hardware cutouts, silencers, and glazing-stop screw preparations to close off interior of openings and prevent mortar or other materials from obstructing hardware operation or installation.

E. Moldings And Stops

1. Provide fixed moldings on inmate side of glazed openings and removable stops on non-inmate side.

a. Height: As required to provide minimum 1-inch (25-mm) glass engagement, but not less than 1-1/4 inches (32 mm).

b. Fixed Moldings: Formed from same material as detention door and frame face sheets, but not less than 0.093-inch- (2.3-mm-) thick, spot welded to face sheets a maximum of 5 inches (127 mm) o.c.

c. Removable Stops: Formed from 0.123-inch- (3.1-mm-) thick angle, of same material as detention door face sheets. Secure with button head security fasteners spaced uniformly not more than 9 inches (229 mm) **OR** 6 inches (152 mm), **as directed,** o.c. and not more than 2 inches (51 mm) from each corner, and as necessary to satisfy performance requirements. Form corners with notched or mitered hairline joints.

2. Coordinate rabbet width between fixed and removable stops with type of glass or panel and type of installation indicated.

F. Accessories

1. Pass-Through Openings: Fabricate flush openings using 0.093-inch- (2.3-mm-) thick interior channels of same material as detention door faces, inverted to be flush with openings, welded to inside of both face sheets and with corners fully welded. Mount shutters on non-inmate side of detention doors. Reinforce for locks and food-pass hinges.
   a. Inset Shutters: Fabricate from 2 steel plates, 0.123 inch (3.1 mm) thick, of same material as detention door face sheets, spot welded together and sized to inset inside opening and to prevent inmate tampering of lock and hinges.
   b. Overlapping Shutters: For surface application on non-inmate side of door. Fabricate from a single steel plate, of same material as detention door face sheets, 0.187 inch (4.7 mm) thick, sized to overlap food-pass openings 1/2 inch (13 mm).
2. Detention Door Louvers: Fabricate flush louver openings using 0.093-inch- (2.3-mm-) thick, interior steel channels of same material as detention door faces, welded to inside of both detention door face sheets and with corners fully welded. Provide welded, inverted V- or Y-shaped vanes allowing specified airflow, fabricated from same material as detention door face sheets, 0.093 inch (2.3 mm) thick, and spaced so no rigid flat instrument can pass through.
   a. Reinforcement: Reinforce louvers that exceed 18 inches (457 mm) in height at louver midpoint with 1/4-by-1-1/2-inch- (6.3-by-38-mm-) square, vertical rectangular steel bar or 3/4-inch- (19-mm-) diameter, vertical steel bar.
   b. Airflow: Airflow and static-pressure loss **as directed**.
   c. Exterior Detention Door Insect Screens: Fabricated from 12-by-12 (2.1-by-2.1-mm) mesh of 0.028-inch- (0.71-mm-) diameter, stainless-steel wire or from perforated metal of same material and thickness as detention door face sheet with 1/8-inch- (3-mm-) diameter holes spaced 1 inch (25 mm) o.c.; where indicated.
3. Speaking Apertures: Consisting of a rectangular pattern of holes, minimum 1 inch high by 4 inches wide (25 mm high by 102 mm wide), with holes 1/4 inch (6 mm) in diameter. Locate holes in both face sheets directly across from each other and spaced not more than 1 inch (25 mm) o.c. vertically and horizontally. Provide 0.067-inch- (1.7-mm-) thick, pressed-steel baffles in interior of detention door between hole patterns to prevent passage of objects.
4. Gun Ports: Fabricate units to comply with UL 752 and to resist same security level as detention doors in which they are installed.

G. Security Fasteners
1. Security Fasteners: Operable only by tools produced for use on specific type of fastener by fastener manufacturer or other licensed fabricator.
2. Drive-System Type, Head Style, Material, and Protective Coating: Provide as required for assembly, installation, and strength, and as follows:
   a. Drive-System Types: Pinned Torx-Plus **OR** Pinned Torx, **as directed**.
   b. Fastener Strength: Grade 8 (Class 10.9).
   c. Socket Button Head Fasteners:
      1) Heat-treated alloy steel, ASTM F 835 (ASTM F 835M).
      2) Stainless steel, ASTM F 879 (ASTM F 879M), Group 1 CW.
   d. Socket Flat Countersunk Head Fasteners:
      1) Heat-treated alloy steel, ASTM F 835 (ASTM F 835M).
      2) Stainless steel, ASTM F 879 (ASTM F 879M), Group 1 CW.
   e. Socket Head Cap Fasteners:
      1) Heat-treated alloy steel, ASTM A 574 (ASTM A 574M).
      2) Stainless steel, ASTM F 837 (ASTM F 837M), Group 1 CW.
   f. Protective Coatings for Heat-Treated Alloy Steel:
      1) Zinc and clear trivalent chromium, for exterior applications and interior applications where indicated.
      2) Zinc phosphate with oil, ASTM F 1137, Grade I, or black oxide unless otherwise indicated.

H. Fabrication
1. Fabricate detention doors and frames rigid, neat in appearance, and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of

metal. Weld exposed joints continuously; grind, fill, dress, and make smooth, flush, and invisible. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

2. Tolerances: Fabricate detention doors and frames to comply with manufacturing tolerances indicated in HMMA 863.
3. Fabricate multiple-opening detention frames with mullions that have closed tubular shapes and with no visible seams or joints.
4. Exterior Detention Doors: Provide weep-hole openings in bottom of detention doors to permit entrapped moisture to escape. Seal joints in top edges of detention doors against water penetration.
5. Hardware Preparation: Factory prepare detention doors and frames to receive mortised hardware, including cutouts, reinforcement, mortising, drilling, and tapping, according to final door hardware schedule and templates provided by detention door hardware supplier.
   a. Reinforce detention doors and frames to receive surface-mounted door hardware. Drilling and tapping may be done at Project site.
   b. Locate door hardware as indicated or, if not indicated, according to HMMA 831.
6. Factory cut openings in detention doors.
7. Weld components to comply with referenced AWS standard. Weld before finishing components to greatest extent possible. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

I. General Finish Requirements
   1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   2. Finish detention doors and frames after assembly.

J. Metallic-Coated Steel Sheet Finishes
   1. Surface Preparation: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas and apply galvanizing repair paint, complying with SPPC-Paint 20, to comply with ASTM A 780.
   2. Factory Priming for Field-Painted Finish: Apply shop primer specified below immediately after surface preparation and pretreatment. Apply a smooth coat of even consistency to provide a uniform dry film thickness of not less than 0.7 mils (0.02 mm).
      a. Shop Primer: Manufacturer's or fabricator's standard, fast-curing, lead- and chromate-free primer complying with ANSI A250.10 acceptance criteria; recommended by primer manufacturer for zinc-coated steel; compatible with substrate and field-applied finish paint system indicated; and providing a sound foundation for field-applied topcoats despite prolonged exposure.

K. Steel Sheet Finishes
   1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning"; remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 3, "Power Tool Cleaning," or SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   2. Factory Priming for Field-Painted Finish: Apply shop primer specified below immediately after surface preparation and pretreatment. Apply a smooth coat of even consistency to provide a uniform dry film thickness of not less than 0.7 mils (0.02 mm).
      a. Shop Primer: Manufacturer's or fabricator's standard, fast-curing, corrosion-inhibiting, lead- and chromate-free, universal primer complying with ANSI A250.10 acceptance criteria; compatible with substrate and field-applied finish paint system indicated; and providing a sound foundation for field-applied topcoats despite prolonged exposure.

L. Stainless-Steel Finishes
   1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
   a. Run grain of directional finishes with long dimension of each piece.
   b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
   c. Directional Satin Finish: No. 4.

1.3 EXECUTION

A. Preparation
1. Remove welded-in shipping spreaders installed at factory.
2. Prior to installation and with shipping spreaders removed, adjust detention frames for squareness, alignment, twist, and plumbness to the following tolerances:
   a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb and perpendicular to frame head.
   b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of face.
   c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of door rabbet.
   d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a perpendicular line from head to floor.

B. Installation
1. General: Install detention doors and frames plumb, rigid, properly aligned, and securely fastened in place, complying with Drawings, schedules, and manufacturer's written recommendations.
2. Anchorage: Set detention frame anchorage devices according to details on Shop Drawings and per anchorage device manufacturer's written instructions.
   a. Masonry Anchors: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
   b. Embedded Anchors: Install embedded plates in wall surrounding frame openings to match frame angle locations.
   c. Postinstalled Expansion Anchors: Drill holes in existing construction at locations to match bolt locations and install bolt expansion shields or inserts.
3. Assemble detention frames fabricated in sections. Install angle splices at each corner, of same material and thickness as detention frame, and extend at least 4 inches (102 mm) on both sides of joint.
   a. Field splice only at approved locations. Weld, grind, and finish as required to conceal evidence of splicing on exposed faces.
   b. Continuously weld and finish smooth joints between faces of abutted, multiple-opening, detention frame members.
   c. Field Welding: Comply with the following requirements:
      1) Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
      2) Obtain fusion without undercut or overlap.
      3) Remove welding flux immediately.
      4) At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
4. Apply bituminous coating to backs of frames prior to filling with grout.
5. Placing Detention Frames: Install detention frames of sizes and profiles indicated. Set detention frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.
   a. Embedded Anchors: Remove jamb faces from detention frames and set detention frames into opening. Weld steel connector angle to frame angle and to embedded plate with 1-

inch- (25-mm-) long welds at each end of connector angle to form a rigid frame assembly solidly anchored. Reinstall jamb faces using security fasteners.

b. Postinstalled Expansion Anchors: Install bolt. After bolt is tightened, weld bolt head to provide nonremovable condition. Grind, dress, and finish smooth welded bolt head.

c. At fire-rated openings, install detention frames according to NFPA 80.

d. Install detention frames with removable stops located on non-inmate side of opening.

6. Grout: Fully grout detention frame jambs and heads. Completely fill space between frames and adjacent substrates. Hand trowel grout and take other precautions, including bracing detention frames, to ensure that frames are not deformed or damaged by grout forces.

7. Swinging Detention Doors: Fit non-fire-rated detention doors accurately in their frames, with the following clearances:

a. Between Doors and Frames at Jambs and Head: 1/8 inch (3.2 mm).

b. Between Edges of Pairs of Doors: 1/8 inch (3.2 mm).

c. At Door Sills with Threshold: 3/8 inch (9.5 mm).

d. At Door Sills without Threshold: 3/4 inch (19.1 mm).

e. Between Door Bottom and Nominal Surface of Floor Covering: 1/2 inch (12.7 mm).

8. Sliding Detention Doors: Fit sliding detention doors in their frames according to manufacturer's written instructions and as required to allow doors to slide without binding.

9. Fire-Rated Detention Doors: Install with clearances as specified in NFPA 80.

10. Smoke-Control Detention Doors: Install according to NFPA 105.

11. Installation Tolerances: Comply with installation tolerances indicated in HMMA 863.

12. Glazing: Comply with installation requirements in Division 08 Section "Security Glazing", unless otherwise indicated.

C. Field Quality Control

1. Inspect installed products to verify compliance with requirements. Prepare inspection reports and indicate compliance with and deviations from the Contract Documents.

2. Remove and replace detention work where inspections indicate that work does not comply with specified requirements.

3. Perform additional inspections to determine compliance of replaced or additional work. Prepare inspection reports.

4. Prepare field quality-control certification that states installed products and their installation comply with requirements in the Contract Documents.

5. Select one detention door at random from detention doors delivered to Project and have it cut in half or otherwise taken apart for verification that construction complies with requirements.

6. Test Method: Verify weld strength by prying or chiseling door apart at edge seams, end channels, or stiffeners. Not more than five percent of welds may fail test.

a. If tested door fails, replace or rework all detention doors to bring them into compliance at Contractor's expense.

b. If tested door passes, replace tested door at Contractor's expense.

D. Adjusting And Cleaning

1. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including detention doors and frames that are warped, bowed, or otherwise unacceptable.

2. Clean grout and other bonding material off detention doors and frames immediately after installation.

3. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying primer.

a. After finishing smooth field welds, apply air-drying primer.

4. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

5. Stainless-Steel Surfaces: Clean surfaces according to manufacturer's written instructions.

END OF SECTION 08340

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Task	Specification	Specification Description
08340	01352	No Specification Required

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SECTION 08350 - FOLDING DOORS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for folding doors. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Accordion folding doors.
   b. Panel folding doors.
   c. Bifold doors.
   d. Bifold mirror doors.
   e. Fire-rated folding doors.

C. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Include plans, elevations, sections, details, attachments to other work.
   a. Fire-Release System: Describe system, including testing and resetting instructions.
   b. Wiring Diagrams: For power, signal, and control wiring.
3. Samples: For each exposed product and for each color and texture specified.
4. Product Schedule: For folding doors. Use same designations indicated on Drawings.
5. Product certificates.
6. Maintenance data.

D. Quality Assurance
1. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   a. Flame-Spread Index: 25 or less.
   b. Smoke-Developed Index: 50 **OR** 450, **as directed**, or less.
2. Fire-Rated Folding Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing according to NFPA 252 **OR** UBC Standard 7-2 **OR** UL 10B, **as directed**.
   a. Oversize Fire-Rated Folding Doors: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
3. Project Conditions
   a. Environmental Limitations: Do not deliver or install folding doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
   b. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication

1.2 PRODUCTS

A. Accordion Folding Doors
1. General: Top-supported, horizontal-sliding, manually operated accordion folding doors, with chain controlling the spacing and extension of pantographic or X-type accordion folding frames.

Inner and outer covers are continuous surface facings that attach to and completely cover the folding frames and are pleated as the door is retracted.

2. Outer Covering: Of type indicated below, complying with indicated surface-burning characteristics; attached to door support frames in a concealed manner at sufficient intervals to prevent sagging and separation and to permit on-site removal and repair, with vertical seams located in valleys and material hemmed at top and bottom.
   a. Vinyl reinforced with woven backing weighing not less than 20 oz./linear yd. (567 g/m).
      1) Color, Texture, and Pattern: As selected from manufacturer's full range.
   b. Fabric weighing not less than 16 oz./linear yd. (496 g/m), treated to resist stains.
      1) Color, Texture, and Pattern: As selected from manufacturer's full range.
   c. Manufacturer's standard nonwoven carpet, needle punched with fused fibers to prevent unraveling.
      1) Color, Texture, and Pattern: As selected from manufacturer's full range.
3. Sweep Seals: Manufacturer's standard top and bottom sweep seals on both **OR** one, **as directred**, side(s).
4. Carriers: Four-wheel carriers at lead post and two-wheel carriers at intermediate spacing, as necessary for size and weight of partition, to ensure secure, easy, and quiet operation.
   a. Doors 96 Inches (2438 mm) High or Less: Nylon wheels on steel shafts.
   b. Doors More Than 96 Inches (2438 mm) High: Ball-bearing wheels with nylon tread and steel shafts.
5. Tracks: Manufacturer's standard metal track made of extruded aluminum or formed steel with factory-applied, corrosion-resistant finish. Limit track deflection, independent of structural supporting system, to no more than 80 percent of bottom clearance. Design and fabricate track to support accordion folding doors and enable their operation without damage to track, folding unit, or adjacent surfaces; complying with the following requirements:
   a. Head Trim: Prefinished wood molding for surface-mounted tracks.
   b. Center stop for center-opening partitions.
   c. Galvanized-steel sheet or aluminum subchannel for forming pocket for recessed suspension track.
   d. Metal ceiling contact guard to protect finished ceiling surface from damage by moving top sweep seals; with finish matching other exposed metal.
   e. Curved track sections with ceiling clips to accommodate configuration indicated.
   f. Glide switch to divert door to auxiliary track.
   g. Pivot switch to change track direction.
   h. Cross-track switch to allow one door to cross another.
6. Hardware: Manufacturer's standard heavy-duty, manually operated metal pulls and latches as follows:
   a. Finish: Clear-anodized aluminum **OR** Satin stainless steel **OR** Dull chromium-finish brass **OR** Dull chromium-finish steel, **as directed**.
   b. Latch: Operable from both **OR** one, **as directed**, side(s) of closed door with coin-slot release on opposite side, **as directed**.
   c. Lock: Manufacturer's standard key-operated cylinder lock, operable from both sides **OR** Manufacturer's standard key-operated cylinder lock, operable from one side; privacy lock on other side **OR** Deadlock to receive cylinder, operable from both sides. Refer to Division 08 Section "Door Hardware" for cylinder requirements **OR** Deadlock to receive cylinder, operable from both sides, **as directed**.
   d. Foot bolts on lead post where indicated. Secure to post to avoid interference with seals.
7. Jamb Molding: Manufacturer's standard wood or metal molding at closing jamb as required for light-tight jamb closure.
8. Lead Posts and Jamb Posts: Not less than 0.048-inch- (1.2-mm-) thick steel **OR** extruded aluminum, **as directed**, formed for rigidity and light seal at supporting construction.
   a. Nonferrous jamb strip for single-operating partitions to ensure tight closure by engaging rubber bumper on lead post.
9. Meeting Post: Fixed single jamb for single-stacked doors **OR** Center meeting post for center-opening doors, **as directed**.

10. Stacking: Tiebacks to maintain door in stacked position.
11. Stacking Configuration: Stack single doors at one end of opening **OR** center-opening doors at both ends of opening **OR** doors in pockets with hinged pocket doors, **as directed**.
12. Opening Size: As directed or as indicated on Drawings.

B. Panel Folding Doors
1. General: Top-supported, horizontal-sliding, manually operated panel folding doors, with panels joined by continuous hinge connectors for the full height of panels.
2. Core Material and Thickness: Manufacturer's standard.
3. Panel Width: 4-inch (100-mm) **OR** 5-inch (125-mm) **OR** 6-inch (150-mm) **OR** 8-inch (200-mm), **as directed**, nominal width.
4. Panel Facing: Facings that comply with indicated surface-burning characteristics.
   a. Vinyl Facing: Vinyl not less than 7 mils (0.175 mm) thick, factory bonded to core.
      1) Color and Texture: As selected from manufacturer's full range.
   b. Vinyl Facing with Woven Backing: Vinyl reinforced with woven backing weighing not less than 12 oz./linear yd. (372 g/m), factory bonded to core.
      1) Color and Texture: As selected from manufacturer's full range.
   c. Plastic-Laminate Facing: Grade VGS, high-pressure plastic laminate complying with NEMA LD 3; adhesive applied under pressure to core.
      1) Color, Texture, and Pattern: As selected from manufacturer's full range.
   d. Wood-Veneer Facing: as directed by the Owner, wood veneer, laminated to core, with manufacturer's standard clear **OR** stained, **as directed**, transparent finish.
      1) Stain Color: As selected from manufacturer's full range.
5. Carriers: Four-wheel carriers at lead post and two-wheel carriers at intermediate spacing, as necessary for size and weight of partition, to ensure secure, easy, and quiet operation.
   a. Panels 5 Inches (125 mm) Wide or Less: Nylon wheels and axles.
   b. Panels More Than 5 Inches (125 mm) Wide: Ball-bearing wheels with nylon tread and steel shafts.
6. Tracks: Manufacturer's standard surface-mounted **OR** recessed, **as directed**, extruded-aluminum or steel track with factory-applied, corrosion-resistant finish. Limit track deflection, independent of structural supporting system, to no more than 80 percent of bottom clearance. Design and fabricate track to support operation without damage to track, folding unit, or adjacent surfaces; complying with the following requirements:
   a. Prefinished ceiling guard/channel for recessed tracks.
   b. Center stop for biparting partitions.
   c. Galvanized-steel sheet or aluminum subchannel for forming pocket for recessed suspension track.
   d. Nonferrous jamb strip for single-operating partitions to ensure tight closure by engaging rubber bumper on lead post.
   e. Curved track sections to accommodate configuration indicated.
   f. Glide switch to divert door to auxiliary track.
   g. Pivot switch to change track direction.
   h. Cross-track switch to allow one door to cross another.
7. Hinge Connector: Manufacturer's standard extruded-vinyl hinge connector.
   a. Color: As selected from manufacturer's full range **OR** Match or coordinate with facing color, **as directed**.
8. Hardware: Manufacturer's standard heavy-duty, manually operated metal pulls and latches as follows:
   a. Finish: Clear-anodized aluminum **OR** Satin stainless steel **OR** Dull chromium-finish brass **OR** Dull chromium-finish steel, **as directed**.
   b. Latch: Operable from both **OR** one, **as directed**, side(s) of closed door.
   c. Lock: Manufacturer's standard key-operated cylinder lock, operable from both sides **OR** Manufacturer's standard key-operated cylinder lock, operable from one side; privacy lock on other side **OR** Deadlock to receive cylinder, operable from both sides. Refer to Division 08 Section "Door Hardware" for cylinder requirements **OR** Deadlock to receive cylinder, operable from both sides, **as directed**.

d. Foot bolts on lead post where indicated. Secure to post to avoid interference with seals.

9. Jamb Molding: Manufacturer's standard wood or metal molding at closing jamb as required for light-tight jamb closure.
   a. Wood: Match species and finish of panel facing.
   b. Metal: Manufacturer's standard finish.
10. Wood Track Molding: Manufacturer's standard wood molding on each side of surface-mounted track to match species and finish of panel facings. Install with tight, hairline joints with all fasteners concealed.
11. Meeting Post: Fixed single jamb for single-stacked doors **OR** Center meeting post for biparting doors, **as directed**.
12. Stacking: Tiebacks to maintain door in stacked position.

C. Bifold Doors
1. General: Metal folding doors hinged together in pairs and supported on pivots at jamb, with floor and overhead track and door guide pins.
2. Metal Panels: Sizes as indicated, formed from nominal 0.024-inch- (0.6-mm-) thick, cold-rolled steel sheet. Channel form vertical edges and weld cross bracing to panel and channel-formed edges.
   a. Surface Profile: Fully louvered **OR** Flush **OR** Paneled **OR** Louvered and paneled, **as directed**.
   b. Configuration: Two **OR** Four, **as directed**,-panel bifold.
   c. Sheet Metal Texture: Smooth **OR** Simulated leather, **as directed**.
   d. Protective Finish: Hot-dip galvanized coating applied to panels, stiffeners, hinges, and decorative trim.
   e. Baked Finish: Baked-enamel factory finish in white **OR** ivory **OR** custom color as selected, **as directed**.
3. Hardware: Manufacturer's standard felt pads, screws, and pulls in standard finish. Hinges, pivots, and manufacturer's standard wheels factory installed and as follows:
   a. Hinges: 3 self-aligning hinges.
   b. Guides and Pivots: Not less than 5/16-inch- (7.9-mm-) diameter, adjustable screw-type, weight-bearing, zinc-plated pivot rod held in place by nylon rod clamp assemblies; with not less than 1/4-inch- (6.4-mm-) diameter, spring-loaded, self-aligning, zinc-plated steel guide rods and top pivot rods held in place by nylon sleeves.
   c. Track: Prefinished rolled steel with baked-enamel paint finish **OR** Aluminum extrusion, Alloy 6063-T5, 0.05 inch (1.3 mm) thick, with manufacturer's standard metal finish, **as directed**.

D. Bifold Mirror Doors
1. General: Folding doors hinged together in pairs and supported on pivots at jamb, with floor and overhead track and door guide pins.
2. Steel-Panel Door Construction: Sizes as indicated, flush profile, formed from nominal 0.024-inch- (0.6-mm-) thick, cold-rolled steel sheet. Channel form vertical edges and weld cross bracing to panel- and channel-formed edges. Attach mirrored glass facing to steel sheet by means of mechanically attached channels at top and bottom and by dual-faced cushion tape.
   a. Configuration: Two **OR** Four, **as directed**,-panel bifold.
   b. Protective Finish: Hot-dip galvanized coating applied to panels, stiffeners, hinges, and decorative trim.
   c. Baked Finish: Baked-enamel factory finish in white **OR** custom color as selected, **as directed**.
3. Metal-Framed Door Construction: Aluminum **OR** Steel, **as directed**, stiles and mechanically fitted rails with screw-attached stiffeners and with mirrored-glass facing attached securely to frames.
   a. Panel Style: Exposed **OR** Concealed, **as directed**, frame.
   b. Configuration: Two **OR** Four, **as directed**,-panel bifold.

c. Baked Finish: Electrostatically applied, baked-enamel factory finish in white **OR** custom color as selected, **as directed**.
d. Bright, Reflective Metallic Finish: Chrome **OR** Gold **OR** Selected from manufacturer's full range, **as directed**.

4. Mirror Facing: Smooth **OR** Beveled, **as directed**,-edged, silvered, mirrored, film-backed safety glass complying with 16 CFR 1201 for Category II safety glass; with ASTM C 1036 for Type I (transparent, flat), Class 1(clear), Quality q2 (mirror) annealed float glass; with the following:
   a. Glass Thickness: 3 mm thick for doors up to 84 inches (2133 mm) in height **OR** 4 mm thick for doors with height more than 84 inches (2133 mm), **as directed**.
   b. Edge Protection: Vertical mirror edges protected by metal **OR** Mylar, **as directed**, trim.
   c. Film-Backed Safety Mirrors: Apply film backing with pressure-sensitive adhesive coating over mirror-backing paint as recommended in writing by film-backing manufacturer to produce a surface free of bubbles, blisters, and other imperfections.
5. Hardware: Manufacturer's standard felt pads, screws, and pulls in standard finish. Hinges, pivots, and manufacturer's standard wheels factory installed and as follows:
   a. Hinges: 3 self-aligning hinges.
   b. Guides and Pivots: Manufacturer's standard.
   c. Guides and Pivots: Spring-loaded, zinc-plated steel guides and tops, and adjustable bottom pivot pins with nylon bushings and tips.
   d. Guides and Pivots: Not less than 5/16-inch- (7.9-mm-) diameter, adjustable screw-type, weight-bearing, zinc-plated pivot rod held in place by nylon rod clamp assemblies; with not less than 1/4-inch- (6.4-mm-) diameter, spring-loaded, self-aligning, zinc-plated steel guide rods and top pivot rods held in place by nylon sleeves.
6. Track: Prefinished rolled steel with baked-enamel paint finish **OR** Aluminum extrusion, Alloy 6063-T5, 0.05 inch (1.3 mm) thick, with manufacturer's standard metal finish, **as directed**.

E. Fire-Rated Folding Doors
1. General: Electrically **OR** Gravity-, **as directed**, operated, automatic- or self-closing, UL- or ITS-listed, biparting folding fire-rated assembly; top supported from overhead track or dual tracks without floor guides; complete with hardware, seals, track, closing devices, releasing devices, controls, pocket doors, and accessories necessary for intended operation and complying with the following requirements:
   a. Assembly remains in normal open (stacked) position. Signal from fire-alarm system initiates self-closing operation.
   b. Controls allow manual operation in either conventional or emergency mode. When opened manually during emergency mode, control mechanism automatically closes assembly.
2. Fire Rating: 1 **OR** 1-1/2 **OR** 3, **as directed**, hour(s).
3. Panel Construction: Formed-steel **OR** Formed stainless-steel, **as directed**, sheet panels connected by formed-steel **OR** formed stainless-steel, **as directed**, hinges.
4. Fire Insulation:
   a. Cover interior surface of both series of panels in parallel panel doors with continuous fire-resistive blanket secured to each panel with metal clip system.
   b. Extend fire insulation from bottom edge of panels to tracks and meet at interior centers of fixed jamb and lead post, forming an effective fire barrier.
5. Perimeter Seals and Closures: Manufacturer's standard vinyl or neoprene vertical seals, horizontal top and bottom seals, and closures identical to products tested for fire rating indicated, and forming an effective smoke and draft seal.
6. Track and Trolley System: 1 track or 2 parallel steel tracks on 8-inch (200-mm) centers, with ball-bearing roller trolleys and adjustable steel hanger rods for overhead support; designed for type of operation, size, and weight of fire-rated folding door indicated. Provide a continuous system of track sections and accessories identical to products tested for fire rating indicated, to accommodate configuration and layout indicated for door operation and storage.
7. Lead Posts: Formed from not less than 0.026-inch (0.66-mm-) thick steel **OR** stainless-steel, **as directed**, sheet, connected to door panels by specially adapted panels and equipped with manufacturer's standard handle on each side.
8. Electric Operators and Controls:

a. Operators: Factory-assembled power-drive unit consisting of motor, remote-located, **as directed**, control panel, limit switches, torque-limiting devices, clutch, reversing magnetic motor operator, leading-edge obstruction detectors, and key-switch control for conventional operation.
   1) Motor: 1/2 hp, controlled by reversing magnetic starter and equipped with overload protection.
   2) Limit Switches: To prevent overtravel.
   3) Roller Chain or Cable: Connected to lead posts by means of vertical stabilizer bar assembly.
   4) Drive Mechanism: Protected by torque limiter and emergency clutch.
   5) Travel Speed: 18 inches (450 mm) per second, maximum; 6 inches (150 mm) per second, minimum.

b. In case of fire, closing system is activated by building's fire- and smoke-detection equipment and automatically closes fire-rated folding doors.

c. Electrical Service: Equip for 120 V, single phase, 60-cycle ac.

d. Battery: Electrical current connects through relay to battery charger that continuously charges 12-V dc battery and automatically maintains battery at capacity. Automatic audible signal device sounds off if battery falls below or exceeds proper charge, power loss has occurred, or high-ac line voltage has been experienced.

e. Leading-Edge Obstruction Detector:
   1) Equip with pressure-sensitive leading edge that, on contact with an obstruction, causes door to stop and pause before attempting to re-close.
   2) Disable leading-edge obstruction detector until fire-rated folding door has opened pocket door.

f. Fire-rated folding doors can be manually opened at any time by pushing against leading edge.

g. Audible alarm sounds at automatic closing of door.

9. Accessories:
   a. Vision panels.
   b. Exit Hardware: Located on both sides of fire-rated folding door. In emergency mode, slight pressure on hardware causes door to open a minimum of 32 inches (812 mm), pause for 3 seconds, and then automatically close. Furnish hardware that can be field programmable to allow automatic opening distances of up to the entire opening width. In conventional mode, hardware is used to operate door and move it back into storage pocket.

10. Finishes:
   a. Baked-enamel finish for panels and hinges in colors selected from manufacturer's full range.
   b. Manufacturer's standard finish for handles.

11. Pocket Door:
   a. Solid-core pocket doors with reverse-action spring **OR** continuous, **as directed**, hinge; 90-degree minimum swing.
   b. Face Finish: Match adjacent finishes.
   c. Magnetic Catch: Holding force of no more than 30 lbf (133 N).
   d. Maximum Opening Force: 50 lbf (222 N).
   e. Bumper on interior side of pocket door as required by fire-rated folding door manufacturer to prevent interference with opening or retracting operation of fire-rated folding door.
   f. Coordinate pocket door sizes with fire-rated folding door manufacturer.

1.3 EXECUTION

A. Preparation

1. For folding doors supported by or anchored to permanent construction, advise installers of specific requirements for placement of anchorage devices. Furnish installers of other work with templates and drawings showing locations of anchorage devices and similar items.
2. In path of fire-rated folding doors, level floor with header to tolerance of plus or minus 1/16 inch (1.6 mm) across opening; grind or fill floor as necessary.

B. Installation
1. General: Install folding doors complying with manufacturer's written installation instructions. Install track in one piece.
   a. Comply with NFPA 80 for installing fire-rated folding doors.
2. Standard Floor Clearances: 1/4 to 3/4 inch (6.4 to 19 mm) maximum (above floor finish).
   a. Comply with NFPA 80 for clearances required for fire-rated folding doors.
3. Coordinate provisions for electrical service, sensing devices, and final connections for fire-rated folding doors.

C. Adjusting
1. Adjust units as necessary to ensure smooth, quiet operation without warping or binding. Adjust hardware to function smoothly. Confirm that latches engage accurately and securely without forcing or binding.
   a. Fire-Rated Folding Doors: Verify that all operations are functional and comply with requirements of authorities having jurisdiction.
2. Pocket Doors: Adjust to operate smoothly and easily, without binding or warping. Adjust hardware to function smoothly. Confirm that latches and locks engage accurately and securely without forcing or binding.

D. Demonstration
1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-rated folding doors.

END OF SECTION 08350

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Task	Specification	Specification Description
08350	01352	No Specification Required
08350	08210	Flush Wood Doors
08353	08350	Folding Doors

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SECTION 08354 - SOUND CONTROL DOORS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for sound-control door assemblies. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Steel sound-control doors.
   b. Wood sound-control doors.
   c. Steel frames and sound-control seals.

C. Submittals
1. Product Data: For each type of product indicated. Include sound ratings, construction details, material descriptions, core descriptions, fire-resistance rating, temperature-rise ratings, and finishes.
2. LEED Submittals:
   a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that wood doors comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body, **as directed**.
   b. Product Data for Credit EQ 4.4: For adhesives and composite wood products, indicating that product contains no urea formaldehyde.
3. Shop Drawings: Include the following:
   a. Elevations of each door design.
   b. Details of sound-control seals, door bottoms, and thresholds.
   c. Details of doors, including vertical and horizontal edge details and metal thicknesses.
   d. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
   e. Locations of reinforcement and preparations for hardware.
   f. Details of each different wall opening condition.
   g. Details of anchorages, joints, field splices, and connections.
   h. Details of accessories.
   i. Details of moldings, removable stops, and glazing.
   j. Details of conduit and preparations for power, signal, and control systems.
4. Samples:
   a. Finishes: For each type of exposed finish required, prepared on Samples of not less than 3 by 5 inches (75 by 125 mm).
   b. Doors: Include section of vertical-edge, top, and bottom construction; automatic door bottom or gasket; core construction; glazing; and hinge and other applied hardware reinforcement.
   c. Frames: Include profile, corner joint, floor and wall anchors, and seals. Include separate section showing fixed sound panels if applicable.
5. Schedule: Provide a schedule of sound-control door assemblies prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with the Door Hardware Schedule.
6. Qualification Data: For qualified Installer, manufacturer, and acoustical testing agency.
7. Product Certificates: For each type of sound-control door assembly, from manufacturer.
8. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of sound-control door assembly.
9. Field quality-control reports.
10. Maintenance Data: For sound-control door assemblies to include in maintenance manuals.

11. Warranty: Samples of special warranty.

D. Quality Assurance
1. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
2. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
3. Acoustical Testing Agency Qualifications: An independent agency accredited as an acoustical laboratory according to the National Voluntary Laboratory Accreditation Program of NIST.
4. Source Limitations: Obtain sound-control door assemblies, including doors, frames, sound-control seals, hinges (when integral for sound control), thresholds, and other items essential for sound control, from single source from single manufacturer.
5. Sound Rating: Provide sound-control door assemblies identical to those of assemblies tested as sound-retardant units by an acoustical testing agency, and have the following minimum rating:
   a. STC Rating: As indicated on Drawings **OR** As indicated in the Door Schedule, **as directed**, as determined by ASTM E 413 when tested in an operable condition according to ASTM E 90 and ASTM E 1408.
6. Forest Certification: Provide doors made with cores **OR** veneers **OR** not less than 70 percent of wood products **OR** all wood products, **as directed**, obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
7. Fire-Rated Door Assemblies: Assemblies listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
   a. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
8. Smoke- and Draft-Control Door Assemblies: Where indicated **OR** At corridors, smoke barriers, and smoke partitions, **as directed**, provide assemblies tested according to UL 1784.
   a. Air-Leakage Rate: Maximum air leakage of 0.3 cfm/sq. ft. (3 cu. m/m x sq. m) at the tested pressure differential of 0.3-inch wg (75 Pa) of water.
9. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
1. Deliver doors and frames palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
   a. Provide additional protection to prevent damage to finish of factory-finished wood doors.
2. Shipping Spreaders: Deliver welded frames with two removable spreader bars across bottom of frames, tack welded or mechanically attached to jambs and mullions.
3. Store doors and frames under cover at Project site. Place units in a vertical position with heads up, spaced by blocking, on minimum 4-inch- (100-mm-) high, wood blocking. Avoid using nonvented plastic or canvas shelters that could create a humidity chamber.
   a. If wrappers on doors become wet, remove cartons immediately. Provide a minimum of 1/4-inch (6-mm) space between each stacked door to permit air circulation.

F. Project Conditions
1. Environmental Limitations: Do not deliver or install wood sound-control wood doors until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
2. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

G. Coordination

1. Coordinate installation of anchorages for sound-control door assemblies. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

H. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of sound-control door assemblies that fail in materials or workmanship within specified warranty period.
a. Failures include, but are not limited to, the following:
1) Failure to meet sound rating requirements.
2) Faulty operation of sound seals.
3) Deterioration of metals, metal finishes, and other materials beyond normal use or weathering.
4) Wood doors that are warped (bow, cup, or twist) more than 1/4 inch (6 mm) in a 42-by-84-inch (1067-by-2134-mm) section, or show telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch (0.25 mm in a 75-mm) span.
b. Warranty Period for Steel Doors: Five years from date of Substantial Completion.
c. Warranty Period for Wood Doors: Two years from date of Substantial Completion.

1.2 PRODUCTS

A. Steel Sound-Control Doors
1. Description: Provide flush-design sound-control doors, 1-3/4 inches (44 mm) thick, of seamless construction; with manufacturer's standard sound-retardant core as required to provide STC **OR** STC and fire, **as directed**, rating indicated. Construct doors with smooth, flush surfaces without visible joints or seams on exposed faces or stile edges. Fabricate according to ANSI/NAAMM-HMMA 865.
a. Exterior Doors: Fabricate from metallic-coated steel sheet 0.052-inch (1.32-mm) nominal thickness, or thicker as required to provide STC rating indicated.
b. Interior Doors: Fabricate from cold-rolled steel sheet unless otherwise indicated, 0.048-inch (1.21-mm) nominal thickness, or thicker as required to achieve STC rating indicated.
c. Loose Stops for Glazed Lites in Doors: Same material as face sheets.
d. Top and Bottom Channels: Closed with continuous channels of same material as face sheets, spot welded to face sheets not more than 6 inches (150 mm) o.c.
e. Hardware Reinforcement: Same material as face sheets.
2. Materials:
a. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
b. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
c. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B, with G60 (Z180) zinc (galvanized) or A40 (ZF120) zinc-iron-alloy (galvannealed) coating designation.
d. Glazing: As required by sound-control door assembly manufacturer to comply with sound-control **OR** sound-control and fire-rated-door labeling, **as directed**, requirements.
3. Finishes:
a. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.
1) Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.
b. Factory-Applied Paint Finish: Manufacturer's standard primer and finish coats, complying with ANSI/SDI A250.3 for performance and acceptance criteria.

1) Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

B. Wood Sound-Control Doors
1. Description: Provide flush-design sound-control doors, 1-3/4 inches (44 mm) thick; with manufacturer's standard sound-retardant core as required to provide STC **OR** STC and fire, **as directed**, rating indicated. Fabricate according to WDMA 1.S.1-A.
2. Materials: Comply with Division 08 Section(s) "Flush Wood Doors" OR "Stile And Rail Wood Doors", **as directed**, for grade, faces, veneer matching, fabrication, finishing, and other requirements unless otherwise indicated.
   a. Glazing: As required by sound-control door assembly manufacturer to comply with sound-control **OR** sound-control and fire-rated-door labeling, **as directed**, requirements.
3. Finishes:
   a. Factory finish sound-control wood doors to match doors specified in Division 08 Section(s) "Flush Wood Doors" OR "Stile And Rail Wood Doors", **as directed**.

C. Sound-Control Panels
1. Provide sound-control panels of same materials, construction, sound rating, and finish as specified for adjoining sound-control steel **OR** wood, **as directed**, doors.

D. Sound-Control Frames
1. Description: Fabricate sound-control door frames with corners mitered, reinforced, and continuously welded full depth and width of frame. Fabricate according to ANSI/NAAMM-HMMA 865.
   a. Weld frames according to NAAMM-HMMA 820.
   b. Exterior Frames: Fabricate from metallic-coated steel sheet 0.079-inch (2.01-mm) nominal thickness, or thicker as required to provide STC rating indicated.
   c. Interior Frames: Fabricate from cold-rolled steel sheet unless otherwise indicated, 0.075-inch (1.90-mm) nominal thickness, or thicker as required to provide STC rating indicated.
   d. Sound-Control Panel Stops: Formed integral with frames, a minimum of 5/8 inch (16 mm) high, unless otherwise indicated.
   e. Hardware Reinforcement: Fabricate according to ANSI/NAAMM-HMMA 865 of same material as face sheets.
   f. Head Reinforcement: Reinforce frames with metallic-coated steel channel or angle stiffener, 0.108-inch (2.74-mm) nominal thickness, welded to head.
   g. Jamb Anchors:
      1) Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.064-inch (1.63-mm) nominal thickness metallic-coated steel with corrugated or perforated straps not less than 2 inches (50 mm) wide by 10 inches (250 mm) long; or wire anchors not less than 0.156 inch (4.0 mm) thick.
      2) Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.048-inch (1.21-mm) nominal thickness uncoated steel unless otherwise indicated.
      3) Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch-(9.5-mm-) diameter, metallic-coated steel bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.
   h. Floor Anchors: Not less than 0.079-inch (2.01-mm) nominal thickness metallic-coated steel, and as follows:
      1) Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
      2) Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch (50-mm) height adjustment. Terminate bottom of frames at finish floor surface.
   i. Ceiling Struts: Minimum 3/8-inch-thick by 2-inch- (9.5-mm-thick by 50-mm-) wide uncoated steel unless otherwise indicated.
   j. Plaster Guards: Metallic-coated steel sheet, not less than 0.026 inch (0.6 mm) thick.

2. Materials:
   a. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
   b. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
   c. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B, with G60 (Z180) zinc (galvanized) or A40 (ZF120) zinc-iron-alloy (galvannealed) coating designation.
   d. Supports and Anchors: After fabricating, galvanize units to be built into exterior walls according to ASTM A 153/A 153M, Class B.
   e. Inserts, Bolts, and Fasteners: Provide items to be built into exterior walls, hot-dip galvanized according to ASTM A 153/A 153M or ASTM F 2329.
   f. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching sound-control door frames of type indicated.
   g. Mineral-Fiber Insulation: Insulation composed of rock-wool fibers, slag-wool fibers, or glass fibers.
3. Finishes:
   a. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.
      1) Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.
   b. Factory-Applied Paint Finish: Manufacturer's standard primer and finish coats, complying with ANSI/SDI A250.3 for performance and acceptance criteria.
      1) Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

E. Sound-Control Hardware
1. Description: Provide manufacturer's standard sound-control system, including head and jamb seals, door bottoms, cam-lift hinges, and thresholds, as required by testing to achieve STC **OR** STC and fire, **as directed**, rating indicated.
   a. Compression Seals: One-piece units; consisting of closed-cell sponge neoprene seal held in place by metal retainer; with retainer cover of same material as door frame; attached to door frame with concealed screws.
      OR
      Magnetic Seals: One-piece units; consisting of closed-cell sponge neoprene seal and resiliently mounted magnet held in place by metal retainer; with retainer cover of same material as door frame; attached to door frame with concealed screws.
   b. Automatic Door Bottoms: Neoprene or silicone gasket, held in place by metal housing, that automatically drops to form seal when door is closed; mounted to bottom edge of door with screws.
      1) Mounting: Mortised or semimortised into bottom of door or surface mounted on face of door as required by testing to achieve STC rating indicated.
      OR
      Door Bottoms: Neoprene or silicone gasket held in place by metal housing; mortised into bottom edge of door.
   c. Cam-Lift Hinges: Full-mortise template type that raises door 1/2 inch (13 mm) when door is fully open; with hardened pin; fabricated from stainless steel.
   d. Thresholds: Flat, smooth, unfluted type as recommended by manufacturer; fabricated from aluminum **OR** stainless steel **OR** solid wood matching wood door faces, **as directed**.
      1) Finish: Clear **OR** Color, **as directed**, anodic finish.
      2) Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As selected from full range of industry colors and color densities, **as directed**.
2. Other Hardware: Comply with requirements in Division 08 Section "Door Hardware".

F. Sound-Control Accessories
1. Glazing: Comply with requirements in Division 08 Section "Glazing"
2. Grout: Comply with ASTM C 476, with a slump of not more than 4 inches (102 mm) as measured according to ASTM C 143/C 143M.
3. Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

G. Fabrication
1. Sound-Control Steel Door Fabrication: Sound-control doors to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal.
   a. Seamless Edge Construction: Fabricate doors with faces joined at vertical edges by welding; welds shall be ground, filled, and dressed to make them invisible and to provide a smooth, flush surface.
   b. Exterior Doors: Close top edges flush and seal joints against water penetration. Provide weep-hole openings in bottom of exterior doors to permit moisture to escape.
   c. Glazed Lites: Factory install glazed lites according to requirements of tested assembly to achieve STC rating indicated. Provide fixed stops and moldings welded on secure side of door.
   d. Hardware Preparation: Factory prepare sound-control doors to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping, according to the Door Hardware Schedule and templates furnished as specified in "Door Hardware".
      1) Reinforce doors to receive nontemplated mortised and surface-mounted door hardware.
      2) Locate door hardware as indicated, or if not indicated, according to NAAMM-HMMA 831, "Recommended Hardware Locations for Custom Hollow Metal Doors and Frames."
   e. Tolerances: Fabricate doors to tolerances indicated in ANSI/NAAMM-HMMA 865.
2. Sound-Control Wood Door Fabrication: Factory fit doors to suit frame-opening sizes indicated, with uniform clearances and bevels according to referenced quality standard, unless otherwise indicated. Comply with final door hardware schedules and hardware templates.
   a. Comply with clearance requirements in NFPA 80 for fire-rated doors.
   b. Locate door hardware as indicated, or if not indicated, according to DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
      1) Coordinate measurements of hardware mortises in steel frames to verify dimensions and alignment before factory machining.
3. Sound-Control Frame Fabrication: Fabricate sound-control frames to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
   a. Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible. Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated from same thickness metal as frames.
   b. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
   c. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
   d. Jamb Anchors: Provide number and spacing of anchors as follows:
      1) Masonry Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:
         a) Two anchors per jamb up to 60 inches (1524 mm) in height.
         b) Three anchors per jamb from 60 to 90 inches (1524 to 2286 mm) in height.

c) Four anchors per jamb from 90 to 96 inches (2286 to 2438 mm) in height.
d) Four anchors per jamb plus one additional anchor per jamb for each 24 inches (610 mm) or fraction thereof more than 96 inches (2438 mm) in height.

2) Stud Wall Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:
a) Three anchors per jamb up to 60 inches (1524 mm) in height.
b) Four anchors per jamb from 60 to 90 inches (1524 to 2286 mm) in height.
c) Five anchors per jamb from 90 to 96 inches (2286 to 2438 mm) in height.
d) Five anchors per jamb plus one additional anchor per jamb for each 24 inches (610 mm) or fraction thereof more than 96 inches (2438 mm) in height.
e) Two anchors per head for frames more than 42 inches (1066 mm) wide and mounted in metal stud partitions.

3) Postinstalled Expansion Type: Locate anchors not more than 6 inches (152 mm) from top and bottom of frame. Space anchors not more than 26 inches (660 mm) o.c.

e. Head Reinforcement: For frames more than 48 inches (1219 mm) wide, provide continuous head reinforcement for full width of opening, welded to back of frame at head.

f. Hardware Preparation: Factory prepare sound-control frames to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping, according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware".
1) Reinforce frames to receive nontemplated mortised and surface-mounted door hardware.
2) Locate hardware as indicated, or if not indicated, according to NAAMM-HMMA 831, "Recommended Hardware Locations for Custom Hollow Metal Doors and Frames."

g. Plaster Guards: Weld guards to frame at back of hardware cutouts and glazing-stop screw and sound-control seal preparations to close off interior of openings in frames to be grouted.

h. Tolerances: Fabricate frames to tolerances indicated in ANSI/NAAMM-HMMA 865.

1.3 EXECUTION

A. Examination
1. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of sound-control door assemblies.
2. Examine roughing-in for embedded and built-in anchors to verify actual locations of sound-control door frame connections before frame installation.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
2. Prior to installation and with installation spreaders in place, adjust and securely brace sound-control door frames to the following tolerances:
a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a perpendicular line from head to floor.

3. Drill and tap doors and frames to receive nontemplated mortised and surface-mounted door hardware.

C. Installation
1. General: Install sound-control door assemblies plumb, rigid, properly aligned, and securely fastened in place; comply with manufacturer's written instructions.
2. Frames: Install sound-control door frames in sizes and profiles indicated.
   a. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
      1) At fire-rated openings, install frames according to NFPA 80.
      2) At openings requiring smoke and draft control, install frames according to NFPA 105.
      3) Where frames are fabricated in sections due to shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, and dress; make splice smooth, flush, and invisible on exposed faces.
      4) Install sound-control frames with removable glazing stops located on secure side of opening.
      5) Remove temporary braces only after frames or bucks have been properly set and secured.
      6) Check squareness, twist, and plumbness of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
      7) Apply corrosion-resistant coatings coating to backs of frames to be filled with mortar, grout, and plaster containing antifreezing agents.
   b. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor and secure with postinstalled expansion anchors.
      1) Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors, if so indicated and approved on Shop Drawings.
   c. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.
   d. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
   e. In-Place Gypsum Board Partitions: Secure frames in place with postinstalled expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
   f. Ceiling Struts: Extend struts vertically from top of frame at each jamb to supporting construction above, unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction above. Provide adjustable wedged or bolted anchorage to frame jamb members.
   g. Grouted Frames: Solidly fill space between frames and substrate with grout. Take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.
   h. Installation Tolerances: Adjust sound-control door frames for squareness, alignment, twist, and plumbness to the following tolerances:
      1) Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
      2) Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
      3) Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
      4) Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a perpendicular line from head to floor.
3. Doors: Fit sound-control doors accurately in frames, within clearances indicated below. Shim as necessary.

a. Non-Fire-Rated Doors: Fit non-fire-rated doors accurately in frames with the following clearances:
   1) Jambs: 1/8 inch (3 mm).
   2) Head with Butt Hinges: 1/8 inch (3 mm).
   3) Head with Cam-Lift Hinges: As required by manufacturer, but not more than 3/8 inch (9.5 mm).
   4) Sill: Manufacturer's standard.
   5) Between Edges of Pairs of Doors: 1/8 inch (3 mm).

b. Fire-Rated Doors: Install fire-rated doors with clearances according to NFPA 80.

4. Sound-Control Seals: Where seals have been prefit and preinstalled in the factory and subsequently removed for shipping, reinstall seals and adjust according to manufacturer's written instructions.
5. Cam-Lift Hinges: Install hinges according to manufacturer's written instructions.
6. Thresholds: Set thresholds in full bed of sealant complying with requirements in Division 7 Section "Joint Sealants."
7. Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with sound-control door assembly manufacturer's written instructions.
   a. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches (230 mm) o.c., and not more than 2 inches (50 mm) o.c. from each corner.

D. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Testing Services: Acoustical testing and inspecting agency shall select one sound-control door at random from sound-control door assemblies that are completely installed and perform testing for verification that assembly complies with STC rating requirements.
   a. Field tests shall be conducted according to ASTM E 336, with results calculated according to ASTM E 413. Acceptable field STC values shall be within 5 dB of laboratory STC values.
   b. Inspection Report: Acoustical testing agency shall submit report in writing to the Owner and Contractor within 24 hours after testing.
   c. If tested door fails, replace or rework all sound-control door assemblies to bring them into compliance at Contractor's expense.
      1) Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
3. Prepare test and inspection reports.

E. Adjusting And Cleaning
1. Final Adjustments: Check and adjust seals, door bottoms, and other sound-control hardware items right before final inspection. Leave work in complete and proper operating condition.
2. Remove and replace defective work, including defective or damaged sound seals and doors and frames that are warped, bowed, or otherwise unacceptable.
   a. Adjust gaskets, gasket retainers, and retainer covers to provide contact required to achieve STC rating.
3. Clean grout off sound-control door frames immediately after installation.
4. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying primer.
5. Metallic-Coated Surfaces: Clean abraded areas of doors and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION 08354

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SECTION 08361 - SECTIONAL OVERHEAD DOORS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for sectional overhead doors. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes manually **OR** electrically, **as directed**, operated sectional doors with integral pass doors, **as directed**.

C. Performance Requirements
1. General Performance: Sectional doors shall meet performance requirements specified without failure due to defective manufacture, fabrication, installation, or other defects in construction and without requiring temporary installation of reinforcing components.
2. Delegated Design: Design sectional doors, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
3. Structural Performance: Exterior sectional doors shall withstand the effects of gravity loads, and the following loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
    a. Wind Loads: As indicated on Drawings **OR** Uniform pressure (velocity pressure) of 20 lbf/sq. ft. (960 Pa), acting inward and outward, **as directed**.
        1) Basic Wind Speed: 85 mph (38 m/s) **OR** 90 mph (40 m/s) **OR** 100 mph (44 m/s) **OR** 110 mph (49 m/s), **as directed**.
        2) Exposure Category: A **OR** B **OR** C **OR** D, **as directed**.
    b. Deflection Limits: Design sectional doors to withstand design wind loads without evidencing permanent deformation or disengagement of door components. Deflection of door in horizontal position (open) shall not exceed 1/120 of the door width.
4. Air Infiltration: Maximum rate not more than indicated when tested according to ASTM E 283 **OR** DASMA 105, **as directed**.
    a. Air Infiltration: Maximum rate of 0.08 cfm/sq. ft. (0.406 L/s per sq. m) at 15 and 25 mph (24.1 and 40.2 km/h).
5. Windborne-Debris-Impact-Resistance Performance: Provide sectional doors **OR** glazed sectional doors, **as directed**, that pass large-missile-impact and cyclic-pressure tests when tested according to ASTM E 1886 and ASTM E 1996 **OR** DASMA 115, **as directed**.
6. Seismic Performance: Sectional doors shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
    b. Seismic Component Importance Factor: 1.5 **OR** 1.0, **as directed**.
7. Operation Cycles: Provide sectional door components and operators capable of operating for not less than number of cycles indicated for each door. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.

D. Submittals
1. Product Data: For each type and size of sectional door and accessory.
2. LEED Submittal:
    a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that flush wood doors comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body, **as directed**. Include statement indicating costs for each certified wood product.

3. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data. Include plans, elevations, sections, details, and attachments to other work.
   a. Wiring Diagrams: For power, signal, and control wiring.
4. Samples: For each exposed product and for each color and texture specified.
5. Delegated-Design Submittal: For sectional doors indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
6. Seismic Qualification Certificates: For sectional doors**,** accessories, and components, from manufacturer.
7. Maintenance data.
8. Warranties: Sample of special warranties.

E. Quality Assurance
1. Wood Door Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
2. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project.
3. Forest Certification: Provide wood doors made with not less than 70 percent of wood products **OR** all wood products, **as directed**, obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
5. Standard for Sectional Doors: Fabricate sectional doors to comply with DASMA 102 unless otherwise indicated.
6. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities" and ICC/ANSI A117.1, **as directed**.

F. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of sectional doors that fail in materials or workmanship within Two **OR** Five, **as directed**, years from date of Substantial Completion.
2. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components that show evidence of deterioration of factory-applied finishes within 10 years from date of Substantial Completion.

1.2 PRODUCTS

A. Steel Door Sections
1. Exterior Section Faces and Frames: Fabricate from zinc-coated (galvanized), cold-rolled, commercial steel (CS) sheet, complying with ASTM A 653/A 653M, with indicated zinc coating and thickness.
   a. Fabricate section faces from single sheets to provide sections not more than 24 inches (610 mm) high and of indicated thickness. Roll horizontal meeting edges to a continuous, interlocking, keyed, rabbeted, shiplap, or tongue-in-groove weathertight seal, with a reinforcing flange return.
   b. For insulated doors, provide sections with continuous thermal-break construction, separating the exterior and interior faces of door.
2. Section Ends and Intermediate Stiles: Enclose open ends of sections with channel end stiles formed from galvanized-steel sheet not less than 0.064-inch- (1.63-mm-) nominal coated thickness and welded to door section. Provide intermediate stiles formed from not less than

0.064-inch- (1.63-mm-) thick galvanized-steel sheet, cut to door section profile, and welded in place. Space stiles not more than 48 inches (1219 mm) apart.

3. Reinforce bottom section with a continuous channel or angle conforming to bottom-section profile and allowing installation of astragal, **as directed**.
4. Reinforce sections with continuous horizontal and diagonal reinforcement, as required to stiffen door and for wind loading. Provide galvanized-steel bars, struts, trusses, or strip steel, formed to depth and bolted or welded in place. Ensure that reinforcement does not obstruct vision lites, **as directed**.
5. Provide reinforcement for hardware attachment.
6. Board Thermal Insulation: Insulate interior of steel sections with door manufacturer's standard CFC-free polystyrene or polyurethane board insulation, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84; or with glass-fiber-board insulation. Secure insulation to exterior face sheet. Enclose insulation completely within steel sections that incorporate the following interior facing material, with no exposed insulation:
   a. Interior Facing Material:
      1) Zinc-coated (galvanized), cold-rolled, commercial steel (CS) sheet, complying with ASTM A 653/A 653M, with indicated thickness.
      2) Manufacturer's standard prefinished hardboard panel, 1/8 inch (3 mm) thick and complying with ANSI A135.5.
7. Foamed-in-Place Thermal Insulation: Insulate interior of steel sections with door manufacturer's standard CFC-free polyurethane insulation, foamed in place to completely fill interior of section and pressure bonded to face sheets to prevent delamination under wind load, and with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84. Enclose insulation completely within steel sections that incorporate the following interior facing material, with no exposed insulation:
   a. Interior Facing Material:
      1) Zinc-coated (galvanized), cold-rolled, commercial steel (CS) sheet, complying with ASTM A 653/A 653M, with indicated thickness.
      2) Manufacturer's standard prefinished hardboard panel, 1/8 inch (3 mm) thick and complying with ANSI A135.5.
8. Fabricate sections so finished door assembly is rigid and aligned, with tight hairline joints and free of warp, twist, and deformation.

B. Wood Door Sections
   1. Paneled Sections: Fabricate stiles and rails of clear, vertical-grain, straight, kiln-dried Douglas fir, West Coast hemlock, or Sitka spruce, not less than 1-3/4 inches (44 mm) thick. Form meeting rails to provide rabbeted, weathertight-seal joint.
      a. Panel Inserts: Tempered hardboard, 1/4 inch (6 mm) thick, smooth on two sides, complying with ANSI A135.4.
      b. Glazed Panel Inserts: 6-mm-thick, clear float glass, complying with ASTM C 1036, Type I, Class 1, Quality Q3, with removable glazing stops of same wood as stiles and rails.
   2. Flush Sections: Construct flush wood door sections with top, bottom, and end closures of clear, vertical-grain, straight, kiln-dried Douglas fir, West Coast hemlock, or Sitka spruce. Provide wood blocking to receive hardware, end stiles, and frames for glazing, glued and doweled in place. Form meeting rails to provide rabbeted weathertight-seal joint.
      a. Core: Manufacturer's standard polystyrene or polyurethane board insulation or honeycomb core complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84. Bond to facing.
      b. Facing: 1/8-inch- (3-mm-) thick, tempered hardboard complying with ANSI A135.4 and smooth on one side.
   3. Fabricate sections of mortise-and-tenon construction with waterproof glue and steel dowels, or of rabbeted construction with waterproof glue and steel dowels and pins.
   4. Reinforce sections with continuous horizontal and diagonal galvanized-steel members as required to stiffen door and for wind loading. Ensure that reinforcement does not obstruct vision lites.

5. Treat wood door members after machining with water-repellent preservative formulation according to WDMA I.S. 4.
6. Fabricate sections so finished door assembly is rigid and aligned, with tight hairline joints and free of warp, twist, deformation, and delamination.
7. Factory prime door sections with one coat of exterior primer compatible with field-applied finish, applied at a minimum dry film thickness of 1 mil (0.025 mm).

C. Aluminum Door Sections
1. Sections: Construct door sections with stiles and rails formed from extruded-aluminum shapes, complying with ASTM B 221 (ASTM B 221M), alloy and temper recommended by manufacturer for type of use and finish indicated, with wall thickness not less than 0.065 inch (1.7 mm) for door section 1-3/4 inches (44 mm) deep. Fabricate sections with stile and rail dimensions and profiles shown on Drawings. Join stiles and rails by welding or with concealed, 1/4-inch- (6-mm-) minimum diameter, aluminum or nonmagnetic stainless-steel through bolts, full height of door section. Form meeting rails to provide a weathertight-seal joint.
   a. Reinforce sections with continuous horizontal and diagonal reinforcement, as required to stiffen door and for wind loading. Ensure that reinforcement does not obstruct vision lites.
   b. Provide reinforcement for hardware attachment.
2. Solid Panels: Fabricate of aluminum sheet, complying with ASTM B 209 (ASTM B 209M), alloy and temper standard with manufacturer for type of use and finish indicated, not less than 0.040 inch (1.02 mm) thick, set in continuous vinyl channel retained with rigid, snap-in, extruded-vinyl moldings or with rubber or neoprene glazing gasket with aluminum stop.
3. Full-Vision Sections: Manufacturer's standard, tubular, aluminum-framed section fully glazed with 6-mm-thick, clear acrylic glazing set in vinyl, rubber, or neoprene glazing channel and with removable extruded-vinyl or aluminum stops.

D. Translucent Door Sections
1. Construct door sections of not less than 0.063-inch- (1.6-mm-) thick, extruded-aluminum stiles and rails complying with ASTM B 221 (ASTM B 221M) and with alloy and temper recommended by manufacturer for type of use and finish indicated, to provide door sections at least 1-3/4 inches (44 mm) deep. Fabricate units with overlapped or interlocked weathertight-seal joints at meeting rails. Reinforce or truss each section as required for strength and rigidity. Provide reinforcement for hardware attachment.
2. Provide translucent, ribbed, glass-fiber-reinforced plastic panels, secured and sealed watertight to framing, and reinforced to meet performance requirements.

E. Tracks, Supports, And Accessories
1. Tracks: Manufacturer's standard, galvanized-steel track system of configuration indicated, sized for door size and weight, designed for lift type indicated and clearances shown on Drawings, and complying with ASTM A 653/A 653M for minimum G60 (Z180) zinc coating. Provide complete track assembly including brackets, bracing, and reinforcement for rigid support of ball-bearing roller guides for required door type and size. Slot vertical sections of track spaced 2 inches (51 mm) apart for door-drop safety device. Slope tracks at proper angle from vertical or design tracks to ensure tight closure at jambs when door unit is closed.
2. Track Reinforcement and Supports: Galvanized-steel track reinforcement and support members, complying with ASTM A 36/A 36M and ASTM A 123/A 123M. Secure, reinforce, and support tracks as required for door size and weight to provide strength and rigidity without sag, sway, and vibration during opening and closing of doors.
   a. Vertical Track Assembly: Track with continuous reinforcing angle attached to track and attached to wall with jamb brackets **OR** wall jamb brackets attached to track and attached to wall, **as directed**.
   b. Horizontal Track Assembly: Track with continuous reinforcing angle attached to track and supported at points from curve in track to end of track by laterally braced attachments to overhead structural members.

3. Removable Center Posts: Manufacturer's standard carry-away **OR** roll-away **OR** swing-up, **as directed**, type for multiple doors in one opening.
4. Weatherseals: Replaceable, adjustable, continuous, compressible weather-stripping gaskets of flexible vinyl, rubber, or neoprene fitted to bottom and top of sectional door unless otherwise indicated.
5. Windows: Manufacturer's standard window units of type and size indicated and in arrangement shown. Set glazing in vinyl, rubber, or neoprene glazing channel for metal-framed doors and elastic glazing compound for wood doors, as required. Provide removable stops of same material as door-section frames.
6. Pass Doors: Manufacturer's standard pass doors where indicated, complete with glazing, operating hardware, and mortise lock. Construct pass doors of same materials, design, and finish as sectional door assembly.
    a. Lock Cylinders: Provide cylinders specified in Division 08 Section "Door Hardware" **OR** standard with manufacturer, **as directed**, and keyed to building keying system, **as directed**.
    b. Keys: Two **OR** Three, **as directed**, for each cylinder.

F. Hardware
1. General: Provide heavy-duty, corrosion-resistant hardware, with hot-dip galvanized, stainless-steel, or other corrosion-resistant fasteners, to suit door type.
2. Hinges: Heavy-duty, galvanized-steel hinges of not less than 0.079-inch- (2.01-mm-) nominal coated thickness at each end stile and at each intermediate stile, according to manufacturer's written recommendations for door size. Attach hinges to door sections through stiles and rails with bolts and lock nuts or lock washers and nuts. Use rivets or self-tapping fasteners where access to nuts is not possible. Provide double-end hinges where required, for doors over 16 feet (4.88 m) wide unless otherwise recommended by door manufacturer.
3. Rollers: Heavy-duty rollers with steel ball-bearings in case-hardened steel races, mounted with varying projections to suit slope of track. Extend roller shaft through both hinges where double hinges are required. Provide 3-inch- (76-mm-) diameter roller tires for 3-inch- (76-mm-) wide track and 2-inch- (51-mm-) diameter roller tires for 2-inch- (51-mm-) wide track.
4. Push/Pull Handles: For push-up or emergency-operated doors, provide galvanized-steel lifting handles on each side of door.

G. Locking Devices
1. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on single-jamb side, operable from inside only.
2. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded deadbolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.
    a. Lock Cylinders: Provide cylinders specified in Division 08 Section "Door Hardware" **OR** standard with manufacturer, **as directed**, and keyed to building keying system, **as directed**.
    b. Keys: Two **OR** Three, **as directed**, for each cylinder.
3. Chain Lock Keeper: Suitable for padlock.
4. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

H. Counterbalance Mechanism
1. Torsion Spring: Counterbalance mechanism consisting of adjustable-tension torsion springs fabricated from steel-spring wire complying with ASTM A 229/A 229M, mounted on torsion shaft made of steel tube or solid steel. Provide springs designed for number of operation cycles indicated.
2. Weight Counterbalance: Counterbalance mechanism consisting of filled pipe weights that move vertically in a galvanized-steel weight pipe. Connect pipe weights with cable to weight-cable drums mounted on torsion shaft made of steel tube or solid steel.
3. Cable Drums and Shaft for Doors: Cast-aluminum or gray-iron casting cable drums mounted on torsion shaft and grooved to receive door-lifting cables as door is raised. Mount counterbalance

mechanism with manufacturer's standard ball-bearing brackets at each end of torsion shaft. Provide one additional midpoint bracket for shafts up to 16 feet (4.88 m) long and two additional brackets at one-third points to support shafts more than 16 feet (4.88 m) long unless closer spacing is recommended by door manufacturer.

4. Cables: Galvanized-steel lifting cables with cable safety factor of at least 5 **OR** 7, **as directed**, to 1.
5. Cable Safety Device: Include a spring-loaded steel or spring-loaded bronze cam mounted to bottom door roller assembly on each side and designed to automatically stop door if either lifting cable breaks.
6. Bracket: Provide anchor support bracket as required to connect stationary end of spring to the wall and to level the shaft and prevent sag.
7. Provide a spring bumper at each horizontal track to cushion door at end of opening operation.

I. Manual Door Operators
1. Equip door with manufacturer's recommended manual door operator unless another type of door operator is indicated.
2. Push-up Operation: Lift handles and pull rope for raising and lowering doors, with counterbalance mechanism designed so that required lift or pull for door operation does not exceed 25 lbf (111 N).
3. Chain-Hoist Operator: Consisting of endless steel hand chain, chain-pocket wheel and guard, and gear-reduction unit with a maximum 25-lbf (111-N) **OR** 35-lbf (155-N), **as directed**, force for door operation. Provide alloy-steel hand chain with chain holder secured to operator guide.

J. Electric Door Operators
1. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and "operation cycles" requirement specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, remote-control stations, control devices, integral gearing for locking door, and accessories required for proper operation.
   a. Comply with NFPA 70.
   b. Provide control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6; with NFPA 70, Class 2 control circuit, maximum 24-V ac or dc.
2. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.
3. Door-Operator Type: Unit consisting of electric motor, gears, pulleys, belts, sprockets, chains, and controls needed to operate door and meet required usage classification.
   a. Trolley: Trolley operator mounted to ceiling above and to rear of door in raised position and directly connected to door with drawbar.
   b. Jackshaft, Center Mounted: Jackshaft operator mounted on the inside front wall above door and connected to torsion shaft with an adjustable coupling or drive chain.
   c. Jackshaft, Side Mounted: Jackshaft operator mounted on the inside front wall on right or left side of door and connected to torsion shaft with an adjustable coupling or drive chain.
4. Electric Motors: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 11 Section "Common Motor Requirements For Equipment", unless otherwise indicated.
   a. Electrical Characteristics:
      1) Phase: Single phase **OR** Polyphase, **as directed**.
      2) Volts: 115 **OR** 208 **OR** 230 **OR** 460, **as directed**, V.
      3) Hertz: 60.
   b. Motor Type and Controller: Reversible motor and controller (disconnect switch) for motor exposure indicated.
   c. Motor Size: Minimum size as indicated. If not indicated, large enough to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. (203 mm/s) and not more than 12 in./sec. (305 mm/s), without exceeding nameplate ratings or service factor.

d. Operating Controls, Controllers (Disconnect Switches), Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
e. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.
f. Use adjustable motor-mounting bases for belt-driven operators.

5. Limit Switches: Equip each motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.
6. Obstruction Detection Device: Equip motorized door with indicated external automatic safety sensor capable of protecting full width of door opening. Activation of device immediately stops and reverses downward door travel.
   a. Photoelectric Sensor: Manufacturer's standard system designed to detect an obstruction in door opening without contact between door and obstruction.
      1) Self-Monitoring Type: Designed to interface with door operator control circuit to detect damage to or disconnection of sensor device. When self-monitoring feature is activated, door closes only with sustained pressure on close button.
   b. Sensor Edge: Automatic safety sensor edge, located within astragal or weather stripping mounted to bottom bar. Contact with sensor activates device. Connect to control circuit using manufacturer's standard take-up reel or self-coiling cable.
      1) Self-Monitoring Type: Four-wire configured device designed to interface with door-operator control circuit to detect damage to or disconnection of sensor edge.
7. Remote-Control Station: Momentary-contact, three-button control station with push-button controls labeled "Open," "Close," and "Stop."
   a. Interior units, full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.
   b. Exterior units, full-guarded, standard-duty, surface-mounted, weatherproof type, NEMA ICS 6, Type 4 enclosure, key operated.
8. Emergency Manual Operation: Equip each electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed 25 lbf (111 N) **OR** 35 lbf (155 N), **as directed**.
9. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.
10. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.
11. Audible and Visual Signals: Audible alarm and visual indicator lights in compliance with regulatory requirements for accessibility.
12. Radio-Control System: Consisting of the following:
    a. Three-channel universal coaxial receiver to open, close, and stop door; one **OR** two, **as directed**, per operator.
       OR
       Multifunction remote control.
       OR
       Remote antenna and mounting kit.

K. Door Assembly
1. Steel **OR** Wood **OR** Aluminum **OR** Full-Vision Aluminum **OR** Translucent, **as directed**, Sectional Door: Sectional door formed with hinged sections.
2. Operation Cycles: Not less than 10,000 **OR** 20,000 **OR** 50,000 **OR** 100,000, **as directed**.
3. R-Value **OR** Installed R-Valu, **as directed**: 4.5 deg F x h x sq. ft./Btu (0.792 K x sq. m/W) **OR** 6.0 deg F x h x sq. ft./Btu (1.057 K x sq. m/W) **OR** 12.0 deg F x h x sq. ft./Btu (2.113 K x sq. m/W) **OR** 15.0 deg F x h x sq. ft./Btu (2.642 K x sq. m/W) **OR** 17.5 deg F x h x sq. ft./Btu (3.082 K x sq. m/W), **as directed**.
4. Steel Sections: Zinc-coated (galvanized) steel sheet with G60 (Z180) **OR** G90 (Z275), **as directed**, zinc coating.

a. Section Thickness: 1-3/8 inches (35 mm) **OR** 1-3/4 inches (44 mm) **OR** 2 inches (51 mm), **as directed**.
b. Exterior-Face, Steel Sheet Thickness: 0.064-inch- (1.63-mm-) **OR** 0.040-inch- (1.02-mm-) **OR** 0.028-inch- (0.71-mm-) **OR** 0.022-inch- (0.56-mm-) **OR** 0.019-inch- (0.48-mm-), **as directed**, nominal coated thickness.
1) Surface:
a) Flat.
OR
Manufacturer's standard, grooved **OR** ribbed **OR** paneled **OR** wood-grain embossed, **as directed**.
c. Insulation: Board **OR** Foamed in place, **as directed**.
d. Interior Facing Material: Zinc-coated (galvanized) steel sheet of 0.028-inch- (0.71-mm-) **OR** 0.022-inch- (0.56-mm-) **OR** 0.019-inch- (0.48-mm-) **OR** manufacturer's recommended thickness to meet performance requirements, **as directed**, nominal coated thickness.
e. Interior Facing Material: Hardboard panel.

5. Wood Sections: Paneled **OR** Flush, **as directed**, and with manufacturer's standard insulation, **as directed**.
6. Aluminum Sections: Solid panels **OR** Full vision, **as directed**, with manufacturer's standard, nonglazed panels across bottom section of door, **as directed**.
7. Translucent Sections: Manufacturer's standard with manufacturer's standard, nonglazed panels across bottom section of door, **as directed**.
8. Track Configuration: Standard-lift **OR** Low-headroom **OR** High-lift **OR** Vertical-lift **OR** Contour, **as directed**, track with removable center post shared with adjacent door, **as directed**.
9. Weatherseals: Fitted to bottom and top and around entire perimeter of door. Provide combination bottom weatherseal and sensor edge, **as directed**.
10. Windows: Approximately 24 by 7 inches (610 by 178 mm) **OR** 24 by 11 inches (610 by 279 mm), **as directed**, with curved corners, **OR** with square corners, **as directed**, and spaced apart the approximate distance as indicated on Drawings; in one row **OR** two rows, **as directed**, at height indicated on Drawings; installed with glazing **OR** insulated glazing, **as directed**, of the following type:
a. Clear Float Glass: 3 mm thick and complying with ASTM C 1036, Type I, Class 1, Quality Q3.
b. Clear Acrylic Plastic: 3 mm thick, transparent, smooth or polished, and formulated to be UV resistant.
c. Clear Polycarbonate Plastic: 3-mm-thick, transparent, fire-retardant, UV-resistant, polycarbonate sheet manufactured by extrusion process.
d. Insulating Glass: Manufacturer's standard.
11. Pass Door: As shown.
12. Roller-Tire Material: Case-hardened steel **OR** Neoprene or bronze **OR** Manufacturer's standard, **as directed**.
13. Locking Devices: Equip door with slide bolt for padlock **OR** locking device assembly, **as directed**, and chain lock keeper, **as directed**.
a. Locking Device Assembly: Single-jamb side **OR** Cremone type, both jamb sides, **as directed**, locking bars, operable from inside with thumbturn **OR** outside with cylinder **OR** outside only, with cylinder **OR** inside and outside, with cylinders, **as directed**.
14. Counterbalance Type: Torsion spring **OR** Weight counterbalance, **as directed**.
15. Manual Door Operator: Push-up operation **OR** Chain-hoist operator, **as directed**.
16. Electric Door Operator:
a. Usage Classification: Heavy duty, 60 to 90 cycles per hour **OR** Standard duty, up to 60 cycles per hour **OR** Medium duty, up to 15 cycles per hour **OR** Light duty, up to 10 cycles per hour, **as directed**.
b. Operator Type: Trolley **OR** Jackshaft, center mounted **OR** Jackshaft, side mounted **OR** As shown on Drawings, **as directed**.
c. Motor Exposure: Interior, clean, and dry **OR** Exterior, dusty, wet, or humid, **as directed**.
d. Emergency Manual Operation: Push-up **OR** Chain, **as directed**, type.

e. Obstruction-Detection Device: Automatic photoelectric sensor **OR** electric sensor edge on bottom bar **OR** pneumatic sensor edge on bottom bar, **as directed**; self-monitoring type, **as directed**.
   1) Sensor Edge Bulb Color: Black **OR** As selected from manufacturer's full range, **as directed**.
f. Remote-Control Station: Interior **OR** Exterior **OR** Where shown on Drawings, **as directed**.
g. Other Equipment: Audible and visual signals **OR** Radio-control system, **as directed**.

17. Door Finish:
   a. Aluminum Finish: Clear anodized **OR** Bronze anodized **OR** Anodized color matching sample **OR** Anodized color as selected from manufacturer's full range, **as directed**.
   b. Baked-Enamel or Powder-Coated Finish: Color and gloss as selected from manufacturer's full range.
   c. Factory Prime Finish: Manufacturer's standard color.
   d. Finish of Interior Facing Material: Match finish of exterior section face **OR** Finish as selected from manufacturer's full range, **as directed**.

L. General Finish Requirements
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

M. Aluminum Finishes
1. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
2. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
3. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, application, and baking.

N. Steel And Galvanized-Steel Finishes
1. Factory Prime Finish: Manufacturer's standard primer, compatible with field-applied finish. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.
2. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

1.3 EXECUTION

A. Installation
1. Install sectional doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.
2. Tracks:
   a. Fasten vertical track assembly to opening jambs and framing, spaced not more than 24 inches (610 mm) apart.
   b. Hang horizontal track assembly from structural overhead framing with angles or channel hangers attached to framing by welding or bolting, or both. Provide sway bracing, diagonal bracing, and reinforcement as required for rigid installation of track and door-operating equipment.
   c. Repair galvanized coating on tracks according to ASTM A 780.
3. Accessibility: Install sectional doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility.

B. Startup Services
   1. Engage a factory-authorized service representative to perform startup service.
      a. Complete installation and startup checks according to manufacturer's written instructions.
      b. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Adjusting
   1. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.
   2. Lubricate bearings and sliding parts as recommended by manufacturer.
   3. Adjust doors and seals to provide weathertight fit around entire perimeter.
   4. Align and adjust motors, pulleys, belts, sprockets, chains, and controls according to manufacturer's written instructions.
   5. Touch-up Painting: Immediately after welding galvanized materials, clean welds and abraded galvanized surfaces and repair galvanizing to comply with ASTM A 780.

END OF SECTION 08361

Task	Specification	Specification Description
08362	08361	Sectional Overhead Doors
08363	08361	Sectional Overhead Doors
08364	08330	Overhead Coiling Doors
08364	08361	Sectional Overhead Doors
08390	01352	No Specification Required

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SECTION 08410 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for aluminum framed entrances and storefronts. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Exterior and interior storefront framing.
b. Storefront framing for window walls.
c. Storefront framing for ribbon walls.
d. Storefront framing for punched openings.
e. Exterior and interior manual-swing entrance doors and door-frame units.

C. Definitions
1. ADA/ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disability Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities."

D. Performance Requirements
1. General Performance: Aluminum-framed systems shall withstand the effects of the following performance requirements without exceeding performance criteria or failure due to defective manufacture, fabrication, installation, or other defects in construction:
a. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.
b. Dimensional tolerances of building frame and other adjacent construction.
c. Failure includes the following:
1) Deflection exceeding specified limits.
2) Thermal stresses transferring to building structure.
3) Framing members transferring stresses, including those caused by thermal and structural movements to glazing.
4) Glazing-to-glazing contact.
5) Noise or vibration created by wind and by thermal and structural movements.
6) Loosening or weakening of fasteners, attachments, and other components.
7) Sealant failure.
8) Failure of operating units.
2. Delegated Design: Design aluminum-framed systems, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
3. Structural Loads:
a. Wind Loads: As indicated on Drawings **OR as directed**.
1) Basic Wind Speed: 85 mph (38 m/s) **OR** 90 mph (40 m/s) **OR** 100 mph (44 m/s) **OR** 110 mph (49 m/s), **as directed**.
2) Exposure Category: A **OR** B **OR** C **OR** D, **as directed**.
4. Deflection of Framing Members:
a. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane shall not exceed L/175 of the glass edge length for each individual glazing lite **OR** 1/175 of clear span for spans up to 13 feet 6 inches (4.1 m) and to 1/240 of clear span plus 1/4 inch (6.35 mm) for spans greater than 13 feet 6 inches (4.1 m), **as directed**, or an

amount that restricts edge deflection of individual glazing lites to 3/4 inch (19 mm), whichever is less.

b. Deflection Parallel to Glazing Plane: Limited to L/360 of clear span or 1/8 inch (3.2 mm), whichever is smaller **OR** amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components directly below them to less than 1/8 inch (3.2 mm) and clearance between members and operable units directly below them to less than 1/16 inch (1.5 mm), **as directed**.

5. Structural-Test Performance: Provide aluminum-framed systems tested according to ASTM E 330 as follows:
   a. When tested at positive and negative wind-load design pressures, systems do not evidence deflection exceeding specified limits.
   b. When tested at 150 percent of positive and negative wind-load design pressures, systems, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
   c. Test Durations: As required by design wind velocity, but not fewer than 10 seconds.
6. Windborne-Debris-Impact-Resistance Performance: Provide aluminum-framed systems that pass missile-impact and cyclic-pressure tests when tested according to ASTM E 1886 and testing information in ASTM E 1996 **OR** AAMA 506, **as directed**.
   a. Large-Missile Impact: For aluminum-framed systems located within 30 feet (9.1 m) of grade.
   b. Small-Missile Impact: For aluminum-framed systems located more than 30 feet (9.1 m) above grade.
7. Story Drift: Provide aluminum-framed systems that accommodate design displacement of adjacent stories indicated.
   a. Design Displacement: As indicated on Drawings **OR as directed**.
   b. Test Performance: Meet criteria for passing, based on building occupancy type, when tested according to AAMA 501.4 at design displacement and 1.5 times design displacement.
8. Air Infiltration: Provide aluminum-framed systems with maximum air leakage through fixed glazing and framing areas of 0.06 cfm/sq. ft. (0.03 L/s per sq. m) of fixed wall area when tested according to ASTM E 283 at a minimum static-air-pressure difference of 1.57 lbf/sq. ft. (75 Pa) **OR** 6.24 lbf/sq. ft. (300 Pa), **as directed**.
9. Water Penetration under Static Pressure: Provide aluminum-framed systems that do not evidence water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure difference of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa).
10. Water Penetration under Dynamic Pressure: Provide aluminum-framed systems that do not evidence water leakage through fixed glazing and framing areas when tested according to AAMA 501.1 under dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa).
    a. Maximum Water Leakage: According to AAMA 501.1 **OR** No uncontrolled water penetrating aluminum-framed systems or water appearing on systems' normally exposed interior surfaces from sources other than condensation, **as directed**. Water leakage does not include water controlled by flashing and gutters that is drained to exterior and water that cannot damage adjacent materials or finishes.
11. Thermal Movements: Provide aluminum-framed systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
    a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
    b. Test Performance: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.

1) High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F (82 deg C).
2) Low Exterior Ambient-Air Temperature: 0 deg F (minus 18 deg C).

c. Interior Ambient-Air Temperature: 75 deg F (24 deg C).

12. Condensation Resistance: Provide aluminum-framed systems with fixed glazing and framing areas having condensation-resistance factor (CRF) of not less than 45 **OR** 53, **as directed**, when tested according to AAMA 1503.
13. Thermal Conductance: Provide aluminum-framed systems with fixed glazing and framing areas having an average U-factor of not more than 0.57 Btu/sq. ft. x h x deg F (3.23 W/sq. m x K) **OR** 0.69 Btu/sq. ft. x h x deg F (3.92 W/sq. m x K), **as directed**, when tested according to AAMA 1503.
14. Sound Transmission: Provide aluminum-framed systems with fixed glazing and framing areas having the following sound-transmission characteristics:
    a. Sound Transmission Class (STC): Minimum 26 **OR** 30 **OR** 35, **as directed**, STC when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 413.
    b. Outdoor-Indoor Transmission Class (OITC): Minimum 26 **OR** 30 **OR** 34, **as directed**, OITC when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 1332.
15. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by aluminum-framed systems without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.
    a. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
    b. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant's internal strength.
16. Structural-Sealant Joints: Designed to produce tensile or shear stress of less than 20 psi (138 kPa).

E. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:
    a. Product Data for Credit EQ 4.1: For adhesives and sealants used inside of the weatherproofing system, including printed statement of VOC content.
3. Shop Drawings: For aluminum-framed systems. Include plans, elevations, sections, details, and attachments to other work.
    a. Include details of provisions for system expansion and contraction and for drainage of moisture in the system to the exterior.
    b. For entrance doors, include hardware schedule and indicate operating hardware types, functions, quantities, and locations.
4. Samples: For each type of exposed finish required.
5. Other Action Submittals:
    a. Entrance Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.
6. Delegated-Design Submittal: For aluminum-framed systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
7. Seismic Qualification Certificates: For aluminum-framed systems**,** accessories, and components, from manufacturer.
    a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
8. Welding certificates.

9. Product Test Reports.
10. Quality-Control Program for Structural-Sealant-Glazed System: Include reports.
11. Field quality-control reports.
12. Maintenance Data.
13. Warranties: Sample of special warranties.

F. Quality Assurance
1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
2. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.
3. Engineering Responsibility: Prepare data for aluminum-framed systems, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in systems similar to those indicated for this Project.
4. Quality-Control Program for Structural-Sealant-Glazed System: Develop quality control program specifically for Project. Document quality-control procedures and verify results for aluminum-framed systems. Comply with ASTM C 1401 recommendations including, but not limited to, system material-qualification procedures, preconstruction sealant-testing program, procedures for system fabrication and installation, and intervals of reviews and checks.
5. Product Options: Information on Drawings and in Specifications establishes requirements for systems' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.
   a. Do not revise intended aesthetic effects, as judged solely by the Owner, except with the Owner's approval. If revisions are proposed, submit comprehensive explanatory data to the Owner for review.
6. Accessible Entrances: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1, **as directed**.
7. Source Limitations for Aluminum-Framed Systems: Obtain from single source from single manufacturer.
8. Structural-Sealant Glazing: Comply with ASTM C 1401, "Guide for Structural Sealant Glazing" for design and installation of structural-sealant-glazed systems.
9. Structural-Sealant Joints: Design reviewed and approved by structural-sealant manufacturer.
10. Welding Qualifications: Qualify procedures and personnel according to AWS D1.2, "Structural Welding Code - Aluminum."
11. Preinstallation Conference: Conduct conference at Project site.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that fail in materials or workmanship within two **OR** five **OR** 10, **as directed**, years from date of Substantial Completion.
2. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes do not comply with requirements or that fail in materials or workmanship within five **OR** 10 **OR** 20, **as directed**, years from date of Substantial Completion. Warranty does not include normal weathering.

1.2 PRODUCTS

A. Materials
1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
   a. Sheet and Plate: ASTM B 209 (ASTM B 209M).

b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
c. Extruded Structural Pipe and Tubes: ASTM B 429.
d. Structural Profiles: ASTM B 308/B 308M.
e. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.

2. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer, complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
   a. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
   b. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
   c. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

B. Framing Systems
1. Framing Members: Manufacturer's standard extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.
   a. Construction: Nonthermal **OR** Thermally improved **OR** Thermally broken **OR** Structurally glazed, **as directed**.
   b. Glazing System: Retained mechanically with gaskets on four sides **OR** Retained by structural sealant at vertical edges and mechanically with gaskets at horizontal edges, **as directed**.
   c. Glazing Plane: As indicated **OR** Front **OR** Center **OR** Back **OR** Multiplane, **as directed**.
2. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
3. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
   a. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
   b. Reinforce members as required to receive fastener threads.
   c. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system **OR** fabricated from stainless steel, **as directed**.
4. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts, complying with ASTM A 123/A 123M or ASTM A 153/A 153M.
5. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials **OR** Dead-soft, 0.018-inch- (0.457-mm-) thick stainless steel, ASTM A 240/A 240M of type recommended by manufacturer, **as directed**.
6. Framing System Gaskets and Sealants: Manufacturer's standard, recommended by manufacturer for joint type.
   a. Provide sealants for use inside of the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Glazing Systems
1. Glazing: As specified in Division 08 Section "Glazing".
2. Glazing Gaskets: Manufacturer's standard compression types; replaceable, molded or extruded, of profile and hardness required to maintain watertight seal.
3. Spacers and Setting Blocks: Manufacturer's standard elastomeric type.
4. Bond-Breaker Tape: Manufacturer's standard TFE-fluorocarbon or polyethylene material to which sealants will not develop adhesion.
5. Glazing Sealants: For structural-sealant-glazed systems, as recommended by manufacturer for joint type, and as follows:
   a. Structural Sealant: ASTM C 1184, single-component neutral-curing silicone formulation that is compatible with system components with which it comes in contact, specifically formulated and tested for use as structural sealant and approved by a structural-sealant manufacturer for use in aluminum-framed systems indicated.
      1) Provide sealants for use inside of the weatherproofing system that have a VOC content of 100 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2) Color: Black **OR** As selected from manufacturer's full range of colors, **as directed**.

b. Weatherseal Sealant: ASTM C 920 for Type S, Grade NS, Class 25, Uses NT, G, A, and O; single-component neutral-curing formulation that is compatible with structural sealant and other system components with which it comes in contact; recommended by structural-sealant, weatherseal-sealant, and aluminum-framed-system manufacturers for this use.

1) Provide sealants for use inside of the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2) Color: Matching structural sealant.

D. Entrance Door Systems

1. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing operation.

a. Door Construction: 1-3/4-inch (44.5-mm) overall thickness, with minimum 0.125-inch- (3.2-mm-) **OR** 2-inch (50.8-mm) overall thickness, with minimum 0.188-inch- (4.8-mm-) **OR** 2- to 2-1/4-inch (50.8- to 57.2-mm) overall thickness, with minimum 0.125-inch- (3.2-mm-), **as directed**, thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.

1) Thermal Construction: High-performance plastic connectors separate aluminum members exposed to the exterior from members exposed to the interior.

b. Door Design: As indicated **OR** Narrow stile; 2-1/8-inch (54-mm) nominal width **OR** Medium stile; 3-1/2-inch (88.9-mm) nominal width **OR** Wide stile; 5-inch (127-mm) nominal width, **as directed**.

1) Accessible Doors: Smooth surfaced for width of door in area within 10 inches (255 mm) above floor or ground plane.

c. Glazing Stops and Gaskets: Beveled **OR** Square, **as directed**, snap-on, extruded-aluminum stops and preformed gaskets.

1) Provide nonremovable glazing stops on outside of door.

E. Entrance Door Hardware

1. General: Provide entrance door hardware and entrance door hardware sets indicated in door and frame schedule **OR** and entrance door hardware sets indicated in "Entrance Door Hardware Sets" Article, **as directed**, for each entrance door to comply with requirements in this Section.

a. Entrance Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and named manufacturers' products **OR** products equivalent in function and comparable in quality to named products **OR** products complying with BHMA standard referenced, **as directed**.

b. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.

c. Opening-Force Requirements:

1) Egress Doors: Not more than 15 lbf (67 N) to release the latch and not more than 30 lbf ((133 N))to set the door in motion and not more than 15 lbf (67 N) to open the door to its minimum required width.

2) Accessible Interior Doors: Not more than 5 lbf (22.2 N) to fully open door.

2. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of entrance door hardware are indicated in "Entrance Door Hardware Sets" Article. Products are identified by using entrance door hardware designations as follows:

a. References to BHMA Standards: Provide products complying with these standards and requirements for description, quality, and function.

3. Opening-Force Requirements:

a. Delayed-Egress Locks: Lock releases within 15 seconds after applying a force of not more than 15 lbf (67 N) for not more than 3 seconds.

b. Latches and Exit Devices: Not more than 15 lbf (67 N) required to release latch.

4. Pivot Hinges: BHMA A156.4, Grade 1.

a. Offset-Pivot Hinges: Provide top, bottom, and intermediate offset pivots at each door leaf.

5. Butt Hinges: BHMA A156.1, Grade 1, radius corner.
   a. Nonremovable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while entrance door is closed.
   b. Exterior Hinges: Stainless steel, with stainless-steel pin **OR** Nonferrous, **as directed**.
   c. Quantities:
      1) For doors up to 87 inches (2210 mm) high, provide 3 hinges per leaf.
      2) For doors more than 87 and up to 120 inches (2210 and up to 3048 mm) high, provide 4 hinges per leaf.
6. Continuous-Gear Hinges: Manufacturer's standard with stainless-steel bearings between knuckles, fabricated to full height of door and frame.
7. Mortise Auxiliary Locks: BHMA A156.5, Grade 1.
8. Manual Flush Bolts: BHMA A156.16, Grade 1.
9. Automatic and Self-Latching Flush Bolts: BHMA A156.3, Grade 1.
10. Panic Exit Devices: BHMA A156.3, Grade 1, listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.
11. Cylinders: As specified in Division 08 Section "Door Hardware" **OR** BHMA A156.5, Grade 1, **as directed**.
    a. Keying: No master **OR** Master, **as directed**, key system. Permanently inscribe each key with a visual key control number and include notation "DO NOT DUPLICATE" **OR** to be furnished by Owner, **as directed**.
12. Strikes: Provide strike with black-plastic dust box for each latch or lock bolt; fabricated for aluminum framing.
13. Operating Trim: BHMA A156.6.
14. Removable Mullions: BHMA A156.3, extruded aluminum.
    a. When used with panic exit devices, provide removable mullions listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305. Use only mullions that have been tested with exit devices to be used.
15. Closers: BHMA A156.4, Grade 1, with accessories required for a complete installation, sized as required by door size, exposure to weather, and anticipated frequency of use; adjustable to meet field conditions and requirements for opening force.
16. Concealed Overhead Holders: BHMA A156.8, Grade 1.
17. Surface-Mounted Holders: BHMA A156.16, Grade 1.
18. Door Stops: BHMA A156.16, Grade 1, floor or wall mounted, as appropriate for door location indicated, with integral rubber bumper.
19. Weather Stripping: Manufacturer's standard replaceable components.
    a. Compression Type: Made of ASTM D 2000, molded neoprene, or ASTM D 2287, molded PVC.
    b. Sliding Type: AAMA 701, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.
20. Weather Sweeps: Manufacturer's standard exterior-door bottom sweep with concealed fasteners on mounting strip.
21. Silencers: BHMA A156.16, Grade 1.
22. Thresholds: BHMA A156.21, raised thresholds beveled with a slope of not more than 1:2, with maximum height of 1/2 inch (13 mm).
23. Finger Guards: Manufacturer's standard collapsible neoprene or PVC gasket anchored to frame hinge-jamb at center-pivoted doors.

F. Accessory Materials
1. Joint Sealants: For installation at perimeter of aluminum-framed systems, as specified in Division 07 Section "Joint Sealants".
   a. Provide sealants for use inside of the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Bituminous Paint: Cold-applied, asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos; formulated for 30-mil (0.762-mm) thickness per coat.

G. Fabrication
1. Form or extrude aluminum shapes before finishing.
2. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
3. Framing Members, General: Fabricate components that, when assembled, have the following characteristics:
   a. Profiles that are sharp, straight, and free of defects or deformations.
   b. Accurately fitted joints with ends coped or mitered.
   c. Means to drain water passing joints, condensation within framing members, and moisture migrating within the system to exterior.
   d. Physical and thermal isolation of glazing from framing members.
   e. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
   f. Provisions for field replacement of glazing from exterior **OR** interior **OR** interior for vision glass and exterior for spandrel glazing or metal panels, **as directed**.
   g. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
4. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.
5. Structural-Sealant-Glazed Framing Members: Include accommodations for using temporary support device to retain glazing in place while structural sealant cures.
6. Storefront Framing: Fabricate components for assembly using shear-block system **OR** screw-spline system **OR** head-and-sill-receptor system with shear blocks at intermediate horizontal members, **as directed**.
7. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
   a. At exterior doors, provide compression weather stripping at fixed stops.
   b. At interior doors, provide silencers at stops to prevent metal-to-metal contact. Install three silencers on strike jamb of single-door frames and two silencers on head of frames for pairs of doors.
8. Entrance Doors: Reinforce doors as required for installing entrance door hardware.
   a. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.
   b. At exterior doors, provide weather sweeps applied to door bottoms.
9. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.
10. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

H. Aluminum Finishes
1. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
2. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
   a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Champagne **OR** Black **OR** Match sample **OR** As selected from full range of industry colors and color densities, **as directed**.
3. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

a. Color and Gloss: Match sample **OR** As selected from manufacturer's full range, **as directed**.

4. High-Performance Organic Finish:
   a. 2-coat fluoropolymer finish complying with AAMA 2604 **OR** AAMA 2605, **as directed**, and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      OR
      3-coat **OR** 4-coat, **as directed**, fluoropolymer finish complying with AAMA 2605 and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      1) Color and Gloss: Match sample **OR** As selected from manufacturer's full range, **as directed**.

1.3 EXECUTION

A. Installation
   1. General:
      a. Comply with manufacturer's written instructions.
      b. Do not install damaged components.
      c. Fit joints to produce hairline joints free of burrs and distortion.
      d. Rigidly secure nonmovement joints.
      e. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration.
      f. Seal joints watertight unless otherwise indicated.
   2. Metal Protection:
      a. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or applying sealant or tape, or by installing nonconductive spacers as recommended by manufacturer for this purpose.
      b. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
   3. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
   4. Set continuous sill members and flashing in full sealant bed as specified in Division 07 Section "Joint Sealants" to produce weathertight installation.
   5. Install components plumb and true in alignment with established lines and grades, and without warp or rack.
   6. Install glazing as specified in Division 08 Section "Glazing".
      a. Structural-Sealant Glazing:
         1) Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.
         2) Install weatherseal sealant according to Division 07 Section "Joint Sealants" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.
   7. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.
      a. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
      b. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.
   8. Install perimeter joint sealants as specified in Division 07 Section "Joint Sealants" to produce weathertight installation.

B. Erection Tolerances

1. Install aluminum-framed systems to comply with the following maximum erection tolerances:
   a. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet (3 mm in 3.7 m); 1/4 inch (6 mm) over total length.
   b. Alignment:
      1) Where surfaces abut in line, limit offset from true alignment to 1/16 inch (1.5 mm).
      2) Where surfaces meet at corners, limit offset from true alignment to 1/32 inch (0.8 mm).
2. Diagonal Measurements: Limit difference between diagonal measurements to 1/8 inch (3 mm).

C. Field Quality Control
1. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections.
2. Testing Services: Testing and inspecting of representative areas to determine compliance of installed systems with specified requirements shall take place as follows and in successive phases as indicated on Drawings. Do not proceed with installation of the next area until test results for previously completed areas show compliance with requirements.
   a. Structural-Sealant Compatibility and Adhesion: Structural sealant shall be tested according to recommendations in ASTM C 1401.
      1) Destructive Test Method A, "Hand Pull Tab (Destructive)," in ASTM C 1401, Appendix X2, shall be used.
         a) A minimum of two **OR** four **OR** six, **as directed**, areas on each building face shall be tested.
         b) Repair installation areas damaged by testing.
   b. Structural-Sealant Glazing Inspection: After installation of aluminum-framed systems is complete, structural-sealant glazing shall be inspected and evaluated according to recommendations in ASTM C 1401.
   c. Air Infiltration: Areas shall be tested for air leakage of 1.5 times the rate specified for laboratory testing under "Performance Requirements" Article, but not more than 0.09 cfm/sq. ft. (0.03 L/s per sq. m), of fixed wall area when tested according to ASTM E 783 at a minimum static-air-pressure difference of 1.57 lbf/sq. ft. (75 Pa) **OR** 6.24 lbf/sq. ft. (300 Pa), **as directed**.
   d. Water Penetration: Areas shall be tested according to ASTM E 1105 at a minimum uniform and cyclic static-air-pressure difference of 0.67 times the static-air-pressure difference specified for laboratory testing under "Performance Requirements" Article, but not less than 4.18 lbf/sq. ft. (200 Pa), and shall not evidence water penetration.
   e. Water Spray Test: Before installation of interior finishes has begun, a minimum area of 75 feet (23 m) by 1 story of aluminum-framed systems designated by the Owner shall be tested according to AAMA 501.2 and shall not evidence water penetration.
3. Repair or remove work if test results and inspections indicate that it does not comply with specified requirements.
4. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
5. Aluminum-framed assemblies will be considered defective if they do not pass tests and inspections.
6. Prepare test and inspection reports.

D. Adjusting
1. Adjust operating entrance door hardware to function smoothly as recommended by manufacturer.
   a. For entrance doors accessible to people with disabilities, adjust closers to provide a 3-second closer sweep period for doors to move from a 70-degree open position to 3 inches (75 mm) from the latch, measured to the leading door edge.

END OF SECTION 08410

Task	Specification	Specification Description
08410	01352	No Specification Required

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SECTION 08420 - ALL-GLASS ENTRANCES AND STOREFRONTS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for all-glass entrances and storefronts. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Interior **OR** Exterior **OR** Interior and exterior, **as directed**, manual-swinging **OR** manual-sliding, **as directed**, all-glass entrance doors.
b. All-glass sidelights and transoms.
c. Interior **OR** Exterior **OR** Interior and exterior, **as directed**, all-glass storefronts.

C. Definitions
1. ADA/ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disability Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities."

D. Performance Requirements
1. General Performance: All-glass systems shall withstand the effects of the following performance requirements without exceeding performance criteria or failure due to defective manufacture, fabrication, installation, or other defects in construction.
2. Structural Performance: All-glass systems shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to SEI/ASCE 7.
a. Wind Loads: **As directed**.
1) Basic Wind Speed: 85 mph (38 m/s) **OR** 90 mph (40 m/s) **OR** 100 mph (44 m/s) **OR** 110 mph (49 m/s), **as directed**.
2) Importance Factor.
3) Exposure Category: A **OR** B **OR** C **OR** D, **as directed**.
b. Seismic Loads: **As directed**.
c. Deflection Limits: Deflection normal to glazing plane is limited to 1 inch (25 mm) **OR** 1/175 of clear span or 3/4 inch (19 mm), whichever is smaller, **as directed**.
3. Delegated Design: Design all-glass systems, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
4. Thermal Movements: Allow for thermal movements resulting from the following ambient and surface temperature changes.
a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

E. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Show fabrication and installation details, including the following:
a. Plans, elevations, and sections.
b. Details of fittings and glazing, including isometric drawings of patch fittings **OR** rail fittings **OR** patch and rail fittings, **as directed**.
c. Door hardware locations, mounting heights, and installation requirements.
3. Samples: For each type of exposed finish required

4. Delegated-Design Submittal: For all-glass systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
5. Seismic Qualification Certificates
6. Product Test Reports.
7. Field quality-control reports.
8. Maintenance Data.
9. Warranty: Sample of special warranty.

F. Quality Assurance
1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
2. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.
3. Engineering Responsibility: Prepare data for all-glass systems, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in systems similar to those indicated for this Project.
4. Source Limitations: Obtain all-glass systems from single source from single manufacturer.
5. Accessible All-Glass Entrance Doors: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.
6. Preinstallation Conference: Conduct conference at Project site.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of all-glass systems that do not comply with requirements or that fail in materials or workmanship within two years from date of Substantial Completion

1.2 PRODUCTS

A. Materials
1. Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated surfaces), Type I (transparent), tested for surface and edge compression per ASTM C 1048 and for impact strength per 16 CFR 1201 for Category II materials.
   a. Class 1: Clear monolithic.
      1) Thickness: 3/8 inch (10 mm) **OR** 1/2 inch (13 mm) **OR** 5/8 inch (16 mm) **OR** 3/4 inch (19 mm), **as directed**.
      2) Locations: As directed.
   b. Class 2: Tinted monolithic.
      1) Color: Gray **OR** Bronze, **as directed**.
      2) Thickness: 3/8 inch (10 mm) **OR** 1/2 inch (13 mm), **as directed**.
      3) Locations: As directed.
   c. Exposed Edges: Machine ground and flat polished.
   d. Butt Edges: Flat ground.
   e. Corner Edges: Lap-joint corners with exposed edges polished.
2. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), with strength and durability characteristics of not less than Alloy 6063-T5.
   a. Bronze Cladding: ASTM B 36/B 36M, alloy matching sample **OR** UNS No. C28000 (muntz metal, 60 percent copper) **OR** UNS No. C22000 (commercial bronze, 90 percent copper) **OR** as standard with manufacturer, **as directed**.
   b. Brass Cladding: ASTM B 36/B 36M, alloy matching sample **OR** UNS No. C26000 (cartridge brass, 70 percent copper) **OR** UNS No. C28000 (muntz metal, 60 percent copper) **OR** as standard with manufacturer, **as directed**.
   c. Stainless-Steel Cladding: ASTM A 666, Type 304.

B. Metal Components
   1. Fitting Configuration:
      a. Manual-Swinging, All-Glass Entrance Doors Sidelights and Transoms: Patch fittings at head and sill on pivot side only **OR** Patch fittings at head and sill on pivot side, and for lock at sill of swing side **OR** Patch fitting at top and continuous rail fitting at bottom **OR** Continuous rail fitting at top and bottom, **as directed**.
      b. Manual-Sliding, All-Glass Entrance Doors Sidelights and Transoms: Continuous rail fitting at top and bottom.
      c. All-Glass Storefronts: Recessed glazing channel at top and continuous rail fitting at bottom **OR** Recessed glazing channel at top and bottom **OR** Continuous rail fitting at top and bottom, **as directed**.
   2. Patch Fittings: Aluminum **OR** Bronze-clad aluminum **OR** Brass-clad aluminum **OR** Stainless-steel-clad aluminum, **as directed**.
   3. Rail Fittings:
      a. Material: Match patch-fitting metal and finish **OR** Aluminum **OR** Bronze-clad aluminum **OR** Brass-clad aluminum **OR** Stainless-steel-clad aluminum, **as directed**.
      b. Height:
         1) Top Rail: 3-1/2 inches (89 mm) **OR** As indicated, **as directed**.
         2) Bottom Rail: 3-1/2 inches (89 mm) **OR** 10 inches (255 mm) **OR** As indicated, **as directed**.
      c. Profile: Tapered **OR** Tapered flat **OR** Tapered at 60 degrees minimum from the horizontal **OR** Square **OR** Curved **OR** As indicated, **as directed**.
      d. End Caps: Manufacturer's standard precision-fit end caps for rail fittings.
   4. Accessory Fittings: Match patch-fitting **OR** rail-fitting **OR** patch- and rail-fitting, **as directed**, metal and finish for the following:
      a. Overhead doorstop.
      b. Center-housing lock.
      c. Glass-support-fin brackets.
   5. Anchors and Fastenings: Concealed.
   6. Weather Stripping: Pile type; replaceable without removing all-glass entrance doors from pivots.

C. Fabrication
   1. Provide holes and cutouts in glass to receive hardware, fittings, and accessory fittings before tempering glass. Do not cut, drill, or make other alterations to glass after tempering.
      a. Fully temper glass using horizontal (roller-hearth) process, and fabricate so that when glass is installed, roll-wave distortion is parallel with bottom edge of door or lite.
   2. Factory assemble components and factory install hardware and fittings to greatest extent possible.

D. Aluminum Finishes
   1. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
   2. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
      a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black, **as directed**.

E. Stainless-Steel Finishes
   1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
   2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
      a. Run grain of directional finishes with long dimension of each piece.
      b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
      c. Directional Satin Finish: No. 4.
      d. Mirrorlike Reflective, Nondirectional Polish: No. 8.

F. Copper-Alloy Finishes

1. Buffed Finish, Lacquered: M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear organic, air drying, as specified below).
   a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in 2 coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
2. Hand-Rubbed Finish, Lacquered: M31-M34-O6x (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed; Coating: clear organic, air drying, as specified below).
   a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in 2 coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
3. Statuary Conversion Coating over Satin Finish: M31-C55 (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide).
   a. Color: Match sample.

1.3 EXECUTION

A. Installation
   1. Install all-glass systems and associated components according to manufacturer's written instructions.
   2. Set units level, plumb, and true to line, with uniform joints.
   3. Maintain uniform clearances between adjacent components.
   4. Lubricate hardware and other moving parts according to manufacturer's written instructions.
   5. Set, seal, and grout floor closer cases as required to suit hardware and substrate indicated.
   6. Install joint sealants as specified in Division 07 Section "Joint Sealants" and to produce weathertight installation.

B. Field Quality Control
   1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
   2. After completion of all-glass storefront installation and nominal curing of sealant and glazing compounds, but before installation of interior finishes, test for water leaks according to AAMA 501.2.
   3. Perform test for total areas as designated.
   4. Work will be considered defective if it does not pass tests and inspections.
   5. Prepare test and inspection reports.

C. Adjusting And Cleaning
   1. Adjust all-glass entrance doors and hardware to produce smooth operation and tight fit at contact points and weather stripping.
      a. For all-glass entrance doors accessible to people with disabilities, adjust closers to provide a 3-second closer sweep period for doors to move from a 70-degree open position to 3 inches (75 mm) from the latch measured to the leading door edge.
   2. Remove excess sealant and glazing compounds and dirt from surfaces.

END OF SECTION 08420

Task	Specification	Specification Description
08420	08410	Aluminum-Framed Entrances And Storefronts

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SECTION 08510 - STEEL WINDOWS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for steel windows. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Steel windows from hot-rolled sections.
b. Steel windows from cold-formed steel members.

C. Performance Requirements
1. Structural Performance: Provide steel windows capable of withstanding the effects of the following loads and stresses within limits and under conditions indicated, based on testing windows that are representative of those specified according to ASTM E 330 or structural calculations:
a. Design Wind Loads: Determine design wind loads under conditions indicated according to ASCE/SEI 7.
1) Basic Wind Speed: 85 mph (38 m/s) **OR** 90 mph (40 m/s), **as directed**.
2) Importance Factor.
3) Exposure Category: B **OR** C **OR** D, **as directed**.
b. Deflection Limits: Design glass framing system to limit lateral deflections of glass edges to less than 1/175 of glass-edge length or 3/4 inch (19 mm), whichever is less, at design pressures.
2. Windborne-Debris Resistance: Provide glazed steel windows capable of resisting impact from windborne debris, based on the pass/fail criteria as determined from testing glazed steel windows identical to those specified, according to ASTM E 1886 and testing information in ASTM E 1996 and requirements of authorities having jurisdiction.
3. Condensation-Resistance: Provide steel windows with a CRF when tested according to AAMA 1503 **OR** CR determined according to NFRC 500, **as directed**, of 36 **OR** 40, **as directed**, minimum.
4. Thermal Transmittance: Provide steel windows with the maximum whole-fenestration product U-factor indicated, when tested according to AAMA 1503 **OR** determined according to ASTM E 1423 **OR** determined according to NFRC 100, **as directed**.
a. U-Factor: 0.49 Btu/sq. ft. x h x deg F **OR** 2.8 W/sq. m x K, **as directed**.
5. Solar Heat-Gain Coefficient (SHGC): Provide steel windows with a maximum whole-fenestration product SHGC of 0.40 **OR** 0.55, **as directed**, determined according to NFRC 200.
6. Air Infiltration for Weather-Stripped Ventilators: Not more than 0.37 cfm/ft. (0.18 L/s per m) of ventilator crack length at an inward test pressure of 6.24 lbf/sq. ft. (298 Pa) when tested according to ASTM E 283.
7. Air Infiltration for Non-Weather-Stripped Ventilators: Not more than 1.0 cfm/ft. (0.47 L/s per m) of ventilator crack length at an inward test pressure of 1.56 lbf/sq. ft. (75 Pa) when tested according to ASTM E 283.
8. Water Penetration: No leakage for 15 minutes when window is subjected to a rate of flow of 5 gal./h per sq. ft. (0.05 L/s per sq. m) with a differential pressure across the window of 2.86 lbf/sq. ft. (137 Pa) **OR** 6.24 lbf/sq. ft. (298 Pa), **as directed**, when tested according to ASTM E 331.
9. Forced-Entry Resistance: Comply with Performance Grade 10 requirements when tested according to ASTM F 588.
10. Crack Tolerances: Test each type and size of required window unit, with ventilators closed and locked, for compliance with the following tolerances:

a. Casement Windows: It shall not be possible to freely insert a steel feeler gage 2 inches (51 mm) wide by 0.020 inch (0.5 mm) thick between more than 40 percent of the inside metal-to-metal contacts between frames and ventilators without forcing.
b. Projected Windows: It shall not be possible to freely insert a steel feeler gage 2 inches (51 mm) wide by 0.031 inch (0.8 mm) thick between the inside metal-to-metal contacts between frames and ventilators without forcing, or to freely insert a steel feeler gage 2 inches (51 mm) wide by 0.020 inch (0.5 mm) thick between more than 40 percent of such contacts between frames and ventilators without forcing.

11. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.

D. Submittals
1. Product Data: For each type of product indicated. Include construction details, material descriptions, fabrication methods, dimensions of individual components and profiles, hardware, finishes, and operating instructions.
   a. Motors: Show nameplate data, ratings, characteristics, and mounting arrangements.
2. LEED Submittal:
   a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.
3. Shop Drawings: Include plans, elevations, sections, details, hardware, attachments to other work, operational clearances, installation details, and the following:
   a. Mullion details including reinforcement and stiffeners.
   b. Joinery details.
   c. Expansion provisions.
   d. Flashing and drainage details.
   e. Weather-stripping details.
   f. Glazing details.
   g. Window-cleaning provisions.
   h. Window System Operators: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
   i. Wiring Diagrams: Power, signal, and control wiring.
   j. Accessories.
4. Samples: For steel windows and components required, prepared on Samples of size indicated below:
   a. Main Framing Member: 12-inch- (300-mm-) long, full-sized sections, with glazing bead, weather stripping and factory-applied color finish.
   b. Hardware: Full-size units with factory-applied finish.
5. Product Schedule: For steel windows. Use same designations indicated on Drawings.
6. Delegated-Design Submittal: For steel windows indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
7. Qualification Data: For qualified Installer, manufacturer, professional engineer and testing agency.
8. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for steel windows.
9. Field quality-control reports.
10. Operation and Maintenance Data: For operable window sash, operable hardware, operable fire-rated window hardware, window system operators, weather stripping and finishes to include in operation and maintenance manuals.
11. Warranties: Sample of special warranty.

E. Quality Assurance
1. Manufacturer Qualifications: A manufacturer capable of fabricating steel windows that meet or exceed performance requirements indicated and of documenting this performance by inclusion in lists, and by labels, test reports, and calculations.
2. Installer Qualifications: An installer acceptable to window manufacturer for installation of units required for this Project.
   a. Installer's responsibilities include providing professional engineering services needed to assume engineering responsibility including preparation of data for steel windows, including Shop Drawings and Designated Design Submittal based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
3. Source Limitations: Obtain steel windows from single source from single manufacturer.
4. Fire-Test-Response Characteristics: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated on Drawings, based on testing indicated.
   a. Neutral-Pressure Test: NFPA 257 **OR** UL 9, **as directed**.
      OR
      Positive-Pressure Test: ASTM E 2010 **OR** NFPA 257 **OR** UBC 7-4 **OR** UL 9, **as directed**.
5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
6. SWI Publication: Comply with applicable requirements in SWI's "The Architect's Guide to Steel Windows and Doors" except where more stringent requirements are indicated.
7. Preinstallation Conference: Conduct conference at Project site.

F. Project Conditions
1. Field Measurements: Verify actual dimensions of steel window openings by field measurements before fabrication.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of steel windows that fail in materials or workmanship within specified warranty period.
   a. Failures include, but are not limited to, the following:
      1) Failure to meet performance requirements.
      2) Structural failures including excessive deflection.
      3) Water leakage or air infiltration.
      4) Faulty operation of operable sash and hardware.
      5) Deterioration of metals, metal finishes, and other materials beyond normal weathering.
   b. Warranty Period: Two **OR** Three, **as directed**, years from date of Substantial Completion.
   c. Warranty Period for Metal Finishes: Five **OR** 10 **OR** 15, **as directed**, years from date of Substantial Completion.

1.2 PRODUCTS

A. Materials
1. Fasteners: Provide fasteners of bronze, brass, stainless steel, or other metal that are warranted by manufacturer to be noncorrosive and compatible with trim, hardware, anchors, and other components of steel windows.
   a. Exposed Fasteners: If exposed fasteners are used, provide Phillips flat-head machined screws that match finish of member or hardware being fastened, as appropriate.
2. Anchors, Clips, and Window Accessories: Provide units of stainless steel, hot-dip zinc-coated steel, bronze, brass, or iron complying with ASTM A 123/A 123M. Provide units with sufficient strength to withstand design pressure indicated.

3. Compression-Type Weather Stripping: Provide compressible weather stripping designed for permanently resilient sealing under bumper or wiper action and for complete concealment when steel window is closed.
   a. Weather-Stripping Material: Elastomeric, cellular, preformed gaskets complying with ASTM C 509.
      OR
      Weather-Stripping Material: Dense elastomeric gaskets complying with ASTM C 864.
      OR
      Weather-Stripping Material: Manufacturer's standard.
4. Sliding-Type Weather Stripping: Provide manufacturer's standard woven-pile weather stripping of wool, polypropylene, or nylon pile and resin-impregnated backing fabric.
   a. Weather Seals: Provide weather stripping with integral barrier fin or fins of semirigid, polypropylene sheet or polypropylene-coated material.
5. Trim Members, Screen Frames, Retainers for Weather Stripping, Flashing, and Similar Items: Extruded aluminum **OR** Formed sheet aluminum **OR** Stainless steel **OR** Formed steel **OR** Manufacturer's standard, **as directed**.
6. Glazing Stops: Extruded aluminum **OR** Formed sheet aluminum **OR** Stainless steel **OR** Formed steel **OR** Manufacturer's standard, **as directed**.
7. Sealant: For sealants required within fabricated windows, provide manufacturer's standard, permanently elastic, nonshrinking, and nonmigrating type recommended by sealant manufacturer for joint size and movement.

B. Window
1. Window Type: Casement **OR** Double hung **OR** Fixed **OR** Horizontally pivoted **OR** Horizontal sliding **OR** Projected **OR** Single hung **OR** Vertically pivoted **OR** As indicated on Drawings **OR** As indicated in a schedule, **as directed**.
2. Hot-Rolled Steel Window Members: Provide frame and ventilator members formed from hot-rolled, new billet steel sections. For combined weight of frame and ventilator members and front-to-back depth of frame or ventilator members, comply with the following requirements:
   a. Light Intermediate Windows: Not less than 2.0 lb/ft. (2.98 kg/m) in combined weight and not less than 1 inch (25.4 mm) deep.
   b. Standard Intermediate Windows: Not less than 3.0 lb/ft. (4.46 kg/m) in combined weight and not less than 1-1/4 inches (32 mm) deep.
   c. Heavy Intermediate Windows: Not less than 3.5 lb/ft. (5.21 kg/m) in combined weight and not less than 1-5/16 inches (33.34 mm) deep.
   d. Heavy Custom Windows: Not less than 4.2 lb/ft. (6.25 kg/m) in combined weight and not less than 1-1/2 inches (38.1 mm) deep.
      1) Dimensions of Projected Frame and Ventilator Members: Nominally 1/8 inch (3 mm) thick by 1-3/8 inches (35 mm) deep except members nominally 1-1/4 inches (32 mm) deep may be used provided corners are welded and ground.
      2) Applied Weather Stripping: Where indicated, 0.074-inch (1.9-mm) **OR** 0.060-inch (1.5-mm), **as directed**, minimum thickness.
   e. Window Finish: Galvanized **OR** Galvanized and factory primed **OR** Factory primed **OR** Baked enamel **OR** Powder coat **OR** High performance, organic, **as directed**.
      1) Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
3. Cold-Formed Steel Window Members: Provide frame and ventilator members mechanically formed from metallic-coated, low-carbon, cold-rolled steel sheet complying with ASTM A 653/A 653M. For combined weight of frame and ventilator members and front-to-back depth of frame or ventilator members, comply with the following requirements:
   a. Commercial and Industrial Windows: Not less than 2.75 lb/ft. (4.09 kg/m) in combined weight, and not less than 1-1/4 inches (32 mm) deep.
   b. Window Finish: Baked enamel **OR** Powder coat, **as directed**.
      1) Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

C. Glazing
1. Glass and Glazing System: See Division 08 Section "Glazing" for glass units and glazing requirements for steel windows.

D. Hardware
1. General: Provide manufacturer's standard nonremovable, **as directed**, solid bronze **OR** malleable iron **OR** die-cast metal, **as directed**, hardware, with operating components of stainless steel, carbon steel complying with AAMA 907, brass, bronze, or other corrosion-resistant material designed to operate smoothly, to close tightly, and to lock steel window ventilators securely. Provide hardware of sufficient strength to accommodate size and weight of ventilator for which it is intended.
2. Sill Cap/Track: Designed to comply with performance requirements indicated and to drain to the exterior.
3. Locks and Latches: Designed to allow unobstructed movement of the sash across adjacent sash in direction indicated and to operate from the inside only.
4. Roller Assemblies: Low-friction design.
5. Friction Shoes: Adjustable friction shoes of bronze, brass, nylon, or other nonabrasive, nonstaining, noncorrosive, durable material.
6. Hinges: Four-bar friction hinges complying with AAMA 904.
7. Limit Device: Provide concealed friction adjustor/stay-bar **OR** friction adjustor/stay-bar with release key or tool **OR** support arms with adjustable, limited hold-open, **as directed**, limit devices designed to restrict sash or ventilator opening.
8. Gear-Type Rotary Operators: Comply with AAMA 901 when tested according to ASTM E 405, Method A.
   a. Operator shall operate all ventilators simultaneously, securely closing them at both jambs without use of additional manually controlled locking devices.
9. Pole Operators: Tubular-shaped, anodized aluminum; with rubber-capped lower end and standard push-pull hook at top to match hardware design; of sufficient length to operate window without reaching more than 60 inches (1500 mm) above floor; one pole operator and pole hanger per room that has operable windows more than 72 inches (1800 mm) above floor.
10. Casement Windows: Provide the following operating hardware:
    a. Operating Device: Gear-type rotary operator located on the jamb at the sill.
       OR
       Operating Device: Combination lever-handle and cam-type latch.
    b. Hinges: Concealed, four-bar friction hinges with adjustable slide shoes; two per ventilator.
       OR
       Hinges: Heavy duty, three-knuckle butt hinges with nylon bushings; two per ventilator.
       OR
       Hinges: Provide standard-duty, concealed, four-bar friction egress hinges with adjustable slide shoes; two per ventilator where indicated. Provide hinge designed to achieve 90-degree ventilator opening.
       OR
       Hinges: Extension hinges or pivots, nonfriction type; two per ventilator.
    c. Lock: Lift-type, cam-action lock.
    d. Limit Device: Stay bar with an adjustable hold-open device.
11. Double **OR** Single, **as directed**,-Hung Windows: Provide the following operating hardware:
    a. Sash Balances: Two per sash.
    b. Counterbalance and Pulley: Two per sash to operate ventilators in unison with stainless-steel-cable sash cord.
       1) Single-Hung Upper Sash Retainer: Manufacturer's standard.
    c. Self-Closing Device for Single-Hung, Fire-Rated Windows: Fusible link **OR** Electrically operated, resettable thermal link, labeled and tested per UL 33, **as directed**.
    d. Handle(s): Lift **OR** Pull-down, **as directed**, handle; one **OR** two, **as directed**, per sash.
    e. Lock: Cam-action sweep lock and keeper on meeting rail; one **OR** two, **as directed**, per sash.
12. Horizontal-Sliding Windows: Provide the following operating hardware:

a. Rollers: Steel, lubricated, ball-bearing rollers.
b. Lock: Manufacturer's standard.
c. Limit Device: Manufacturer's standard.
d. Pull Handle: Manufacturer's standard.
e. Automatic Closer for Fire-Rated Steel Sash: Heat- **OR** Heat- and electrically, **as directed**, activated spring-driven closer.

13. Pivoting Windows: Provide the following operating hardware:
    a. Pivot Assembly: Manganese-bronze pivot assembly designed for center **OR** off-center, **as directed**, axis pivoting.
    b. Lock: Internal, key-operated, limited-access locks; one **OR** two, **as directed**, per jamb.
        1) Bronze safety drop bolts.
        2) Bronze cam fasteners.
    c. Limit device.
14. Projected Windows: Provide the following operating hardware:
    a. Operating Device: Gear-type rotary **OR** Push-bar-type, **as directed**, underscreen, **as directed**, ventilator operator located at the sill.
    b. Hinges: Concealed, four-bar friction hinges with adjustable slide shoes; two per ventilator.
    OR
    Hinges: Balance arms with adjustable, nonabrasive friction pivots; two per ventilator.
    OR
    Hinges: Balance arms with adjustable, nonabrasive friction shoes; two per ventilator.
        1) Provide ventilator operation that permits cleaning of the outside glass face from the interior.
        2) Provide jamb-mounted, sliding, brass friction shoes with screw adjusters.
    c. Lock: Cam-action, sweep lock handle with surface-mounted strike.
    OR
    Lock: Key-operated security lock and keeper.
    OR
    Lock: Pole-operated, spring catch lock.
    OR
    Lock: Pole-operated, cam-action, sweep lock handle and keeper.

E. Group Window Operating Systems
1. Provide window operating system for window groups as indicated. Coordinate operating system design with window fabrication and hardware selections to ensure smooth, durable operation of ventilators.
2. Operation Function: All ventilators move simultaneously and close securely at sash frames without using additional manually controlled locking devices.
3. Operating System: Complete with shafts, brackets, levers, rods, oil-encased gear boxes, and standard fittings and accessories for operation indicated.
    a. Rack-and-Pinion Operating System: Torsion-type with steel pipe torsion shaft and factory-sealed, oil-encased gear box. Provide system with rack-and-pinion sets and operating arms. Provide standard fittings and accessories for operation indicated. Space support bearings at 10 feet (3 m) o.c. maximum.
        1) Space operating arms not more than 60 inches (1500 mm) o.c.
        2) Provide one operating arm for each operating vent.
    b. Horizontal-Movement Operating System: Tension-type with steel rod or cable transmission lines operating in conduit between ventilator operators, factory-sealed lubricated rotary thrust unit, and toggle-type operator arms. Provide standard fittings and accessories for operation indicated. Provide support bracket at each operator, at bends, and not more than 10 feet (3 m) o.c. elsewhere.
        1) Space operating arms not more than 10 feet (3 m) o.c. along each continuous unit.
        2) Provide one operating arm for each operating vent.
4. Operation: Manual, with chain-wheel operator on each gear box shaft; with chain loops terminated 24 inches (600 mm) above floor.

OR

Operation: Manual, with crank-type operator on each gear box shaft; with removable crank and oil-enclosed miter gear box. Where necessary, extend crankshaft with universal joints and support brackets to a suitable crank-operator mounting location not more than 44 inches (1115 mm) above floor.

5. Operation: Electric, with factory-assembled electric operator designed for operating windows of type, size, weight, construction, use, and operating frequency indicated.
   a. Electric Operator: Provide operating system complying with NFPA 70; of size and capacity and with features, characteristics, and accessories suitable for Project conditions recommended in writing by window manufacturer; complete with operating system indicated, electric motor and factory-prewired motor controls with limit switches, remote-control stations, power disconnect switches, enclosures to protect controls and all operating parts, and accessories required for reliable operation. Include wiring from motor controls to motor. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
      1) Control Equipment: Comply with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6.
      2) Electric Motor: Comply with NEMA MG 1; with thermal-overload protection; sized to start and operate size and weight of window sash ventilators under any conditions; one per each gear-box shaft.
         a) Motor Characteristics: Single phase, sized by electric operator manufacturer, 60 Hz.
      3) Remote Controls: Electric controls with NEMA ICS 6, Type 1 enclosure and momentary-contact, single push-button-operated control **OR** three-position, push-button-operated control with open, close, and stop functions, **as directed**.
      4) Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop sash ventilators at fully opened and fully closed positions.

F. Insect Screens
   1. Design windows and hardware to accommodate screens in a tight-fitting, removable arrangement, with a minimum of exposed fasteners and latches. Fabricate insect screens to fully integrate with window frame, with mitered or coped joints or corner extrusions, concealed fasteners, adjustable rollers, **as directed**, and removable PVC spline/anchor concealing edge of frame. Locate screens on inside **OR** outside, **as directed**, of window and provide for each operable exterior sash or ventilator.
      a. Screen Frames: Fabricate frames of tubular-shaped, extruded- **OR** formed-, **as directed**, aluminum members of 0.04-inch (1.0-mm) minimum wall thickness.
         1) Finish: Anodized aluminum **OR** Baked-on organic coating, **as directed**, in manufacturer's standard color.

            OR

            Finish: Anodized aluminum **OR** Baked-on organic coating, **as directed**, in color selected from manufacturer's full range.

            OR

            Finish: Manufacturer's standard.
      b. Screen Frames: Fabricate frames of tubular-shaped, nonmagnetic stainless-steel members of 0.02-inch (0.5-mm) minimum wall thickness.
         1) Finish: No. 2B bright mill finish **OR** Match steel window finish, **as directed**.
      c. Screen Frames (inside only): Fabricate frames of tubular-shaped, steel sheet members of 0.03-inch (0.8-mm) minimum wall thickness. Finish the frames to match window units.
   2. Glass-Fiber Mesh Fabric: ASTM D 3656, 18-by-14 or 18-by-16 **OR** 20-by-20 or 20-by-30, **as directed**, count per sq. in. (645 sq. mm) mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration.
      a. Mesh Color: Gray.
   3. Aluminum Wire Fabric: 18-by-16 count per sq. in. (645 sq. mm) mesh of 0.011-inch- (0.28-mm-) diameter, coated aluminum wire.
      a. Wire-Fabric Finish: Natural bright **OR** Charcoal gray **OR** Black, **as directed**.

4. Copper Wire Fabric: 16-by-16 count per sq. in. (645 sq. mm) mesh of 0.011-inch- (0.28-mm-) diameter copper wire.
5. Bronze Wire Fabric: 18-by-14 count per sq. in. (645 sq. mm) mesh of 0.011-inch- (0.28-mm-) diameter bronze wire with a clear varnish finish.
6. Stainless-Steel Wire-Fabric: 18-by-16 **OR** 18-by-18, **as directed**, count per sq. in. (645 sq. mm) mesh of 0.009-inch- (0.2-mm-) minimum diameter, nonmagnetic stainless-steel wire, Type 304 or 316.
7. Solar-Screening Mesh Fabric: 17-by-15 **OR** 40-by-40, **as directed**, count per sq. in. (645 sq. mm) mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration. Comply with ASTM D 3656.
8. Wickets: Provide sliding or hinged wickets, framed and trimmed for a tight fit and durability during handling.

G. Accessories
1. General: Provide manufacturer's standard accessories that comply with indicated standards.
2. Window Cleaner Anchor Bolts: Provide window cleaner anchor bolts of standard design, complying with requirements of authorities having jurisdiction. Fabricate bolts of nonmagnetic stainless steel.
    a. Reinforce window units or mullions to receive bolts and provide additional anchorage of units at bolt locations.

H. Fabrication
1. General: Fabricate steel windows of type and in sizes indicated to comply with SWI standards. Include a complete system for assembly of components and anchorage of window units.
    a. Provide units that are reglazable without dismantling ventilator framing.
    b. Prepare window ventilators for site glazing **OR** factory glazing, **as directed**.
2. Mullions: Formed of hot-rolled **OR** cold-formed, **as directed**, steel matching window units; with anchors for support to structure and for installation of window units and having sufficient strength to withstand design pressure indicated. Provide mullions of profile indicated and with cover plates. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections.
3. Subframes and Operable Ventilators: Formed of hot-rolled **OR** cold-formed, **as directed**, steel of profile indicated. Miter or cope corners, and mechanically fasten and seal joints **OR** weld and dress joints smooth, **as directed**.
4. Provide weep holes and internal water passages to conduct infiltrating water to the exterior.
5. Provide water-shed members above casement **OR** horizontal-sliding, **as directed**, ventilators.
6. Glazing Stops: Provide screw-applied **OR** snap-on, **as directed**, glazing stops; coordinate with Division 08 Section "Glazing" and with glazing system indicated. Provide glazing stops to match panel frames. Finish glazing stops to match window units if fabricated of steel; otherwise, provide manufacturer's standard finish.
7. Glazing Clips: Where face glazing (without glazing stops) is indicated, furnish glazing clips for concealment in glazing compound.

I. Metallic-Coated Steel Sheet Finishes
1. Surface Preparation: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas and apply galvanizing repair paint complying with SSPC-Paint 20 and ASTM A 780.
2. Factory Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.
3. Baked-Enamel or Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil (0.025 mm) for topcoat. Comply with coating

manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils (0.05 mm).

J. Steel Finishes
1. Surface Preparation: Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning" **OR** SSPC-SP 8, "Pickling", **as directed**. After cleaning, apply a conversion coating suited to the organic coating to be applied over it, **as directed**.
2. Galvanized Finish: Hot-dip galvanize per ASTM A 123.
3. Steel and Galvanized-Steel Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.
4. Baked-Enamel or Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils (0.05 mm).
5. High-Performance Organic Finish: Two-coat fluoropolymer finish containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1.3 EXECUTION

A. Examination
1. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Verify rough opening dimensions, levelness of sill plate, accurate locations of connections to building electrical system, **as directed**, and operational clearances. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure a coordinated, weathertight window installation.
   a. Masonry Surfaces: Visibly dry and free of excess mortar, sand, and other construction debris.
   b. Wood Frame Walls: Dry, clean, sound, well nailed, free of voids, and without offsets at joints. Ensure that nail heads are driven flush with surfaces in opening and within 3 inches (76 mm) of opening.
   c. Metal Surfaces: Dry, clean, and free of grease, oil, dirt, rust, corrosion, and welding slag; without sharp edges or offsets at joints.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Installation
1. Comply with manufacturer's written instructions for installing windows, hardware, operators, accessories, and other components.
2. Install windows level, plumb, square, true to line, without distortion or impediment to thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction.
3. Set sill members in bed of sealant or with gaskets, as indicated, to provide weathertight construction.
4. Install windows and components to drain condensation, water-penetrating joints, and moisture migrating within windows to the exterior.
5. Separate corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials according to ASTM E 2112, Section 5.12 "Dissimilar Materials."

C. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Tests and Inspections:

a. Testing Methodology: Testing of windows for air-penetration resistance and water resistance will be performed according to AAMA 502, Test Method A **OR** B, **as directed**, by applying same test pressures required for performance.
b. Testing Extent: Three windows as selected by the Owner and a qualified independent testing and inspecting agency. Windows shall be tested immediately after installation.

3. Window will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports according to AAMA 502. Testing agency will interpret test results and state in each report whether tested work complies with or deviates from requirements.

D. Adjusting, Cleaning, And Protection
1. Adjust operating sashes and ventilators, screens, hardware, operators, **as directed**, and accessories for a tight fit at contact points and weather stripping for smooth operation and weathertight closure. Lubricate hardware and moving parts.
2. Clean factory-finished steel surfaces immediately after installing windows. Comply with manufacturer's written recommendations for final cleaning and maintenance. Avoid damaging protective coatings and finishes.
3. Clean glass immediately after installing windows. Comply with manufacturer's written recommendations for final cleaning and maintenance. Remove nonpermanent labels, and clean surfaces.
4. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.
5. Protect window surfaces from contact with contaminating substances resulting from construction operations. Remove contaminants immediately according to manufacturer's written recommendations.
6. Refinish or replace windows with damaged finish.

E. Demonstration
1. Train Owner's maintenance personnel to adjust, operate, and maintain group window operating system for steel windows.

END OF SECTION 08510

SECTION 08520 - ALUMINUM WINDOWS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for fixed and operable aluminum framed windows for exterior locations. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes fixed and operable aluminum-framed windows.

C. Definitions
1. Performance class designations according to AAMA/WDMA 101/I.S.2/NAFS:
   a. AW: Architectural.
   b. HC: Heavy Commercial.
   c. C: Commercial.
   d. LC: Light Commercial.
   e. R: Residential.
2. Performance grade number according to AAMA/WDMA 101/I.S.2/NAFS:
   a. Design pressure number in pounds force per square foot (pascals) used to determine the structural test pressure and water test pressure.
3. Structural Test Pressure: For uniform load structural test, is equivalent to 150 percent of the design pressure.
4. Minimum Test Size: Smallest size permitted for performance class (gateway test size). Products must be tested at minimum test size or at a size larger than minimum test size to comply with requirements for performance class.

D. Performance Requirements
1. General: Provide aluminum windows capable of complying with performance requirements indicated, based on testing manufacturer's windows that are representative of those specified, and that are of minimum test size indicated below:
   a. Size required by AAMA/WDMA 101/I.S.2/NAFS for gateway performance **OR** optional performance grade **OR** gateway performance for both gateway performance and optional performance grade, **as directed**.
   b. Size indicated on Drawings **OR** in a schedule, **as directed**.
2. Structural Performance: Provide aluminum windows capable of withstanding the effects of the following loads, based on testing units representative of those indicated for Project that pass AAMA/WDMA 101/I.S.2/NAFS, Uniform Load Structural Test:
   a. Design Wind Loads: Determine design wind loads applicable to Project from basic wind speed indicated in miles per hour (meters per second) at 33 feet (10 m) above grade, according to ASCE 7, Section 6.5, "Method 2-Analytical Procedure," based on mean roof heights above grade indicated on Drawings.
      1) Basic Wind Speed: 85 mph (38 m/s) **OR** 90 mph (40 m/s), **as directed**.
      2) Importance Factor.
      3) Exposure Category: A **OR** B **OR** C **OR** D, **as directed**.
   b. Deflection: Design glass framing system to limit lateral deflections of glass edges to less than 1/175 of glass-edge length or 3/4 inch (19 mm), whichever is less, at design pressure based on testing performed according to AAMA/WDMA 101/I.S.2/NAFS, Uniform Load Deflection Test or structural computations.
3. Windborne-Debris Resistance: Provide glazed windows capable of resisting impact from windborne debris, based on the pass/fail criteria as determined from testing glazed windows

identical to those specified, according to ASTM E 1886 and testing information in ASTM E 1996 or AAMA 506 and requirements of authorities having jurisdiction.

4. Thermal Movements: Provide aluminum windows, including anchorage, that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C) material surfaces.

E. Submittals
1. Product Data: For each type of aluminum window indicated.
2. Shop Drawings: Include plans, elevations, sections, details, hardware, attachments to other work, operational clearances, and installation details
3. Samples: For each exposed finish.
4. Product Schedule: Use same designations indicated on Drawings.
5. Field quality-control test reports.
6. Product test reports.
7. Maintenance data.

F. Quality Assurance
1. Installer: A qualified installer, approved by manufacturer to install manufacturer's products.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
3. Fenestration Standard: Comply with AAMA/WDMA 101/I.S.2/NAFS, "North American Fenestration Standard Voluntary Performance Specification for Windows, Skylights and Glass Doors," for definitions and minimum standards of performance, materials, components, accessories, and fabrication. Comply with more stringent requirements if indicated.
   a. Provide AAMA **OR** WDMA, **as directed**,-certified aluminum windows with an attached label.
4. Glazing Publications: Comply with published recommendations of glass manufacturers and with GANA's "Glazing Manual" unless more stringent requirements are indicated.
5. Preinstallation Conference: Conduct conference at Project site.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace aluminum windows that fail in materials or workmanship within specified warranty period.
   a. Failures include, but are not limited to, the following:
      1) Failure to meet performance requirements.
      2) Structural failures including excessive deflection, water leakage, air infiltration, or condensation.
      3) Faulty operation of movable sash and hardware.
      4) Deterioration of metals, other materials, and metal finishes beyond normal weathering.
      5) Failure of insulating glass.
   b. Warranty Period:
      1) Window: Two **OR** Three, **as directed**, years from date of Substantial Completion.
      2) Glazing: Five **OR** 10, **as directed**, years from date of Substantial Completion.
      3) Metal Finish: Five **OR** 10 **OR** 15, **as directed**, years from date of Substantial Completion.

1.2 PRODUCTS

A. Materials

1. Aluminum Extrusions: Alloy and temper recommended by aluminum window manufacturer for strength, corrosion resistance, and application of required finish, but not less than 22,000-psi (150-MPa) ultimate tensile strength, not less than 16,000-psi (110-MPa) minimum yield strength, and not less than 0.062-inch (1.6-mm) thickness at any location for the main frame and sash members.
2. Fasteners: Aluminum, nonmagnetic stainless steel, epoxy adhesive, or other materials warranted by manufacturer to be noncorrosive and compatible with aluminum window members, trim, hardware, anchors, and other components.
    a. Reinforcement: Where fasteners screw anchor into aluminum less than 0.125 inch (3.2 mm) thick, reinforce interior with aluminum or nonmagnetic stainless steel to receive screw threads, or provide standard, noncorrosive, pressed-in, splined grommet nuts.
    b. Exposed Fasteners: Unless unavoidable for applying hardware, do not use exposed fasteners. For application of hardware, use fasteners that match finish of member or hardware being fastened, as appropriate.
3. Anchors, Clips, and Accessories: Aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.
4. Reinforcing Members: Aluminum, nonmagnetic stainless steel, or nickel/chrome-plated steel complying with ASTM B 456 for Type SC 3 severe service conditions, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.
5. Compression-Type Weather Stripping: Provide compressible weather stripping designed for permanently resilient sealing under bumper or wiper action and for complete concealment when aluminum window is closed.
    a. Weather-Stripping Material: Elastomeric cellular preformed gaskets complying with ASTM C 509.
    b. Weather-Stripping Material: Dense elastomeric gaskets complying with ASTM C 864.
    c. Weather-Stripping Material: Manufacturer's standard system and materials complying with AAMA/WDMA 101/I.S.2/NAFS.
6. Sliding-Type Weather Stripping: Provide woven-pile weather stripping of wool, polypropylene, or nylon pile and resin-impregnated backing fabric. Comply with AAMA 701/702.
    a. Weather Seals: Provide weather stripping with integral barrier fin or fins of semirigid, polypropylene sheet or polypropylene-coated material. Comply with AAMA 701/702.
7. Replaceable Weather Seals: Comply with AAMA 701/702.
8. Sealant: For sealants required within fabricated windows, provide window manufacturer's standard, permanently elastic, nonshrinking, and nonmigrating type recommended by sealant manufacturer for joint size and movement.

B. Window

1. Window Type: Casement **OR** Double hung **OR** Dual action **OR** Fixed **OR** Horizontal sliding **OR** Projected **OR** Projected awning **OR** Single hung **OR** Top-hinged inswinging **OR** Vertically pivoted **OR** As indicated on Drawings **OR** As indicated in a schedule, **as directed**.
2. AAMA/WDMA Performance Requirements: Provide aluminum windows of performance indicated that comply with AAMA/WDMA 101/I.S.2/NAFS unless more stringent performance requirements are indicated.
    a. Performance Class and Grade: R15 **OR** R20 **OR** R25**, as directed**.
    b. Performance Class and Grade: LC25 **OR** LC30 **OR** LC35, **as directed**.
    c. Performance Class and Grade: C30 **OR** C35 **OR** C40, **as directed**.
    d. Performance Class and Grade: HC40 **OR** HC45 **OR** HC50, **as directed**.
    e. Performance Class and Grade: AW40 **OR** AW45 **OR** AW50, **as directed**.
    f. Performance Class and Grade: As indicated.

g. Performance Class (if test performance method is selected for specifying windows and designating a performance class does not conflict with basic wind speed and performance testing indicated): R **OR** LC **OR** C **OR** HC **OR** AW, **as directed**.

3. Condensation-Resistance Factor (CRF): Provide aluminum windows tested for thermal performance according to AAMA 1503, showing a CRF of 45 **OR** 52, **as directed**.
4. Thermal Transmittance: Provide aluminum windows with a whole-window, U-factor maximum indicated at 15-mph (24-km/h) exterior wind velocity and winter condition temperatures when tested according to AAMA 1503 **OR** ASTM E 1423 **OR** NFRC 100, **as directed**.
   a. U-Factor: 0.35 Btu/sq. ft. x h x deg F (2.0 W/sq. m x K) **OR** 0.40 Btu/sq. ft. x h x deg F (2.3 W/sq. m x K) **OR** 0.43 Btu/sq. ft. x h x deg F (2.5 W/sq. m x K) **OR** 0.60 Btu/sq. ft. x h x deg F (3.4 W/sq. m x K), **as directed**, or less.
5. Solar Heat-Gain Coefficient (SHGC): Provide aluminum windows with a whole-window SHGC maximum of 0.40 **OR** 0.50 **OR** 0.55, **as directed**, determined according to NFRC 200 procedures.
6. Sound Transmission Class (STC): Provide glazed windows rated for not less than 26 **OR** 30 **OR** 35, **as directed**, STC when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 413.
7. If test performance method is selected for specifying windows
   a. Air Infiltration: Maximum rate not more than indicated when tested according to AAMA/WDMA 101/I.S.2/NAFS, Air Infiltration Test.
      1) Maximum Rate: 0.3 cfm/sq. ft. (5 cu. m/h x sq. m) of area at an inward test pressure of 1.57 lbf/sq. ft. (75 Pa).
      2) Maximum Rate: 0.3 cfm/sq. ft. (5 cu. m/h x sq. m) of area at an inward test pressure of 6.24 lbf/sq. ft. (300 Pa).
      3) Maximum Rate: 0.1 cfm/sq. ft. (2 cu. m/h x sq. m) of area at an inward test pressure of 6.24 lbf/sq. ft. (300 Pa).
   b. Water Resistance: No water leakage as defined in AAMA/WDMA referenced test methods at a water test pressure equaling that indicated, when tested according to AAMA/WDMA 101/I.S.2/NAFS, Water Resistance Test.
      1) Test Pressure: 15 percent of positive design pressure, but not less than 2.86 lbf/sq. ft. (140 Pa) or more than 15 lbf/sq. ft. (720 Pa).
      2) Test Pressure: 20 percent of positive design pressure, but not more than 15 lbf/sq. ft. (720 Pa).
8. Forced-Entry Resistance: Comply with Performance Grade 10 **OR** 20 **OR** 30 **OR** 40, **as directed**, requirements when tested according to ASTM F 588.
9. Life-Cycle Testing: Test according to AAMA 910 and comply with AAMA/WDMA 101/I.S.2/NAFS.
10. Operating Force and Auxiliary (Durability) Tests: Comply with AAMA/WDMA 101/I.S.2/NAFS for operating window types indicated.

C. Glazing
1. Glass: Clear, insulating-glass units **OR** Clear, insulating-glass units, with low-E coating pyrolytic on second surface or sputtered on second or third surface, **OR** Clear, insulating-glass units, argon gas filled, with low-E coating pyrolytic on second surface or sputtered on second or third surface, **as directed**, complying with Division 08 Section "Glazing".
2. Glazing System: Manufacturer's standard factory-glazing system that produces weathertight seal. **OR** Manufacturer's standard factory-glazing system that produces weathertight seal and complies with requirements for windborne-debris resistance **OR** Manufacturer's standard factory-glazing system as indicated in Division 08 Section "Glazing", **as directed**.
3. Dual-Action Windows: Provide pivoting unit for double glazing, constructed of one sheet of glass in a removable sash for access to interior of unit, installed with airtight gaskets.

D. Hardware
1. General: Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with aluminum; designed to smoothly operate, tightly close, and securely lock aluminum windows, and

sized to accommodate sash or ventilator weight and dimensions. Do not use aluminum in frictional contact with other metals. Where exposed, provide solid bronze **OR** extruded, cast, or wrought aluminum **OR** die-cast zinc with special coating finish **OR** nonmagnetic stainless steel, **as directed**.

2. Counterbalancing Mechanism: Comply with AAMA 902.
   a. Sash Balance: Concealed, tape-spring type **OR** spiral-tube type **OR** spring-loaded, block-and-tackle type **OR** ultralift spring type capable of lifting 70 percent of sash weight, **as directed**, of size and capacity to hold sash stationary at any open position.
3. Sill Cap/Track: Extruded-aluminum track with natural anodized finish **OR** Rigid PVC or other weather-resistant plastic track with manufacturer's standard integral color, **as directed**, of thickness, dimensions, and profile indicated; designed to comply with performance requirements indicated and to drain to the exterior.
4. Locks and Latches: Designed to allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only.
5. Roller Assemblies: Low-friction design.
6. Push-Bar Operators: Provide telescoping-type, push-bar operator designed to open and close ventilators with fixed screens.
7. Gear-Type Rotary Operators: Comply with AAMA 901 when tested according to ASTM E 405, Method A.
   a. Operation Function: All ventilators move simultaneously and securely close at both jambs without using additional manually controlled locking devices.
8. Four- or Six-Bar Friction Hinges: Comply with AAMA 904.
   a. Locking mechanism and handles for manual operation.
   b. Friction Shoes: Provide friction shoes of nylon or other nonabrasive, nonstaining, noncorrosive, durable material.
9. Limit Devices: Provide limit devices designed to restrict sash or ventilator opening.
   a. Safety Devices: Limit clear opening to 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, for ventilation; with custodial key release.
10. Pole Operators: Tubular-shaped anodized aluminum; with rubber-capped lower end and standard push-pull hook at top to match hardware design; of sufficient length to operate window without reaching more than 60 inches (1500 mm) above floor; 1 pole operator and pole hanger per room that has operable windows more than 72 inches (1800 mm) above floor.
11. Casement Windows: Provide the following operating hardware:
    a. Operator: Gear-type rotary single-arm operator located on jamb at sill **OR** Gear-type rotary dual-arm operator located on jamb at sill, **as directed**.
       1) Rating: Provide rotary operator rated C-R15 **OR** C-C20 **OR** C-HC40, **as directed**, according to AAMA 901.
       2) Handle: Standard crank **OR** Folding crank **OR** Removable crank **OR** Knob **OR** T-handle, **as directed**.
    b. Hinge: Extension hinge or pivot, nonfriction type.
    c. Hinge: Heavy-duty, three **OR** five, **as directed**,-knuckle butt hinge with nylon bushings.
    d. Hinge: Standard **OR** Heavy, **as directed**,-duty, concealed, four- or six-bar friction hinge with adjustable-slide friction shoe; designed to permit ventilator operation for inside cleaning of outside glass face; two per ventilator.
    e. Hinge: Standard **OR** Heavy, **as directed**,-duty, concealed, four- or six-bar friction egress hinge with adjustable-slide friction shoe; designed to achieve 90-degree ventilator opening and to permit ventilator operation for inside cleaning of outside glass face; two per ventilator.
    f. Lock: Lift-type throw, cam-action lock with keeper; one **OR** two, **as directed**, per ventilator.
    g. Lock: Combination lever handle and cam-action lock with keeper; one **OR** two, **as directed**, per ventilator.
    h. Lock: Combination dual lever handles, tie rod, and cam-action lock with keepers.
    i. Lock: Key-operated custodial lock and keeper with removable handle; one **OR** two, **as directed**, per ventilator.

j. Lock: Concealed multipoint lock operated by single lever handle or lift-type throw; three per ventilator.
k. Limit Device: Concealed friction adjustor, adjustable stay bar **OR** support arms with adjustable, limited, hold-open, **as directed**, limit device.

12. Double **OR** Single, **as directed**,-Hung Windows: Provide the following operating hardware:
a. Sash Balances: Two per sash.
b. Handles: Applied sash lift bar **OR** pull-downs, **as directed**, on bottom rail of forward-placed operating sash; two per sash.
c. Handle: Continuous, integral, sash lift bar **OR** pull-down, **as directed**, on bottom rail of forward-placed operating sash.
d. Sash Lock: Cam-action sweep lock and keeper on meeting rail; one **OR** two, **as directed**, per sash.
e. Sash Lock: Spring-loaded, snap-type lock on bottom rail of lower sash; two per sash.
f. Sash Lock: Spring-loaded plunger lock with keeper on meeting rail of lower sash; two per sash.
g. Sash Lock: Pole-operated, cam-action lock on meeting rail of windows with meeting rail more than 72 inches (1800 mm) above floor; with keeper.
h. Pole Socket: Provide a pole socket or groove on inside face of top rail of upper **OR** lower, **as directed**, sash on windows with meeting rails more than 72 inches (1800 mm) above floor.
i. Limit Device: Sash stop **OR** Keyed sash, **as directed**, limit device; for top **OR** bottom **OR** each operable, **as directed**, sash located at jamb; one **OR** two, **as directed**, per sash.
j. Removable Lift-Out Sash: Design windows and provide with tamperproof, key-operated, **as directed**, hardware to permit removal of sash from inside for cleaning.
k. Tilt Lock: Design windows and provide with tamperproof, key-operated, **as directed**, tilt latch and pivot bar hardware to permit tilting of sash inward for cleaning both sides of sash from interior.

13. Dual-Action Windows: Provide the following operating hardware:
a. Operator: Two-position, combination lever handle and cam-type latch.
b. Operator: Concealed, internal, multipoint locking bar and combination locking handle mechanism.
c. Hinge: Combination three-knuckle **OR** five-knuckle butt, **as directed**, hinge and stay bar.
d. Lock: Key-operated, concealed **OR** exposed, **as directed**, custodial lock.
e. Stabilizing Arm: Aluminum.

14. Horizontal-Sliding Windows: Provide the following operating hardware:
a. Sash Rollers: Nylon rollers **OR** Steel, lubricated ball-bearing rollers with nylon tires **OR** Stainless-steel, lubricated ball-bearing rollers with nylon tires, **as directed**.
b. Sash Lock: Cam-action sweep sash lock and keeper at meeting rails.
c. Sash Lock: Spring-loaded, snap-type lock at jambs; two per sash.
d. Sash Lock: Spring-loaded plunger lock with keeper on meeting rail; two per sash.
e. Limit Device: Sash stop limit device; mounted in bottom of pull stile.
f. Removable Lift-Out Sash: Design windows and provide with tamperproof, key-operated, **as directed**, hardware to permit removal of sash from inside for cleaning.

15. Projected Windows: Provide the following operating hardware:
a. Operator: Underscreen push-bar **OR** Underscreen pivot-shoe-type, gear-type rotary operator, **as directed**.
b. Hinge: Five-knuckle butt hinge.
c. Hinge: Concealed four- or six-bar friction hinge with adjustable-slide friction shoe; two per ventilator.
d. Lock: Cam-action, sweep lock handle with strike; one **OR** two, **as directed**, per ventilator.
e. Lock: Combination lever handle and cam-action lock with concealed pawl and keeper.
f. Lock: Key-operated security lock and keeper.
g. Lock: Key-operated custodial lock and keeper with removable handle.
h. Lock: Pole-operated, spring-catch lock and keeper **OR** cam-action, sweep lock handle and strike, **as directed**.

i. Limit Device: Concealed friction adjustor, adjustable stay bar **OR** support arms with adjustable, limited, hold-open, **as directed**, limit device; located on jamb of each ventilator.

16. Projected Awning Windows: Provide the following operating hardware:
    a. Operator: Push-bar **OR** Lever **OR** Gear-type rotary, **as directed**, operator located on jamb at sill.
        1) Handle: Standard crank **OR** Folding crank **OR** Removable crank **OR** Knob **OR** T-handle, **as directed**.
    b. Window-Operating System: Wall-mounted, group or gang-type window operating system with chain-wheel **OR** rotary crank-type **OR** electric, **as directed**, operator.
    c. Hinge: Concealed four- or six-bar friction hinge located on each jamb near top rail; two per ventilator.
    d. Lock: Lift-type throw, cam-action lock with keeper; one **OR** two, **as directed**, per ventilator.
    e. Lock: Combination lever handle and cam-action lock with concealed pawl and keeper; one **OR** two, **as directed**, per ventilator.
    f. Lock: Pole-operated, combination handle and cam-action lock **OR** face-mounted transom latch, **as directed**, and keeper.
    g. Lock: Key-operated custodial lock with removable handle.
    h. Limit Device: Concealed friction adjustor, adjustable stay bar **OR** support arms with adjustable, limited, hold-open, **as directed**, limit device; located on jamb of each ventilator.
17. Top-Hinged Inswinging Windows: Provide the following operating hardware:
    a. Hinge: Exposed, applied butt hinge located at corners; two **OR** three, **as directed**, per ventilator.
    b. Hinge: Exposed, applied continuous hinge.
    c. Hinge: Concealed, applied pivot hinge located at corners; two **OR** three, **as directed**, per ventilator.
    d. Hinge: Continuous, integrally extruded hinge.
    e. Hinge: Four- or six-bar friction hinge with adjustable-slide friction shoe; two per ventilator.
    f. Lock: Internal, key-operated, limited-access locks located not more than 48 inches (1220 mm) o.c. at jambs and sill.
    g. Hold-Open Device: Automatic-locking hold-open arms **OR** stay bars, **as directed**,; designed to permit sash operation for inside cleaning of outside glass face; two per ventilator.
18. Vertically Pivoted Windows: Provide the following operating hardware:
    a. Pivot Assembly: Aluminum-alloy **OR** Manganese-bronze **OR** Stainless-steel, **as directed**, pivot assembly designed for center **OR** off-center, **as directed**, axis pivoting.
    b. Lock: Internal, key-operated, limited-access lock; one **OR** two, **as directed**, per jamb.
    c. Limit device.

E. Group Or Gang-Type Window Operating Systems
1. Provide window operating system of the type and in groups as indicated. Coordinate operating system design with window fabrication and hardware selection to ensure smooth, durable operation of ventilators.
2. Operation Function: All ventilators move simultaneously and securely close at sash frames without using additional manually controlled locking devices.
3. Rack-and-Pinion **OR** Screw, **as directed**,-Type Operating System: Complete with shafts, brackets, levers, rods, oil-encased gear boxes, and standard fittings and accessories for operation indicated.
4. Horizontal-Movement Operating System: Tension type; complete with mounting brackets, oil-encased gear boxes, steel rod or cable operating in conduit between sash operator units, and standard fittings and accessories for operation indicated.
5. Operation: Manual, with chain-wheel operator on each gear box shaft; with chain loops terminated 24 inches (600 mm) above floor.
6. Operation: Manual, with crank-type operator on each gear box shaft, with removable crank. Where necessary, extend crankshaft with universal joints and support brackets to a suitable

crank-mounting location not more than 44 inches (1115 mm) above floor, with an oil-encased miter gear box.

7. Operation: Electric, with factory-assembled electric operator designed for operating windows of type, size, weight, construction, use, and operating frequency indicated.
   a. Electric Operator: Provide operating system complying with NFPA 70; of size and capacity and with features, characteristics, and accessories suitable for Project conditions, recommended in writing by window manufacturer; complete with operating system indicated, electric motor and factory-prewired motor controls with limit switches,remote-remote-control stations, power disconnect switches, enclosures protecting controls and all operating parts, and accessories required for reliable operation. Include wiring from motor controls to motor. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
      1) Control Equipment: Comply with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6.
      2) Electric Motor: Comply with NEMA MG 1; with thermal-overload protection; sized to start and operate size and weight of window sash ventilators under any conditions; one per each gear box shaft.
         a) Motor Characteristics: Single phase, sized by electric operator manufacturer, 60 Hz.
      3) Remote Controls: Electric controls with NEMA ICS 6, Type 1 enclosure and momentary-contact, single push-button-operated control **OR** three-position, push-button-operated control with open, close, and stop functions, **as directed**.
      4) Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop sash ventilators at fully opened and fully closed positions.

F. Insect Screens
   1. General: Design windows and hardware to accommodate screens in a tight-fitting, removable arrangement, with a minimum of exposed fasteners and latches. Fabricate insect screens to fully integrate with window frame. Locate screens on inside **OR** outside, **as directed**, of window and provide for each operable exterior sash or ventilator.
      a. Aluminum Tubular Frame Screens: Comply with SMA 1004, "Specifications for Aluminum Tubular Frame Screens for Windows," Residential R-20 **OR** Architectural C-24 **OR** Monumental M-32, **as directed**, class.
      b. Comply with SMA 1004, "Specifications for Aluminum Tubular Frame Screens for Windows," for minimum standards of appearance, fabrication, attachment of screen fabric, hardware, and accessories unless more stringent requirements are indicated.
   2. Stainless-Steel Insect Screen Frames: Fabricate frames of nonmagnetic stainless-steel members of 0.020-inch (0.5-mm) minimum wall thickness, with mitered or coped joints or corner extrusions, concealed fasteners, adjustable rollers, and removable PVC spline/anchor concealing edge of frame. Finish frames with No. 2B, bright mill finish.
   3. Aluminum Insect Screen Frames: Manufacturer's standard aluminum alloy complying with SMA 1004. Fabricate frames with mitered or coped joints or corner extrusions, concealed fasteners, adjustable rollers, **as directed**, and removable PVC spline/anchor concealing edge of frame.
      a. Aluminum Tubular Framing Sections and Cross Braces: Roll formed from aluminum sheet with minimum wall thickness as required for class indicated.
      b. Extruded-Aluminum or Aluminum Tubular Framing Sections and Cross Braces: Not less than 0.040-inch (1.0-mm) **OR** 0.050-inch (1.3-mm), **as directed**, wall thickness.
      c. Finish: Match aluminum window members.
      d. Finish: Anodized aluminum **OR** Baked-on organic coating, **as directed**, in manufacturer's standard color.
      e. Finish: Anodized aluminum **OR** Baked-on organic coating, **as directed**, in color selected from manufacturer's full range.
      f. Finish: Manufacturer's standard.
   4. Glass-Fiber Mesh Fabric: 18-by-14 (1.1-by-1.4-mm) or 18-by-16 (1.0-by-1.1-mm) **OR** 20-by-20 (0.85-by-0.85-mm) or 20-by-30 (0.85-by-0.42-mm), **as directed**, mesh of PVC-coated, glass-fiber

threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration; in the following color. Comply with ASTM D 3656.
a. Mesh Color: Charcoal gray **OR** Silver gray **OR** Aquamarine, **as directed**.

5. Aluminum Wire Fabric: 18-by-16 (1.1-by-1.3-mm) mesh of 0.011-inch- (0.28-mm-) diameter, coated aluminum wire.
   a. Wire-Fabric Finish: Natural bright **OR** Charcoal gray **OR** Black, **as directed**.
6. Copper Wire Fabric: 16-by-16 (1.3-by-1.3-mm) mesh of 0.011-inch- (0.28-mm-) diameter copper wire.
7. Bronze Wire Fabric: 18-by-14 (1.2-by-1.6-mm) mesh of 0.009-inch- (0.23-mm-) **OR** 18-by-14 (1.13-by-1.5-mm) mesh of 0.011-inch- (0.28-mm-), **as directed**, diameter bronze wire with a clear varnish finish.
8. Stainless-Steel Wire Fabric: 18-by-14 (1.2-by-1.6-mm) mesh of 0.009-inch- (0.23-mm-) **OR** 18-by-16 (1.2-by-1.4-mm) mesh of 0.009-inch- (0.23-mm-) **OR** 18-by-16 (1.13-by-1.3-mm) mesh of 0.011-inch- (0.28-mm-), **as directed**, diameter, nonmagnetic stainless-steel wire, Type 304 or 316, complying with FS RR-W-365, Type VI.
9. Solar-Screening Mesh Fabric: 17-by-15 (0.86-by-1.1-mm) **OR** 40-by-40 (0.3-by-0.3-mm), **as directed**, mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration. Comply with ASTM D 3656.
10. Wickets: Provide sliding **OR** hinged, **as directed**, wickets, framed and trimmed for a tight fit and for durability during handling.

G. Accessories
1. Integral Ventilating System/Device: Where indicated, provide weather-stripped, adjustable, horizontal fresh-air vent, with a free airflow slot, full width of window sash by approximately 1 inch (25 mm) **OR** 3 inches (75 mm), **as directed**, when open, complying with AAMA/WDMA 101/I.S.2/NAFS. Equip vent bar with an integral insect screen, removable for cleaning.
2. Window Cleaner Anchor Bolts: Provide window cleaner anchor bolts of standard design, complying with requirements of authorities having jurisdiction. Fabricate bolts of nonmagnetic stainless steel.
   a. Reinforce window units or mullions to receive bolts and provide additional anchorage of units at bolt locations.
3. Integral Louver Blinds: Provide remotely operated horizontal louver blinds in the space between two panes of glass. Construct blinds of aluminum slats, approximately 1 inch (25 mm) wide, with polyester fiber cords, equipped for tilting, raising, and lowering by standard operating hardware located on inside face of sash.
4. Exterior Louver Units: Manually adjustable, extruded-aluminum, solar-shade louver units; of type recommended by manufacturer for application over operable or fixed windows. Provide main extrusion members of 0.062-inch (1.6-mm) minimum wall thickness.
   a. Operator: Crank-type gang operator, operable from inside building, designed to rotate louver blades simultaneously at least 80 degrees and to lock units in closed position; one operator per each louver unit. Form unit framing or mounting without interfering with insect screens.

H. Fabrication
1. Fabricate aluminum windows in sizes indicated. Include a complete system for assembling components and anchoring windows.
2. Fabricate aluminum windows that are reglazable without dismantling sash or ventilator framing.
3. Thermally Improved Construction: Fabricate aluminum windows with an integral, concealed, low-conductance thermal barrier; located between exterior materials and window members exposed on interior side; in a manner that eliminates direct metal-to-metal contact.
   a. Provide thermal-break construction that has been in use for not less than three years and has been tested to demonstrate resistance to thermal conductance and condensation and to show adequate strength and security of glass retention.

b. Provide thermal barriers tested according to AAMA 505; determine the allowable design shear flow per the appendix in AAMA 505.
c. Provide hardware with low conductivity or nonmetallic material for hardware bridging thermal breaks at frame or vent sash.

4. Weather Stripping: Provide full-perimeter weather stripping for each operable sash and ventilator.
   a. Horizontal-Sliding Windows: Provide operable sash with a double row of sliding weather stripping in horizontal rails and single- or double-row weather stripping in meeting or jamb stiles, as required to meet specified performance requirements. Provide compression-type weather stripping at perimeter of each movable panel where sliding-type weather stripping is not appropriate.
   b. Vertically Pivoted Windows: Provide double-row weather stripping.
5. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.
6. Provide water-shed members above side-hinged ventilators and similar lines of natural water penetration.
7. Mullions: Provide mullions and cover plates as shown, matching window units, complete with anchors for support to structure and installation of window units. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections, as indicated. Provide mullions and cover plates capable of withstanding design loads of window units.
8. Subframes: Provide subframes with anchors for window units as shown, of profile and dimensions indicated but not less than 0.062-inch- (1.6-mm-) thick extruded aluminum. Miter or cope corners, and weld and dress smooth with concealed mechanical joint fasteners. Finish to match window units. Provide subframes capable of withstanding design loads of window units.
9. Factory-Glazed Fabrication: Glaze aluminum windows in the factory where practical and possible for applications indicated. Comply with requirements in Division 08 Section "Glazing" and with AAMA/WDMA 101/I.S.2/NAFS.
10. Glazing Stops: Provide snap-on glazing stops coordinated with Division 08 Section "Glazing" and glazing system indicated. Provide glazing stops to match sash and ventilator frames.

I. Finishes, General
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
3. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

J. Aluminum Finishes
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.
3. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
4. Class II, Color Anodic Finish: AA-M12C22A32/A34 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, integrally colored or electrolytically deposited color coating 0.010 mm or thicker) complying with AAMA 611.

5. Class I, Color Anodic Finish: AA-M12C22A42/A44 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
   a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** Match sample **OR** As selected from full range of industry colors and color densities, **as directed**.
6. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Apply baked enamel complying with paint manufacturer's written instructions for cleaning, conversion coating, and painting.
   a. Organic Coating: Thermosetting, modified-acrylic or polyester enamel primer/topcoat system complying with AAMA 2603, except with a minimum dry film thickness of 1.5 mils (0.04 mm), medium gloss.
   b. Color: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
7. High-Performance Organic Finish (2-Coat Fluoropolymer): AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coating; Organic Coating: manufacturer's standard 2-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 50 **OR** 70, **as directed**, percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2604 **OR** AAMA 2605, **as directed**, and with coating and resin manufacturers' written instructions.
8. High-Performance Organic Finish (3-Coat Fluoropolymer): AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coatings; Organic Coating: manufacturer's standard 3-coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2605 and with coating and resin manufacturers' written instructions.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.

1.3 EXECUTION

A. Installation
1. Comply with Drawings, Shop Drawings, and manufacturer's written instructions for installing windows, hardware, accessories, and other components.
2. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction.
3. Set sill members in bed of sealant or with gaskets, as indicated, for weathertight construction.
4. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.
5. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.
6. Connect automatic operators to building electrical system.

B. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
   a. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.
2. Testing Services: Testing and inspecting of installed windows shall take place as follows:
   a. Testing Methodology: Testing of windows for air infiltration and water resistance shall be performed according to AAMA 502, Test Method A **OR** B, **as directed**, by applying same

test pressures required to determine compliance with AAMA/WDMA 101/I.S.2/NAFS in Part 1 "Performance Requirements" Article.

b. Testing Extent: Three windows as selected by the Owner and a qualified independent testing and inspecting agency. Windows shall be tested immediately after installation.

c. Test Reports: Shall be prepared according to AAMA 502.

3. Remove and replace noncomplying aluminum window and retest as specified above.
4. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

C. Adjusting, Cleaning, And Protection

1. Adjust operating sashes and ventilators, screens, hardware, operators, **as directed**, and accessories for a tight fit at contact points and weather stripping for smooth operation and weathertight closure. Lubricate hardware and moving parts.
2. Clean aluminum surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.
3. Clean factory-glazed glass immediately after installing windows. Comply with manufacturer's written recommendations for final cleaning and maintenance. Remove nonpermanent labels, and clean surfaces.
4. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.
5. Protect window surfaces from contact with contaminating substances resulting from construction operations. In addition, monitor window surfaces adjacent to and below exterior concrete and masonry surfaces during construction for presence of dirt, scum, alkaline deposits, stains, or other contaminants. If contaminating substances do contact window surfaces, remove contaminants immediately according to manufacturer's written recommendations.

END OF SECTION 08520

SECTION 08520a - ALUMINUM REPLACEMENT WINDOWS

DESCRIPTION OF WORK

This specification covers the furnishing and installation of materials for aluminum replacement windows. Products shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

GENERAL

Definitions

1. Window Types: ANSI/AAMA 101.
   a. Horizontal Slider (HS): Primary horizontally operating window.
   b. Single Hung (SH): Primary vertically operating window with only one operable sash.
   c. Double Hung (DH): Primary vertically operating window with two operable sashes.
   d. Thermally Improved: Primary window with thermal break between interior and exterior metal surfaces both at frame and sash or panel members.
      1) Single Window Construction: Provide insulating glass.
      2) Thermally improved aluminum windows may use members with thermal breaks or be of dual window construction (i.e.. primary-secondary (storm) or primary-primary).
   e. Dual Window Construction (DW):
      1) Primary-Secondary: Primary window with either interior or exterior secondary (storm) window.
      2) Primary-Primary: Combination of two primary windows employing common frame.
2. Type of Stainless Steel Screens (Frames and Screening): Medium, and Heavy Types: As defined by and comply with requirements of ANSI/SMA 6001.
3. Supply and Delivery Only: Include supply and delivery to site(s) FOB destination freight prepaid. Unless otherwise specified or scheduled, unloading and handling at site is by Owner.

System Description

4. Performance Requirements: Comply with following:
   a. Aluminum Replacement Windows: HUD UM 39a.
   b. Aluminum Replacement Windows: ANSI/AAMA 101 (Including test size requirements):
      1) Horizontal Sliding Windows: HS C35.
         a) Water Resistance: ASTM E 547, no leakage at 251.4 Pa (5.25 PSF) test pressure.
      2) Single Hung and Double Hung Windows: DH C35.
         a) Water Resistance: ASTM E 547, no leakage at 251.4 Pa (5.25 PSF) test pressure.
      3) Single Hung and Double Hung Windows: DH C45.
         a) Water Resistance: ASTM E 547, no leakage at 323.4 Pa (6.75 PSF) test pressure.
      4) Air Infiltration: ASTM E 283, Not exceed 0.049 cu m/s/mm (0.34 CFM/ft) of crack length of operable sash at 75 Pa (1.57 PSF) test pressure.
      5) Dual Window Construction: DW.
   c. Aluminum Replacement Windows: ASTM F 588, Annex AI, forced entry resistance performance level 10.
   d. Thermally Improved Windows: AAMA 1504:
      1) Thermal Transmittance (U-Value): Maximum U70, 3.97 W/sq. m C (0.70 BTU/HR.FT.F) if not otherwise scheduled.
      2) Condensation Resistance Factor (CRF): Minimum CRF C50 if not otherwise scheduled.

e. Sealed Insulating Glass: Tested and certified in accordance with HUD UM 82 complying with ASTM E 774, Class C.

Submittals

5. Product Data:
6. Shop Drawings:
   a. Include window elevations, installation details, anchorage details, clearance between frame and rough opening, hardware, glazing, and accessories.
7. Samples: Submit full set of finish color samples for color selection.
   a. For Supply and Deliver Only Contract: Submit one full size sample of each type of aluminum replacement window with specified finish for acceptance. Include sample of trickle ventilator.
8. Quality Assurance/Control Submittals:
   a. Certificates: Manufacturer's written third party certification that aluminum windows meet or exceed HUD UM 39a. HUD 82, and ANSI/AAMA 101 and other specified requirements.
   b. Manufacturer's installation instructions.
9. Closeout Submittals
   a. Operation and maintenance data.
   b. Special warranty.

Quality Assurance

10. Regulatory Requirements:
    a. Glazing Materials: Comply with CPSC 16 CFR 1201 or ANSI Z97.1.
    b. Egress Requirements: Comply with applicable codes and regulations.
    c. Provide emergency egress, single point locking release, and bit key lock fire entry from exterior as and where required by applicable codes and regulations.
    d. Accessibility:
       1) Architectural Barriers Act of 1968 as amended (42 USC 4152-4157) and HUD implementing regulations (24 CFR Part 40).
          a) Uniform Federal Accessibility Standards (UFAS).
       2) Section 504 of the Rehabilitation Act of 1973 as amended (29 USC 794) and HUD implementing regulations 24 CFR Part 8.
       3) Fair Housing Accessibility Guidelines (24 CFR Chapter 1).
       4) Americans with Disabilities Act of 1990 (ADA) (28 CFR Part 35).
11. Certifications: Comply with HUD UM 39a, HUD UM 82, ANSI Z34.1 and HUD 24 CFR 200.935.
12. Mock-ups: For Supply and Install Contract: Install one full size mock-up of each type of aluminum replacement window with specified finish for acceptance.
    a. Location
    b. Approved Mock-up: Standard for rest of work.
    c. Approved Mock-up: May remain part of completed project.

Delivery, Storage, And Handling

13. Packing. Shipping, Handling, and Unloading: Pack materials at manufacturing plant to prevent damage during shipping.
    a. Aluminum Replacement Windows: Label in accordance with HUD UM 39a attached signifying compliance with ANSI/AAMA 101 performance requirements.
    b. Thermally Improved Windows: Label in accordance with HUD UM 39a attached signifying compliance with specified AAMA 1504 performance requirements.
14. Acceptance at Site: Inspect aluminum replacement windows upon delivery. Replace damaged or defective materials before installation.
15. Storage and Protection: Store aluminum replacement windows in manner to protect from weather and other damage.

Project Conditions

16. Field Measurements: Field measure openings for aluminum replacement windows before start of fabrication.

Scheduling And Sequencing

17. Scheduling and Completion: Comply with requirements of Detailed Scope of Work.

Warranty

18. Special Warranty: Provide one year written covering materials and installation for aluminum replacement windows.
    a. Warranty: Include coverage of inserts, hardware, and latches.
        1) Screening and glazing not included.
        2) Defects resulting from vandalism not included.
    b. For Supply and Delivery Only Contract:
        1) Contractor: Agrees to supply and deliver to Owner, free of charge, any required replacement parts that can be readily installed by Owner without special tools.
        2) Contractor: Agrees to supply and deliver free of charge, complete replacement window, when defective part or parts cannot be installed without use of special tools.
    c. For Supply and Install Contract:
        1) Contractor: Agrees to supply and install, free of charge, any required replacement parts or complete replacement window.

PRODUCTS

Aluminum Replacement Windows

19. General: Type(s) and size(s) indicated, specified, or scheduled with necessary hardware, anchors and equipment.

Materials

20. Aluminum Materials:
    a. Extruded Aluminum: ASTM B 221, Alloy 6063-T5 or stronger.
    b. Aluminum Alloys: Commercial quality and of proper alloy for window construction, free from defects impairing strength and/or durability.
        1) Wrought Aluminum Alloys: Alloying Elements: ANSI/AAMA 101.
    c. Window Members, Including Muntins: Aluminum except as allowed by ANSI/AAMA 101.
        1) Sill Members: Minimum 2.0 mm (0.078 inch) thick.
    d. Interlocks and mating fins may vary by tapering at maximum projected distance of 8 mm (5/16 inch) from edge.
        1) Other appendages may taper providing design results in net area of at least that calculated by using prescribed wall thickness for appendage length.
    e. Edge or Corner: May be eased with radius not to exceed wall thickness permitted for member.
    f. Glazing Legs, Channels or Glazing Bead Retainers, Serrated or Not: Minimum 1.3 mm (0.050 inch) thick for distance of not more than 13 mm (1/2 inch) each leg.
21. Other Metal Materials:
    a. Carbon Steel (reinforcing members): ASTM A 36, zinc coated in accordance with ASTM B 633 or cadmium coated in accordance with ASTM B 766.
    b. Stainless Steel: ASTM A 167, Type 302.
    c. Welding Filler Rods: AWS A5.3.
22. Glazing Materials: Comply with CPSC 16 CFR 1201 or ANSI Z97.1.
    a. Glass: ASTM C 1036, Type 1, Class 1, Glazing B Quality.
    b. Tempered Glass: ASTM C 1048, Kind FT, Condition A, Type 1, Class 1, Glazing B Quality.
    c. Plastic: Extruded polycarbonate clear sheets, minimum 4.5 mm (0.177 inch) thick with following characteristics:
        1) Impact Resistance: ASTM D 256, Method A, 12-18 foot-pound per inch.
        2) Elongation/Modulus of Elasticity: ASTM D 638, 110 percent maximum/340,000 PSI.
        3) Heat Deflection: ASTM D 648, 132.2 degrees C (270 degrees F) at 264 PSI.
        4) Abrasion Resistance: Coated on both surfaces to produce abrasion resistance of 3-19 percent maximum haze increase for 500 revolutions of CS-1 OF wheel per ASTM D 1044.

d. Insulating Glass Units: HUD UM 82 and ASTM E 774, Class CBA.
e. Glass Thickness: Determined in accordance with ANSI/AAMA 101 Appendix, minimum 3 mm (1/8 inch) (DS).
   1) Design Wind Pressures: Determined in accordance with applicable codes and regulations.
f. Glass: Labeled to show name of manufacturer and type.

23. Glazing Materials: Particularly suited for use with aluminum and not require painting.
   a. Make adequate provisions for use of glazing compound, if applicable.
   b. Remove material from glazing surfaces to which glazing compound will not readily adhere.
   c. Windows: May be either factory or field glazed by either channel-type gaskets or back-bedding materials.
   d. Glazing Clips: Not required when face stops are used.
24. Glazing Beads or Retainers: Material compatible with aluminum, and 6 required to retain glass, of sufficient strength and fixation to serve this purpose.
   a. Thickness of Glazing Beads: Optional except as otherwise specified.
25. Screens: Provide windows with screens as indicated, specified, or scheduled in manufacturer's standard approved design, applicable to specific aluminum windows.
   a. Screen Frames: Extruded aluminum frames of suitable alloy and of sufficient rigidity, crossbraces, as required, to lie flat against window and to prevent excessive bow in frame members and sag in screening.
      1) Frame Corners: Firmly joined in secure and rigid manner.
      2) Screen Spline: Aluminum or a material compatible with aluminum.
   b. Screening: One of following as indicated, specified, or scheduled:
      1) Vinyl Coated Fibrous Glass Yam: ASTM D 3656, Class 1, 18 by 16 mesh, 0.29 mm (0.0115 inch) diameter yam.
      2) Polyvinylidene Chloride or Polypropylene Filament: FS L-S-12513, Type I or III, Class 1 or 2, 18 by 18 mesh, 0.31 mm (0.012 inch) or 0.38 mm (0.015 inch) diameter filament.
      3) Aluminum: FS RR-W-365, Type VII, 18 x 16 or 18 by 18 regular, 0.28 mm (0.011 inch) diameter wire.
      4) Stainless Steel: Type 304 stainless steel:
         a) Medium: ANSI/SMA 6001 Medium Type, 12 x 12 mesh 0.58 mm (0.023 inch) diameter wire.
         b) Heavy: ANSI/SMA 6001 Heavy Type, 12 x 12 mesh 0.71 mm (0.028 inch) diameter wire, high tensile strength.
         c) Screen Frames: ANSI/SMA 6001 performance requirements, minimum 1.6 mm (0.062 inch) aluminum extruded 6063-T5 alloy designed to accept stainless steel wire cloth.
         d) Emergency Egress Windows: Design screen to be opened from interior only (to allow for egress to exterior).
   c. Screening: Fastened to frame in manner to permit replacement of screening.
   d. Screens: Provide with fastening devices, suited particularly for application to specific window made of aluminum or materials compatible with aluminum and of sufficient strength to perform satisfactorily.
   e. Assembled Screen with Insect Screening and Spline in Place: Outside dimension as measured from midpoint of opposite framing members shall not vary more than 4.8 mm (3/16 Inch) from outside dimension as measured at extreme ends of framing members.
   f. Screens: Comply with applicable fire codes for egress and fireman access.
      1) Provide single point release as and where required by applicable codes and regulations.
      2) Provide bit key lock fire entry from exterior if required by applicable codes and regulations.
   g. Window Screens: Include warning label indicating that screen will not stop child from falling out of window in accordance with SMA 7001.

Accessories

26. Hardware: Designed to perform functions for which it is intended and securely attached to window.
27. Thermal Break Material: Urethane, PVC, ISP, vinyl, or other material suitable for application that is compatible with aluminum.
28. Fasteners: Comply with ANSI/AAMA 101.
29. Panning and Receptor Systems: Extruded aluminum designed to fit existing openings, to receive windows, and to withstand wind forces as required by applicable codes and regulation.
    a. Exterior Trim System: Designed to withstand expansion/contraction forces of trim material.
    b. Interior Snap Trim: Provide manufacturer's standard interior trim package.
    c. Extruded Aluminum Minimum Thickness: 1.57 mm (0.062 inches).
30. Thermal Insulation: Unfaced fiberglass batt insulation in accordance with ASTM C 665, Type 1.
    a. Vapor Barrier: ASTM D 4397, 4 mil polyethylene sheeting with pressure sensitive adhesive sealing tape.
31. Joint Sealants:
    a. Exterior Joint Sealant: AAMA 800, Type 808.3 Exterior Perimeter Sealing Compound.
    b. Back-up Material: Standard preformed and precompressed foam material, round rod or semi-circular type, permanently elastic, mildew resistant, nonmigratory, nonstaining, and compatible with joint substrates and with sealant.
        1) Materials impregnated with oil, solvents, or bituminous materials not allowed.
        2) Provide type as recommended by sealant manufacturer for particular installation.
        3) Material: Neoprene, butyl, polyurethane, vinyl, or polyethylene rod.
    c. Interior Joint Sealant: ASTM C 834, latex acrylic.

Fabrication

32. Windows: Assembled in secure manner to perform as specified and to provide neat, weather tight construction.
    a. Make permanent watertight joints at junctions of sill and jamb members.
    b. Joint Sealant at Mechanically Fixed Joints: AAMA 800, Type 803.3.
    c. Welding or Brazing Flux: Completely removed immediately upon completion of welding or brazing operation.
33. Mullions and Structural Members: Mullion (whether joined by integral mullions, independent mullions, or by combination of frame members): Capable of withstanding load outlined under Uniform Load in ANSI/AAMA 101, Section 2 without deflecting more than 1/175th of its span.
34. Fin Trim or Installation Fins: Aluminum or other suitable material compatible with aluminum and of sufficient strength and thickness to assure satisfactory installation.
    a. Nailing grooves and/or break off score lines in extrusions are acceptable.
    b. Applied fins or fin trim may be assembled to windows by interlocking with frame members or with fasteners located not over 400 mm (16 inches) OC.
35. Thermally Improved Windows: Single window construction with thermal breaks and insulating glass units or dual window construction.
    a. Thermal Break in Two Frame or One Frame Windows: Not bridged by any screws, fasteners, panning, etc., that would allow excessive heat transfer through window frame.
    b. Do not make structural connection in loading bearing member into thermal break material.
36. Sills: Provide weep holes in sill of glazing pocket to provide means for water to flow to exterior.
37. Trickle Ventilators: Type which fits within glazing channels of sash frame, and contains gasketed channel to accept sealed insulating glass used in window sash.
    a. Ventilator: Installed in top rail of upper sash, accurately sized to extend full width of sash, properly fit sash, and sash frame above and insulating glass below.
    b. Ventilator: Consist of two piece aluminum housing connected by, and separated by, PVC extrusion forming thermal break.
    c. Gasketed Shutter: Operate Internal flap to open and close ventilator.
    d. Unit: Complete with fly-screen.
    e. Color: Selected from manufacturers standard colors.
38. Secondary Windows (Storm Windows): Comply with Division 8 Section “Aluminum Storm Windows.”
39. Windows: Comply with applicable fire codes for egress.

Finishes

40. Finish:
    a. Aluminum: Provide one of following finishes as specified or scheduled:
        1) Pigmented Organic Coating: Factory applied pigmented organic coating, AAMA 603.8.
            a) Color: As selected from manufacturers standard colors.
        2) High Performance Organic Coating: Factory applied pigmented organic coating, AAMA 605.2.
            a) Color: As selected from manufacturer's standard colors.
        3) Color Anodized: Factory applied anodic coating, AAMA 608.1, Class 1.
            a) Color: As scheduled.
        4) Clear Anodized: Factory applied anodic coating, AAMA 607.1, Class 1.
    b. Exposed Surfaces of Aluminum Members: Clean and free from serious surface blemishes.
    c. Dress and finish exposed welded joints.
41. Protective Coatings:
    a. Steel Subframes: Insulate surfaces of steel from direct contact with aluminum surfaces by heavy coat or alkali-resistant bituminous paint or zinc-chromate prime coat, or other coating suitable for this purpose.
    b. Wood Subframes: Properly treat with preservative which will not promote corrosion of aluminum.
    c. Steel or Wood Subframes: Do not leave exposed on exterior of building.

Source Quality Control

42. Fabrication Tolerances: Wall Thickness, Cross-sectional Size and Overall Size: In accordance with ANSI/AAMA 101.
43. Testing: Performed under Third Party Administrator who is in compliance with HUD UM 39a, ANSI Z34.1, and HUD 24 CFR 200.935.

EXECUTION

Examination

44. Site Verification of Conditions:
    a. Field Measurements: Verify field measurements are as indicated on Shop Drawings.
    b. Existing Conditions: Examine openings before beginning installation.
    c. Do not proceed with installation until conditions are satisfactory.

Preparation

45. Protection: Protect adjacent elements from damage and disfiguration in accordance with Detailed Scope of Work.
    a. Contractor: Responsible for damage to grounds, plantings, buildings and any other facilities or property caused by construction operations.
    b. Adequately enclose and protect against weather any interior space where installation is incomplete at end of working day.
    c. Repair or replace damaged elements in accordance with Detailed Scope of Work.
46. Existing Widows: Remove existing windows and debris from site in accordance with Detailed Scope of Work.
47. Preparation: Prepare openings and existing frames in accordance with ASTM E 737.
    a. Existing Window Jambs: Prepare as necessary to provide for straight, plumb, level, tight and aesthetically appealing installation of new windows.
    b. Preparatory Work: Include, but not limited to repair of jambs, filling holes and/or dents, removing peeling and scaling paint, etc.

Installation

48. General: Install In accordance with ASTM E 737 except as modified by ANSI/AAMA 101 Appendix, manufacturer's recommendations, Reference Standards, and approved Shop Drawings.
    a. Securely fasten windows in place to straight, plumb and level condition, without distortion of window or window frame, and make final adjustments for proper operation and satisfactory weatherstrip contact and seal.
    b. Make proper allowance for expansion/contraction movement of aluminum.
    c. Panning and Receptor Systems: Install to ensure watertight seal at joints with existing opening and with new replacement window.
        1) Thermal Insulation: Fill voids in panning system with thermal insulation.
        2) Vapor Barrier: Apply vapor barrier on inside between panning and existing opening. Seal laps and terminations with pressure sensitive tape.
    d. Comply with applicable codes and regulations regarding egress requirements and fireman entry.
49. Joint Sealants: Apply in accordance with manufacturers recommendations.
    a. Surfaces to be Sealed: Clean, dry and free of any foreign matter that would degrade adhesion. Remove existing calking and joint sealants from areas to receive new joint sealant.
    b. Prime cleaned surfaces in accordance with sealant manufacturer's recommendations.
    c. Protect surfaces adjacent to joints by masking tape before applying sealant. Remove tape upon finishing sealing work.
    d. Seal joints between perimeter of window frame and underlying or surrounding construction at
    e. Exterior and interior with joint sealant to accomplish weather-tight installation. Maximum Width of Sealed Joint: 13 mm (1/2 inch).
50. Dissimilar Materials: Isolate materials from incompatible materials as necessary to prevent deterioration and galvanic action.
    a. Separate dissimilar metals with bituminous paint, suitable sealant, nonabsorptive plastic or elastomeric tape. or gasket between surfaces.
    b. Coat aluminum in direct contact with concrete, masonry, steel, or other non-compatible materials with bituminous paint, zinc chromate primer, or other suitable insulating material.

Field Ouality Control

51. Owners Field Testing: Owner may have field testing of windows conducted by his own testing agency in accordance with AAMA 502.
    a. Tests: May include, but not limited to:
        1) Field Testing (Hose Test) for Water Leakage: AAMA 501.2.
        2) Field Testing (Air Pressure Difference) for Water Leakage: AAMA 502, Test Method B.
            a) Field Testing for Air Leakage: ASTM E 783.
            b) Field Testing for Water Determination: ASTM E 1105.
    b. Test Pressures: Comply with specified performance requirements.
    c. Contractor: Provide incidental labor facilities necessary to facilitate inspections and tests.
    d. Costs of Testing:
        1) By Owner: Successful initial tests.
        2) By Contractor: Initial tests with failures and subsequent tests as required because of test failures. Costs shall include costs of the Owner and other consultants for observations of tests and corrective work.
    e. Corrective Measures: Meet standards of quality of specified window and subject to acceptance of the Owner.

Adjusting And Cleaning

52. Adjusting: At completion of job, check, adjust, and lubricate hardware as required and leave windows and hardware in proper operating condition.
53. Cleaning: Comply with requirements of Detailed Scope of Work.
    a. Clean windows after installation is completed to remove foreign matter and surface blemishes.

b. Scratched or Abraded Surfaces: Touch-up with rust inhibitor primer and enamel paint compatible with factory finish.

Protection

54. Installed Work: Protect windows from damage after installation.

END OF SECTION 08520a

Task	Specification	Specification Description
08530	01352	No Specification Required

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SECTION 08550 - WOOD WINDOWS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for wood windows. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes fixed and operable wood-framed windows of the following type:
   a. Unfinished.
   b. Aluminum clad.
   c. Vinyl clad.

C. Definitions
1. Performance class designations according to AAMA/WDMA 101/I.S.2/NAFS:
   a. AW: Architectural.
   b. HC: Heavy Commercial.
   c. C: Commercial.
   d. LC: Light Commercial.
   e. R: Residential.
2. Performance grade number according to AAMA/WDMA 101/I.S.2/NAFS:
   a. Design pressure number in pounds force per square foot (pascals) used to determine the structural test pressure and water test pressure.
3. Structural Test Pressure: For uniform load structural test, is equivalent to 150 percent of the design pressure.
4. Minimum Test Size: Smallest size permitted for performance class (gateway test size). Products must be tested at minimum test size or at a size larger than minimum test size to comply with requirements for performance class.

D. Performance Requirements
1. General: Provide wood windows capable of complying with performance requirements indicated, based on testing manufacturer's windows that are representative of those specified, and that are of test size required by AAMA/WDMA 101/I.S.2/NAFS.
2. Structural Performance: Provide wood windows capable of withstanding the effects of the following loads based on testing units representative of those indicated for Project that pass AAMA/WDMA 101/I.S.2/NAFS, Uniform Load Structural Test:
   a. Design Wind Loads: Determine design wind loads applicable to Project from basic wind speed indicated in miles per hour (meters per second) at 33 feet (10 m) above grade, according to ASCE 7, Section 6.5, "Method 2-Analytical Procedure," based on mean roof heights above grade indicated on Drawings.
      1) Basic Wind Speed: 85 mph (38 m/s) **OR** 90 mph (40 m/s), **as directed**.
      2) Importance Factor: I **OR** II **OR** III **OR** IV, **as directed**.
      3) Exposure Category: A **OR** B **OR** C **OR** D, **as directed**.
   b. Deflection: Design glass framing system to limit lateral deflections of glass edges to less than 1/175 of glass-edge length or 3/4 inch (19 mm), whichever is less, at design pressure based on testing performed according to AAMA/WDMA 101/I.S.2/NAFS, Uniform Load Deflection Test or structural computations.
3. Windborne-Debris Resistance: Provide glazed windows capable of resisting impact from windborne debris, based on the pass/fail criteria as determined from testing glazed windows identical to those specified, according to ASTM E 1886 and testing information in ASTM E 1996 **OR** AAMA 506, **as directed**, and requirements of authorities having jurisdiction.

E. Submittals
1. Product Data: For each type of wood window indicated.
2. LEED Submittal:
a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that wood windows comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
1) Include statement indicating costs for each certified wood product.
3. Shop Drawings: Include plans, elevations, sections, details, hardware, attachments to other work, operational clearances, installation details.
4. Samples: For each exposed finish.
5. Product Schedule: Use same designations indicated on Drawings.
6. Product test reports.
7. Maintenance data.

F. Quality Assurance
1. Installer: A qualified installer, approved by manufacturer to install manufacturer's products.
2. Manufacturer Qualifications: A qualified manufacturer who is certified for chain of custody by an FSC-accredited certification body.
3. Forest Certification: Provide windows made with not less than 70 percent of wood products **OR** all wood products, **as directed**, obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
4. Fenestration Standard: Comply with AAMA/WDMA 101/I.S.2/NAFS, "North American Fenestration Standard Voluntary Performance Specification for Windows, Skylights and Glass Doors," for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.
a. Provide AAMA-certified **OR** WDMA-certified, **as directed**, wood windows with an attached label.
5. Glazing Publications: Comply with published recommendations of glass manufacturers and with GANA's "Glazing Manual" unless more stringent requirements are indicated.
6. Preinstallation Conference: Conduct conference at Project site.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace wood windows that fail in materials or workmanship within specified warranty period.
a. Warranty Period:
1) Window: Two **OR** Three, **as directed**, years from date of Substantial Completion.
2) Glazing: Five **OR** 10, **as directed**, years from date of Substantial Completion.
3) Metal Finish: Five years from date of Substantial Completion.

1.2 PRODUCTS

A. Materials
1. Wood: Clear ponderosa pine or another suitable fine-grained lumber; kiln dried to a moisture content of 6 to 12 percent at time of fabrication; free of visible finger joints, blue stain, knots, pitch pockets, and surface checks larger than 1/32 inch (0.8 mm) deep by 2 inches (51 mm) wide; water-repellent preservative treated.
2. Aluminum Extrusions and Rolled Aluminum for Cladding: Manufacturer's standard formed sheet or extruded-aluminum cladding, mechanically bonded to exterior exposed wood members. Provide aluminum alloy and temper recommended by wood window manufacturer for strength, corrosion resistance, and application of required finish, but not less than 22,000-psi (150-MPa) ultimate tensile strength, and not less than 16,000-psi (110-MPa) minimum yield strength.
a. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

b. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
c. Baked-Enamel Finish for Extrusions and Sheet: Manufacturer's standard baked enamel complying with AAMA 2603 and paint manufacturer's written specifications for cleaning, conversion coating, and painting.
1) Color: White **OR** Bronze **OR** Brown **OR** Beige **OR** Gray **OR** Green **OR** As selected from manufacturer's full range **OR** Custom color as selected, **as directed**.
d. High-Performance Organic Finish for Extrusions and Sheet: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
1) Fluoropolymer Two-Coat System: Manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2604.
a) Color and Gloss: As selected from manufacturer's full range.
e. Baked-Enamel Finish for Coil: Manufacturer's standard baked enamel complying with AAMA 620 and paint manufacturer's written specifications for cleaning, conversion coating, and painting.
1) Color: White **OR** Bronze **OR** Brown **OR** Beige **OR** Gray **OR** Green **OR** As selected from manufacturer's full range **OR** Custom color as selected, **as directed**.

3. Vinyl for Cladding: Consisting of a rigid PVC sheath, made from PVC complying with ASTM D 4726, not less than 35-mil (0.9-mm) average thickness, in permanent, integral color, white **OR** bronze **OR** tan, **as directed**, finish, mechanically bonded to exterior wood sash and frame members.
4. Wood Trim and Glazing Stops: Material and finish to match frame members.
5. Clad Trim and Glazing Stops: Hollow extrusions **OR** Roll-formed sheet material **OR** Clad-wood material, **as directed**, and finish to match clad frame members.
6. Fasteners: Aluminum, nonmagnetic stainless steel, epoxy adhesive, or other materials warranted by manufacturer to be noncorrosive and compatible with wood window members, cladding, trim, hardware, anchors, and other components.
a. Exposed Fasteners: Unless unavoidable for applying hardware, do not use exposed fasteners. For application of hardware, use fasteners that match finish of member or hardware being fastened, as appropriate.
7. Anchors, Clips, and Accessories: Aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.
8. Reinforcing Members: Aluminum, or nonmagnetic stainless steel, or nickel/chrome-plated steel complying with ASTM B 456 for Type SC 3 severe service conditions, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.
9. Compression-Type Weather Stripping: Provide compressible weather stripping designed for permanently resilient sealing under bumper or wiper action and for complete concealment when wood window is closed.
a. Weather-Stripping Material:
1) Elastomeric cellular preformed gaskets complying with ASTM C 509.
2) Dense elastomeric gaskets complying with ASTM C 864.
3) Manufacturer's standard system and materials complying with AAMA/WDMA 101/I.S.2/NAFS.
10. Sliding-Type Weather Stripping: Provide woven-pile weather stripping of wool, polypropylene, or nylon pile and resin-impregnated backing fabric. Comply with AAMA 701/702.
a. Weather Seals: Provide weather stripping with integral barrier fin or fins of semirigid, polypropylene sheet or polypropylene-coated material. Comply with AAMA 701/702.
11. Replaceable Weather Seals: Comply with AAMA 701/702.

B. Window
1. Window Type: Casement **OR** Double hung **OR** Fixed **OR** Horizontal sliding **OR** Projected awning **OR** Single hung **OR** Bay **OR** Bow **OR** Specialty product **OR** As indicated on Drawings **OR** As indicated in a schedule, **as directed**.
2. AAMA/WDMA Performance Requirements: Provide wood windows of performance indicated that comply with AAMA/WDMA 101/I.S.2/NAFS unless more stringent performance requirements are indicated.
   a. Performance Class and Grade: R15 **OR** 20 **OR** 25, **as directed**.
   b. Performance Class and Grade: LC25 **OR** 30 **OR** 35, **as directed**.
   c. Performance Class and Grade: C30 **OR** 35 **OR** 40, **as directed**.
   d. Performance Class and Grade: HC40 **OR** 45 **OR** 50, **as directed**.
   e. Performance Class and Grade: AW40 **OR** 45 **OR** 50, **as directed**.
   f. Performance Class and Grade: As indicated.
3. Condensation-Resistance Factor (CRF): Provide wood windows tested for thermal performance according to AAMA 1503, showing a CRF of 45 **OR** 52, **as directed**.
4. Thermal Transmittance: Provide wood windows with a whole-window, U-factor maximum indicated at 15-mph (24-km/h) exterior wind velocity and winter condition temperatures when tested according to AAMA 1503 **OR** ASTM E 1423 **OR** NFRC 100, **as directed**.
   a. U-Factor: 0.35 Btu/sq. ft. x h x deg F (2.0 W/sq. m x K) **OR** 0.40 Btu/sq. ft. x h x deg F (2.3 W/sq. m x K) **OR** 0.43 Btu/sq. ft. x h x deg F (2.5 W/sq. m x K) **OR** 0.60 Btu/sq. ft. x h x deg F (3.4 W/sq. m x K), **as directed**, or less.
5. Solar Heat-Gain Coefficient (SHGC): Provide wood windows with a whole-window SHGC maximum of 0.40 **OR** 0.50 **OR** 0.55, **as directed**, determined according to NFRC 200 procedures.
6. Sound Transmission Class (STC): Provide glazed windows rated for not less than 26 **OR** 30 **OR** 35, **as directed**, STC when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 413.
7. Air Infiltration: Maximum rate not more than indicated when tested according to AAMA/WDMA 101/I.S.2/NAFS, Air Infiltration Test.
   a. Maximum Rate:
      1) 0.3 cfm/sq. ft. (5 cu. m/h x sq. m) of area at an inward test pressure of 1.57 lbf/sq. ft. (75 Pa) which is equivalent to 25-mph (40-km/h) wind speed and is typically used to test R, C, and LC performance classes.
      2) 0.3 cfm/sq. ft. (5 cu. m/h x sq. m) of area at an inward test pressure of 6.24 lbf/sq. ft. (300 Pa) which is equivalent to a 50-mph (80-km/h) wind speed and is typically used to test HC and AW performance classes.
   b. Water Resistance: No water leakage as defined in AAMA/WDMA referenced test methods at a water test pressure equaling that indicated, when tested according to AAMA/WDMA 101/I.S.2/NAFS, Water Resistance Test.
   c. Test Pressure:
      1) 15 percent of positive design pressure, but not less than 2.86 lbf/sq. ft. (140 Pa) or more than 15 lbf/sq. ft. (720 Pa).
      2) 20 percent of positive design pressure, but not more than 15 lbf/sq. ft. (720 Pa).
8. Forced-Entry Resistance: Comply with Performance Grade 10 **OR** 20 **OR** 30 **OR** 40, **as directed**, requirements when tested according to ASTM F 588.
9. Life-Cycle Testing: Test according to AAMA 910 and comply with AAMA/WDMA 101/I.S.2/NAFS.
10. Operating Force and Auxiliary (Durability) Tests: Comply with AAMA/WDMA 101/I.S.2/NAFS for operating window types indicated.

C. Glazing
1. Glass and Glazing Materials: Refer to Division 08 Section "Glazing"" for glass units and glazing requirements applicable to glazed wood window units.
2. Glass: Clear, insulating-glass units **OR** Clear, insulating-glass units, with low-E coating pyrolytic on second surface or sputtered on second or third surface, **OR** Clear, insulating-glass units,

argon gas filled, with low-E coating pyrolytic on second surface or sputtered on second or third surface, **as directed**, complying with Division 08 Section "Glazing".

3. Glazing System: Manufacturer's standard factory-glazing system that produces weathertight seal **OR** Manufacturer's standard factory-glazing system that produces weathertight seal and complies with requirements for windborne-debris resistance **OR** Manufacturer's standard factory-glazing system as indicated in Division 08 Section "Glazing", **as directed**.
4. Dual-Glazing System for Venetian Blinds: Manufacturer's standard dual-glazing system with 2 lites of clear float glass, complying with ASTM C 1036, Type I, Quality q3, glazed independently into the sash and separated by a minimum dead-air space of 1-1/2 inches (38 mm).
5. Triple-Glazing System for Venetian Blinds: Manufacturer's standard insulated glass of type specified, combined with an auxiliary lite of clear float glass, complying with ASTM C 1036, Type I, Quality q3, retained in a separate glazing channel or frame and separated from insulated-glass unit by a minimum dead-air space of 1-1/2 inches (38 mm).

D. Hardware
1. General: Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with wood and aluminum cladding, **as directed**; designed to smoothly operate, tightly close, and securely lock wood windows, and sized to accommodate sash or ventilator weight and dimensions. Do not use aluminum in frictional contact with other metals. Where exposed, provide solid bronze **OR** extruded, cast, or wrought aluminum **OR** die-cast zinc with special coating finish **OR** nonmagnetic stainless steel, **as directed**.
2. Counterbalancing Mechanism: Comply with AAMA 902.
   a. Sash-Balance Type: Concealed, tape-spring **OR** spiral-tube **OR** spring-loaded, block-and-tackle, **as directed**, type, of size and capacity to hold sash stationary at any open position.
3. Sill Cap/Track: Extruded-aluminum track with natural anodized finish **OR** Rigid PVC or other weather-resistant plastic track with manufacturer's standard integral color, **as directed**, of thickness, dimensions, and profile indicated; designed to comply with performance requirements indicated and to drain to the exterior.
4. Locks and Latches: Designed to allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only. Provide custodial locks, **as directed**.
5. Roller Assemblies: Low-friction design.
6. Push-Bar Operators: Provide telescoping-type, push-bar operator designed to open and close ventilators with fixed screens.
7. Gear-Type Rotary Operators: Comply with AAMA 901 when tested according to ASTM E 405, Method A.
   a. Operation Function: All ventilators move simultaneously and securely close at both jambs without using additional manually controlled locking devices.
8. Four- or Six-Bar Friction Hinges: Comply with AAMA 904.
   a. Locking mechanism and handles for manual operation.
   b. Friction Shoes: Provide friction shoes of nylon or other nonabrasive, nonstaining, noncorrosive, durable material.
9. Limit Devices: Provide concealed friction adjustor, adjustable stay bar **OR** concealed support arms with adjustable, limited, hold-open, **as directed**, limit devices designed to restrict sash or ventilator opening.
   a. Safety Devices: Limit clear opening to 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, for ventilation; with custodial key release.
10. Pole Operators: Tubular-shaped anodized aluminum; with rubber-capped lower end and standard push-pull hook at top to match hardware design; of sufficient length to operate window without reaching more than 60 inches (1500 mm) above floor; 1 pole operator and pole hanger per room that has operable windows more than 72 inches (1800 mm) above floor.

E. Insect Screens
1. General: Design windows and hardware to accommodate screens in a tight-fitting, removable arrangement, with a minimum of exposed fasteners and latches. Fabricate insect screens to fully

integrate with window frame. Locate screens on inside **OR** outside, **as directed**, of window and provide for each operable exterior sash or ventilator.

a. Aluminum Tubular Frame Screens: Comply with SMA 1004, "Specifications for Aluminum Tubular Frame Screens for Windows," Residential R-20 **OR** Architectural C-24 **OR** Monumental M-32, **as directed**, class.

2. Aluminum Insect Screen Frames: Manufacturer's standard aluminum alloy complying with SMA 1004. Fabricate frames with mitered or coped joints or corner extrusions, concealed fasteners, adjustable rollers, **as directed**, and removable PVC spline/anchor concealing edge of frame.
   a. Aluminum Tubular Framing Sections and Cross Braces: Roll formed from aluminum sheet with minimum wall thickness as required for class indicated.
   b. Finish:
      1) Anodized aluminum **OR** Baked-on organic coating, **as directed**, in manufacturer's standard color **OR** in color selected from manufacturer's full range, **as directed**.
         OR
         Manufacturer's standard.
3. Glass-Fiber Mesh Fabric: 18-by-14 (1.1-by-1.4-mm) or 18-by-16 (1.0-by-1.1-mm) **OR** 20-by-20 (0.85-by-0.85-mm) or 20-by-30 (0.85-by-0.42-mm), **as directed**, mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration; in the following color. Comply with ASTM D 3656.
   a. Mesh Color: Charcoal gray **OR** Silver gray **OR** Aquamarine, **as directed**.
4. Aluminum Wire Fabric: 18-by-16 (1.1-by-1.3-mm) mesh of 0.011-inch- (0.28-mm-) diameter, coated aluminum wire.
   a. Wire-Fabric Finish: Natural bright **OR** Charcoal gray **OR** Black, **as directed**.
5. Wickets: Provide sliding **OR** hinged, **as directed**, wickets, framed and trimmed for a tight fit and for durability during handling.

F. Accessories
1. Dividers (False Muntins): Provide dividers in designs indicated for each sash lite, one per sash, removable from the exposed surface of interior lite of the sash **OR** two per sash, removable from the exposed surfaces of interior and exterior lites of the sash, **as directed**, and one permanently located between glazing lites in the airspace, **as directed**.
   a. Material: Extruded, rigid PVC **OR** Prefinished wood, **as directed**.
   b. Design: Rectangular **OR** Diamond, **as directed**.
   c. Color: White **OR** Bronze, **as directed**.
2. Storm Panels: Provide removable auxiliary glazing panels of clear float glass for each fixed and operating sash of window units. Glass shall comply with ASTM C 1036, Type I, Quality q3. Provide glass of thickness required to comply with requirements in Division 08 Section "Glazing". Frame, preglaze, and attach storm windows to the sash according to manufacturer's published standards. Omit storm panels on sash glazed with insulating glass, **as directed**.
3. Integral Louver Blinds: Provide remotely operated horizontal louver blinds in the space between two panes of glass. Construct blinds of aluminum slats, approximately 1 inch (25 mm) wide, with polyester fiber cords, equipped for tilting, raising, and lowering by standard operating hardware located on inside face of sash.

G. Fabrication
1. Fabricate wood windows in sizes indicated. Include a complete system for assembling components and anchoring windows.
2. Fabricate wood windows that are reglazable without dismantling sash or ventilator framing.
3. Weather Stripping: Provide full-perimeter weather stripping for each operable sash and ventilator, unless otherwise indicated.
   a. Double-Hung Windows: Provide weather stripping only at horizontal rails of operable sash.
4. Factory machine windows for openings and for hardware that is not surface applied.
5. Mullions: Provide mullions and cover plates as shown, matching window units, complete with anchors for support to structure and installation of window units. Allow for erection tolerances

and provide for movement of window units due to thermal expansion and building deflections, as indicated. Provide mullions and cover plates capable of withstanding design loads of window units.

6. Factory-Glazed Fabrication: Except for light sizes in excess of 100 united inches (2500 mm width plus length), glaze wood windows in the factory where practical and possible for applications indicated. Comply with requirements in Division 08 Section "Glazing" and with AAMA/WDMA 101/I.S.2/NAFS.
7. Glazing Stops: Provide nailed or snap-on glazing stops coordinated with Division 08 Section "Glazing" and glazing system indicated. Provide glazing stops to match sash and ventilator frames.
8. Bow **OR** Bay, **as directed**, Windows: Provide wood windows in configuration indicated. Provide window frames, fixed and operating sash, operating hardware, and other trim and components necessary for a complete, secure, and weathertight installation, including the following:
   a. Angled mullion posts with interior and exterior trim.
   b. Angled interior and exterior extension and trim.
   c. Clear pine head and seat boards.
   d. Top and bottom plywood platforms.
   e. Exterior head and sill casings and trim.
   f. Support brackets.
9. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation. Allow for scribing, trimming, and fitting at Project site.

H. Wood Finishes
1. Factory-Primed Windows: Provide manufacturer's standard factory-prime coat complying with WDMA T.M. 11 on exposed exterior **OR** interior **OR** exterior and interior, **as directed**, wood surfaces.
2. Factory-Finished Windows: Provide manufacturer's standard factory finish complying with WDMA T.M. 12. Apply finish to exposed exterior and interior wood surfaces.
   a. Color: White **OR** Brown **OR** Gray **OR** As selected from manufacturer's full range, **as directed**.

1.3 EXECUTION

A. Installation
1. Comply with Drawings, Shop Drawings, and manufacturer's written instructions for installing windows, hardware, accessories, and other components.
2. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction.
3. Set sill members in bed of sealant or with gaskets, as indicated, for weathertight construction.
4. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

B. Adjusting, Cleaning, And Protection
1. Adjust operating sashes and ventilators, screens, hardware, and accessories for a tight fit at contact points and weather stripping for smooth operation and weathertight closure. Lubricate hardware and moving parts.
2. Clean exposed surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.
3. Clean factory-glazed glass immediately after installing windows. Comply with manufacturer's written recommendations for final cleaning and maintenance. Remove nonpermanent labels, and clean surfaces.
4. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

5. Protect window surfaces from contact with contaminating substances resulting from construction operations. In addition, monitor window surfaces adjacent to and below exterior concrete and masonry surfaces during construction for presence of dirt, scum, alkaline deposits, stains, or other contaminants. If contaminating substances do contact window surfaces, remove contaminants immediately according to manufacturer's written recommendations.

END OF SECTION 08550

SECTION 08560 - VINYL WINDOWS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for fixed and operable vinyl framed windows. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes fixed and operable vinyl-framed windows.

C. Definitions
1. Performance class designations according to AAMA/WDMA 101/I.S.2/NAFS:
   a. AW: Architectural.
   b. HC: Heavy Commercial.
   c. C: Commercial.
   d. LC: Light Commercial.
   e. R: Residential.
2. Performance grade number according to AAMA/WDMA 101/I.S.2/NAFS:
   a. Design pressure number in pounds force per square foot (pascals) used to determine the structural test pressure and water test pressure.
3. Structural Test Pressure: For uniform load structural test, is equivalent to 150 percent of the design pressure.
4. Minimum Test Size: Smallest size permitted for performance class (gateway test size). Products must be tested at minimum test size or at a size larger than minimum test size to comply with requirements for performance class.

D. Performance Requirements
1. General: Provide vinyl windows capable of complying with performance requirements indicated, based on testing manufacturer's windows that are representative of those specified, and that are of test size indicated below:
   a. Size required by AAMA/WDMA 101/I.S.2/NAFS for gateway performance **OR** optional performance grade, **as directed**.
   b. Size indicated on Drawings **OR** in a schedule, **as directed**.
2. Structural Performance: Provide vinyl windows capable of withstanding the effects of the following loads, based on testing units representative of those indicated for Project that pass AAMA/WDMA 101/I.S.2/NAFS, Uniform Load Structural Test:
   a. Design Wind Loads: Determine design wind loads applicable to Project from basic wind speed indicated in miles per hour (meters per second) at 33 feet (10 m) above grade, according to ASCE 7, Section 6.5, "Method 2-Analytical Procedure," based on mean roof heights above grade indicated on Drawings.
      1) Basic Wind Speed: 85 mph (38 m/s) **OR** 90 mph (40 m/s), **as directed**.
      2) Importance Factor.
      3) Exposure Category: A **OR** B **OR** C **OR** D, **as directed**.
3. Windborne-Debris Resistance: Provide glazed windows capable of resisting impact from windborne debris, based on the pass/fail criteria as determined from testing glazed windows identical to those specified, according to ASTM E 1886 and testing information in ASTM E 1996 or AAMA 506 and requirements of authorities having jurisdiction.

E. Submittals
1. Product Data: For each type of vinyl window indicated.

2. Shop Drawings: Include plans, elevations, sections, details, hardware, attachments to other work, operational clearances, and installation details.
3. Samples: For each exposed finish.
4. Product Schedule: Use same designations indicated on Drawings.
5. Product test reports.
6. Maintenance data.
7. Warranty: Special warranty specified in this Section.

F. Quality Assurance
1. Installer: A qualified installer, approved by manufacturer to install manufacturer's products.
2. Fenestration Standard: Comply with AAMA/WDMA 101/I.S.2/NAFS, "North American Fenestration Standard Voluntary Performance Specification for Windows, Skylights and Glass Doors," for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.
   a. Provide AAMA **OR** WDMA, **as directed**,-certified vinyl windows with an attached label.
3. Glazing Publications: Comply with published recommendations of glass manufacturers and with GANA's "Glazing Manual" unless more stringent requirements are indicated.
4. Preinstallation Conference: Conduct conference at Project site.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace vinyl windows that fail in materials or workmanship within specified warranty period.
   a. Failures include, but are not limited to, the following:
      1) Failure to meet performance requirements.
      2) Structural failures including excessive deflection, water leakage, air infiltration, or condensation.
      3) Faulty operation of movable sash and hardware.
      4) Deterioration of vinyl, other materials, and finishes beyond normal weathering.
      5) Failure of insulating glass.
   b. Warranty Period:
      1) Window: Two **OR** Three **OR** 10, **as dirtected**, years from date of Substantial Completion.
      2) Glazing: Five **OR** 10, **as directed**, years from date of Substantial Completion.
      3) Vinyl Finish: Five years from date of Substantial Completion.

1.2 PRODUCTS

A. Materials
1. Vinyl Extrusions: Rigid (unplasticized) hollow PVC extrusions, formulated and extruded for exterior applications, complying with AAMA/WDMA 101/I.S.2/NAFS and the following:
   a. PVC Resins: 100 percent virgin resin.
   b. PVC Formulation: High impact, low heat buildup, lead free, nonchalking, and color and UV stabilized.
   c. Extrusion Wall Thickness: Not less than 0.060 inch (1.5 mm) **OR** 0.090 inch (2.3 mm) **OR** 0.125 inch (3.2 mm), **as directed**.
   d. Multichamber Extrusions: Profile designed with two chambers **OR** three chambers **OR** multichambers, **as directed**, between interior and exterior faces of the extrusions.
2. Vinyl Trim and Glazing Stops: Material and finish to match frame members.
3. Fasteners: Aluminum, nonmagnetic stainless steel, epoxy adhesive, or other materials warranted by manufacturer to be noncorrosive and compatible with vinyl window members, cladding, trim, hardware, anchors, and other components.
   a. Exposed Fasteners: Unless unavoidable for applying hardware, do not use exposed fasteners. For application of hardware, use fasteners that match finish of member or hardware being fastened, as appropriate.

4. Anchors, Clips, and Accessories: Aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.
5. Reinforcing Members: Aluminum, or nonmagnetic stainless steel, or nickel/chrome-plated steel complying with ASTM B 456 for Type SC 3 severe service conditions, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.
6. Compression-Type Weather Stripping: Provide compressible weather stripping designed for permanently resilient sealing under bumper or wiper action, and for complete concealment when vinyl window is closed.
    a. Weather-Stripping Material: Elastomeric cellular preformed gaskets complying with ASTM C 509.
    b. Weather-Stripping Material: Dense elastomeric gaskets complying with ASTM C 864.
    c. Weather-Stripping Material: Manufacturer's standard system and materials complying with AAMA/WDMA 101/I.S.2/NAFS.
7. Sliding-Type Weather Stripping: Provide woven-pile weather stripping of wool, polypropylene, or nylon pile and resin-impregnated backing fabric. Comply with AAMA 701/702.
    a. Weather Seals: Provide weather stripping with integral barrier fin or fins of semirigid, polypropylene sheet or polypropylene-coated material. Comply with AAMA 701/702.
8. Replaceable Weather Seals: Comply with AAMA 701/702.

B. Window
1. Window Type: Casement **OR** Double hung **OR** Fixed **OR** Horizontal sliding **OR** Projected awning **OR** Single hung **OR** Bay **OR** Bow **OR** Specialty product **OR** As indicated on Drawings **OR** As indicated on a schedule, **as directed**.
2. AAMA/WDMA Performance Requirements: Provide vinyl windows of performance indicated that comply with AAMA/WDMA 101/I.S.2/NAFS unless more stringent performance requirements are indicated.
    a. Performance Class and Grade: R15 **OR** R20 **OR** R25, **as directed**.
    b. Performance Class and Grade: LC25 **OR** LC30 **OR** LC35, **as directed**.
    c. Performance Class and Grade: C30 **OR** C35 **OR** C40, **as directed**.
    d. Performance Class and Grade: HC40 **OR** HC45 **OR** HC50, **as directed**.
    e. Performance Class and Grade: AW40 **OR** AW45 **OR** AW50, **as directed**.
    f. Performance Class and Grade: As indicated.
    g. Performance Class (if test performance method is selected for specifying windows and designating a performance class does not conflict with basic wind speed and performance testing indicated): R **OR** LC **OR** C **OR** HC **OR** AW, **as directed**.
3. Condensation-Resistance Factor (CRF): Provide vinyl windows tested for thermal performance according to AAMA 1503, showing a CRF of 45 **OR** 52 **OR** 65, **as directed**.
4. Thermal Transmittance: Provide vinyl windows with a whole-window, U-factor maximum indicated at 15-mph (24-km/h) exterior wind velocity and winter condition temperatures when tested according to AAMA 1503 **OR** ASTM E 1423 **OR** NFRC 100, **as directed**.
    a. U-Factor: 0.35 Btu/sq. ft. x h x deg F (2.0 W/sq. m x K) **OR** 0.40 Btu/sq. ft. x h x deg F (2.3 W/sq. m x K) **OR** 0.43 Btu/sq. ft. x h x deg F (2.5 W/sq. m x K) **OR** 0.60 Btu/sq. ft. x h x deg F (3.4 W/sq. m x K), **as directed**, or less.
5. Solar Heat-Gain Coefficient (SHGC): Provide vinyl windows with a whole-window SHGC maximum of 0.40 **OR** 0.50 **OR** 0.55, **as directed**, determined according to NFRC 200 procedures.
6. Sound Transmission Class (STC): Provide glazed windows rated for not less than 26 **OR** 30 **OR** 35, **as directed**, STC when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 413.
7. AAMA/WDMA 101/I.S.2/NAFS, Air Infiltration Test.
    a. Maximum Rate: 0.3 cfm/sq. ft. (5 cu. m/h x sq. m) of area at an inward test pressure of 1.57 lbf/sq. ft. (75 Pa) which is equivalent to 25-mph (40-km/h) wind speed and is typically used to test R, C, and LC performance classes.

b. Maximum Rate: 0.3 cfm/sq. ft. (5 cu. m/h x sq. m) of area at an inward test pressure of 6.24 lbf/sq. ft. (300 Pa) which is equivalent to a 50-mph (80-km/h) wind speed and is typically used to test HC and AW performance classes.

8. Water Resistance: No water leakage as defined in AAMA/WDMA referenced test methods at a water test pressure equaling that indicated, when tested according to AAMA/WDMA 101/I.S.2/NAFS, Water Resistance Test.
   a. Test Pressure: 15 percent of positive design pressure, but not less than 2.86 lbf/sq. ft. (140 Pa) or more than 15 lbf/sq. ft. (720 Pa).
   b. Test Pressure: 20 percent of positive design pressure, but not more than 15 lbf/sq. ft. (720 Pa).
9. Forced-Entry Resistance: Comply with Performance Grade 10 **OR** 20 **OR** 30 **OR** 40, **as directed**, requirements when tested according to ASTM F 588.
10. Life-Cycle Testing: Test according to AAMA 910 and comply with AAMA/WDMA 101/I.S.2/NAFS.
11. Operating Force and Auxiliary (Durability) Tests: Comply with AAMA/WDMA 101/I.S.2/NAFS for operating window types indicated.

C. Glazing
1. Glass: Clear, insulating-glass units **OR** Clear, insulating-glass units, with low-E coating pyrolytic on second surface or sputtered on second or third surface, **OR** Clear, insulating-glass units, argon gas filled, with low-E coating pyrolytic on second surface or sputtered on second or third surface, **as directed**, complying with Division 08 Section "Glazing".
2. Glazing System: Manufacturer's standard factory-glazing system that produces weathertight seal **OR** Manufacturer's standard factory-glazing system that produces weathertight seal and complies with requirements for windborne-debris resistance **OR** Manufacturer's standard factory-glazing system as indicated in Division 08 Section "Glazing", **as directed**.

D. Hardware
1. General: Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with vinyl; designed to smoothly operate, tightly close, and securely lock vinyl windows, and sized to accommodate sash or ventilator weight and dimensions. Do not use aluminum in frictional contact with other metals. Where exposed, provide solid bronze **OR** extruded, cast, or wrought aluminum **OR** die-cast zinc with special coating finish **OR** nonmagnetic stainless steel, **as directed**.
2. Counterbalancing Mechanism: Comply with AAMA 902.
   a. Sash-Balance Type: Concealed, tape-spring **OR** spiral-tube **OR** spring-loaded, block-and-tackle, **as directed**, type, of size and capacity to hold sash stationary at any open position.
3. Sill Cap/Track: Extruded-aluminum track with natural anodized finish **OR** Rigid PVC or other weather-resistant plastic track with manufacturer's standard integral color, **as directed**, of thickness, dimensions, and profile indicated; designed to comply with performance requirements indicated and to drain to the exterior.
4. Locks and Latches: Designed to allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only. Provide custodial locks, **as directed**.
5. Roller Assemblies: Low-friction design.
6. Push-Bar Operators: Provide telescoping-type, push-bar operator designed to open and close ventilators with fixed screens.
7. Gear-Type Rotary Operators: Comply with AAMA 901 when tested according to ASTM E 405, Method A.
   a. Operation Function: All ventilators move simultaneously and securely close at both jambs without using additional manually controlled locking devices.
8. Four- or Six-Bar Friction Hinges: Comply with AAMA 904.
   a. Locking mechanism and handles for manual operation.
   b. Friction Shoes: Provide friction shoes of nylon or other nonabrasive, nonstaining, noncorrosive, durable material.

9. Limit Devices: Provide concealed friction adjustor, adjustable stay bar **OR** concealed support arms with adjustable, limited, hold-open, **as directed**, limit devices designed to restrict sash or ventilator opening.
    a. Safety Devices: Limit clear opening to 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, for ventilation; with custodial key release.
10. Pole Operators: Tubular-shaped anodized aluminum; with rubber-capped lower end and standard push-pull hook at top to match hardware design; of sufficient length to operate window without reaching more than 60 inches (1500 mm) above floor; 1 pole operator and pole hanger per room that has operable windows more than 72 inches (1800 mm) above floor.

E. Insect Screens
1. General: Design windows and hardware to accommodate screens in a tight-fitting, removable arrangement, with a minimum of exposed fasteners and latches. Fabricate insect screens to fully integrate with window frame. Locate screens on inside **OR** outside, **as directed**, of window and provide for each operable exterior sash or ventilator.
    a. Aluminum Tubular Frame Screens: Comply with SMA 1004, "Specifications for Aluminum Tubular Frame Screens for Windows," Residential R-20 **OR** Architectural C-24 **OR** Monumental M-32, **as directed**, class.
2. Aluminum Insect Screen Frames: Manufacturer's standard aluminum alloy complying with SMA 1004. Fabricate frames with mitered or coped joints or corner extrusions, concealed fasteners, adjustable rollers, **as directed**, and removable PVC spline/anchor concealing edge of frame.
    a. Aluminum Tubular Framing Sections and Cross Braces: Roll formed from aluminum sheet with minimum wall thickness as required for class indicated.
    b. Finish: Anodized aluminum **OR** Baked-on organic coating, **as directed**, in manufacturer's standard color.
    c. Finish: Anodized aluminum **OR** Baked-on organic coating, **as directed**, in color selected from manufacturer's full range.
    d. Finish: Manufacturer's standard.
3. Glass-Fiber Mesh Fabric: 18-by-14 (1.1-by-1.4-mm) or 18-by-16 (1.0-by-1.1-mm) **OR** 20-by-20 (0.85-by-0.85-mm) or 20-by-30 (0.85-by-0.42-mm), **as directed**, mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration, in the following color. Comply with ASTM D 3656.
    a. Mesh Color: Charcoal gray **OR** Silver gray **OR** Aquamarine, **as directed**.
4. Aluminum Wire Fabric: 18-by-16 (1.1-by-1.3-mm) mesh of 0.011-inch- (0.28-mm-) diameter, coated aluminum wire.
    a. Wire-Fabric Finish: Natural bright **OR** Charcoal gray **OR** Black, **as directed**.
5. Wickets: Provide sliding **OR** hinged, **as directed**, wickets, framed and trimmed for a tight fit and for durability during handling.

F. Accessories
1. Dividers (False Muntins): Provide dividers in designs indicated for each sash lite, one per sash, removable from the exposed surface of interior lite of the sash **OR** two per sash, removable from the exposed surfaces of interior and exterior lites of the sash **OR** one permanently located between glazing lites in the airspace, **as directed**.
    a. Material: Extruded, rigid PVC **OR** Aluminum, **as directed**.
    b. Design: Rectangular **OR** Diamond, **as directed**.
    c. Color: White **OR** Beige, **as directed**.

G. Fabrication
1. Fabricate vinyl windows in sizes indicated. Include a complete system for assembling components and anchoring windows.
    a. Welded Frame and Sash/Ventilator Corners: Miter-cut and fusion **OR** chemically, **as directed**, welded.
    b. Mechanically Fastened Frame and Sash/Ventilator Corners: Double-butt coped and fastened with concealed screws, **as directed**.

2. Fabricate vinyl windows that are reglazable without dismantling sash or ventilator framing.
3. Weather Stripping: Provide full-perimeter weather stripping for each operable sash and ventilator, unless otherwise indicated.
   a. Double-Hung Windows: Provide weather stripping only at horizontal rails of operable sash.
4. Mullions: Provide mullions and cover plates as shown, compatible with window units, complete with anchors for support to structure and installation of window units. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections, as indicated. Provide mullions and cover plates capable of withstanding design loads of window units. Provide manufacturer's standard finish to match window units.
5. Subframes: Provide subframes with anchors for window units as shown, of profile and dimensions indicated but not less than 0.062-inch- (1.6-mm-) thick extruded aluminum. Miter or cope corners, and weld and dress smooth with concealed mechanical joint fasteners. Provide manufacturer's standard finish to match window units. Provide subframes capable of withstanding design loads of window units.
6. Factory-Glazed Fabrication: Except for light sizes in excess of 100 united inches (2500 mm width plus length), glaze vinyl windows in the factory where practical and possible for applications indicated. Comply with requirements in Division 08 Section "Glazing" and with AAMA/WDMA 101/I.S.2/NAFS.
7. Glazing Stops: Provide nailed or snap-on glazing stops coordinated with Division 08 Section "Glazing" and glazing system indicated. Provide glazing stops to match sash and ventilator frames.
8. Hardware: Mount hardware through double walls of vinyl extrusions or provide corrosion-resistant steel reinforcement complying with requirements for reinforcing members, or do both.
9. Bow **OR** Bay, **as directed**, Windows: Provide vinyl windows in configuration indicated. Provide window frames, fixed and operating sash, operating hardware, and other trim and components necessary for a complete, secure, and weathertight installation, including the following:
   a. Angled mullion posts with interior and exterior trim.
   b. Angled interior and exterior extension and trim.
   c. Clear pine head and seat boards.
   d. Top and bottom plywood platforms.
   e. Exterior head and sill casings and trim.
   f. Support brackets.
10. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation. Allow for scribing, trimming, and fitting at Project site.

H. Vinyl Finishes
   1. Integral Finish and Color: Uniform, solid, homogeneous white **OR** beige, **as directed**, interior and exterior.
   2. Organic Pigmented Finish: Manufacturer's standard finish, interior and exterior, complying with AAMA 613 **OR** AAMA 615, **as directed**, and paint manufacturer's written specifications for cleaning and painting.
      a. Color: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.

1.3 EXECUTION

A. Installation
   1. Comply with Drawings, Shop Drawings, and manufacturer's written instructions for installing windows, hardware, accessories, and other components.
   2. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction.
   3. Set sill members in bed of sealant or with gaskets, as indicated, for weathertight construction.

4. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

B. Adjusting, Cleaning, And Protection

1. Adjust operating sashes and ventilators, screens, hardware, and accessories for a tight fit at contact points and weather stripping for smooth operation and weathertight closure. Lubricate hardware and moving parts.
2. Clean exposed surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.
3. Clean factory-glazed glass immediately after installing windows. Comply with manufacturer's written recommendations for final cleaning and maintenance. Remove nonpermanent labels, and clean surfaces.
4. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.
5. Protect window surfaces from contact with contaminating substances resulting from construction operations. In addition, monitor window surfaces adjacent to and below exterior concrete and masonry surfaces during construction for presence of dirt, scum, alkaline deposits, stains, or other contaminants. If contaminating substances do contact window surfaces, remove contaminants immediately according to manufacturer's written recommendations.

END OF SECTION 08560

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SECTION 08580 - SECURITY WINDOWS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for security windows. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Vision security windows.
   b. Fixed, transaction security windows.
   c. Sliding, transaction security windows.

C. Performance Requirements
1. Ballistics-Resistance Performance: Provide units identical to those tested for compliance with requirements indicated, and as follows:
   a. Listed and labeled as bullet resisting according to UL 752.
   b. Tested for ballistics resistance according to UL 752 **OR** ASTM F 1233 **OR** HPW-TP-0500.03 **OR** NIJ STD-0108.01, **as directed**, by a testing agency acceptable to authorities having jurisdiction.
   c. Certified as complying with SD-STD-01.01, by the U.S. State Department, for ballistics resistance when tested by a qualified testing agency.
2. Forced-Entry-Resistance Performance: Provide units identical to those tested for compliance with requirements indicated, and as follows:
   a. Tested for forced-entry resistance according to HPW-TP-0500.03 **OR** ASTM F 1233, **as directed**, by a testing agency acceptable to authorities having jurisdiction.
   b. For Federal Government Work: Certified as complying with SD-STD-01.01, by the U.S. State Department, for forced-entry resistance when tested by a qualified testing agency.
3. Windborne-Debris-Impact-Resistance-Test Performance: Provide automatic entrances that pass large missile-impact and cyclic-pressure tests of ASTM E 1996 according to the IBC.
4. Structural Performance: Security windows shall withstand the effects of wind loads determined as follows, with no permanent deformation or breakage within window assembly when tested according to ASTM E 330:
   a. Basic Wind Speed: As indicated in miles per hour (meters per second) at 33 feet (10 m) above grade. Determine wind loads and resulting design pressures applicable to Project according to SEI/ASCE 7, "Minimum Design Loads for Buildings and Other Structures," Section 6.4.2, "Analytic Procedure," based on mean roof heights above grade as indicated on Drawings.
5. Air Infiltration for Operable Windows: Not more than 0.370 cfm/ft. (0.573 L/s per m) **OR** 0.500 cfm/ft. (0.774 L/s per m), **as directed**, of operable sash joint at an inward test pressure of 1.56 lbf/sq. ft. (75 Pa) when tested according to ASTM E 283.
6. Air Infiltration for Fixed Windows: Not more than 0.010 cfm/ft. (0.015 L/s per m) **OR** 0.060 cfm/ft. (0.093 L/s per m), **as directed**, of crack length at an inward test pressure of 1.56 lbf/sq. ft. (75 Pa) when tested according to ASTM E 283.
7. Water Penetration: No water penetration as defined in test method at an inward test pressure of 1.56 lbf/sq. ft. (75 Pa) **OR** 2.86 lbf/sq. ft. (137 Pa) **OR** 6.24 lbf/sq. ft. (300 Pa), **as directed**, when tested according to ASTM E 331.

D. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings.

3. Samples: For each type of exposed finish required.
4. Welding certificates.
5. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of security window and accessory indicated as ballistics **OR** forced-entry, **as directed**, resistant.
6. Configuration Disclosure Drawing: For each type of forced-entry-resistant security window, complying with ASTM F 1233.
7. Warranty: Sample of special warranty.

E. Quality Assurance
1. Testing Agency Qualifications: Qualified according to ASTM E 699 and experienced in ballistics- and forced-entry-resistance testing.
2. Welding Qualifications: Qualify procedures and personnel according to the following:
   a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   b. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
   c. AWS D1.3, "Structural Welding Code - Sheet Steel."
   d. AWS D1.6, "Structural Welding Code - Stainless Steel."
3. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Pack security windows in wood crates for shipment. Crate glazing separate from frames unless factory glazed.
2. Label security window packaging with location in Project **OR** drawing designation, **as directed**.
3. Store crated security windows on raised blocks to prevent moisture damage.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace security windows that fail in materials or workmanship within three years from date of Substantial Completion.

1.2 PRODUCTS

A. Materials
1. Aluminum Extrusions: ASTM B 221 (ASTM B 221M). Provide alloy and temper recommended by manufacturer for strength, corrosion resistance, and application of required finish, but not less than 22,000-psi (150-MPa) ultimate tensile strength and not less than 0.125 inch (3.2 mm) thick at any location for main frame and sash members.
2. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
3. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, CS (Commercial Steel), Type B; free of scale, pitting, or surface defects; pickled and oiled.
4. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, CS (Commercial Steel), Type B.
5. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, CS (Commercial Steel), Type B; with G60 (Z180) zinc (galvanized) or A60 (ZF180) zinc-iron-alloy (galvannealed) coating designation.
6. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 240/A 240M or ASTM A 666, austenitic stainless steel, Type 304 **OR** Type 316, **as directed**, stretcher-leveled standard of flatness.
7. Concealed Bolts: ASTM A 307, Grade A unless otherwise indicated.
8. Cast-in-Place Anchors in Concrete: Fabricated from corrosion-resistant materials capable of sustaining, without failure, a load equal to four times the load imposed, as determined by testing per ASTM E 488, conducted by a qualified testing agency.
   a. Threaded or wedge type; galvanized ferrous castings, either ASTM A 27/A 27M cast steel or ASTM A 47/A 47M malleable iron. Provide bolts, washers, and shims as required; hot-dip galvanized per ASTM A 153/A 153M or ASTM F 2329.

9. Embedded Plate Anchors: Fabricated from steel shapes and plates, minimum 3/16 inch (4.8 mm) thick; with minimum 1/2-inch- (12.7-mm-) diameter, headed studs welded to back of plate.
10. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
11. Bituminous Paint: Cold-applied, asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos; formulated for 30-mil (0.76-mm) thickness per coat.
12. Sealants: For sealants required within fabricated security windows, provide type recommended by manufacturer for joint size and movement. Sealant shall remain permanently elastic, nonshrinking, and nonmigrating.

B. Window Components
1. Glazing: Comply with requirements in Division 08 Section "Security Glazing" for performance indicated.
   a. Comply with requirements of UL listing for ballistics-resistance level.
2. Compression-Type Glazing Strips and Weather Stripping: Unless otherwise indicated, provide compressible stripping for glazing and weather stripping, such as molded EPDM or neoprene gaskets complying with ASTM D 2000, Designations 2BC415 to 3BC620; molded PVC gaskets complying with ASTM D 2287; or molded, expanded EPDM or neoprene gaskets complying with ASTM C 509, Grade 4.
3. Miscellaneous Glazing Materials: Provide material, size, and shape complying with requirements of glass manufacturers, and with a proven record of compatibility with surfaces contacted in installation.
   a. Cleaners, Primers, and Sealers: Type recommended by sealant or gasket manufacturer.
   b. Setting Blocks: Elastomeric material with a Type A Shore durometer hardness of 85, plus or minus 5.
   c. Spacers: Elastomeric blocks or continuous extrusions with a Type A Shore durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
   d. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
4. Anchors, Clips, and Window Accessories: Stainless steel; hot-dip, zinc-coated steel or iron, complying with ASTM B 633; provide sufficient strength to withstand design pressure indicated.

C. Vision Security Windows
1. Vision Security Windows: Provide fixed vision security windows with framing on four sides and no operable sash or ventilator.
2. Ballistics Resistance:
   a. Level 1 **OR** Level 2 **OR** Level 3 **OR** Level 4 **OR** Level 5 **OR** Level 6 **OR** Level 7 **OR** Level 8, **as directed**, when tested according to UL 752.
   b. HG1 **OR** HG2 **OR** HG3 **OR** HG4 **OR** SMG **OR** R1 **OR** R2 **OR** R3 **OR** R4-AP **OR** SH1 **OR** SH2, **as directed**, when tested according to ASTM F 1233.
   c. A **OR** B **OR** C **OR** D **OR** E, **as directed**, when tested according to HPW-TP-0500.03.
   d. S **OR** R **OR** AP **OR** SH, **as directed**, when tested according to SD-STD-01.01.
   e. Level I **OR** Level IIA **OR** Level II **OR** Level IIIA **OR** Level III **OR** Level IV, **as directed**, when tested according to NIJ STD-0108.01.
3. Forced-Entry Resistance:
   a. Level I **OR** Level II **OR** Level III **OR** Level IV **OR** Level V, **as directed**, when tested according to HPW-TP-0500.03.
   b. Class I **OR** Class II **OR** Class III **OR** Class IV **OR** Class V, **as directed**, when tested according to ASTM F 1233.
   c. Five **OR** 15 **OR** 60, **as directed**,-minute protection level when tested according to SD-STD-01.01.
4. Framing: Fabricate perimeter framing, mullions, and glazing stops from metal sheet as follows:
   a. Material:
      1) Cold-rolled steel sheet, factory primed for field-painted finish **OR** with baked-enamel finish, **as directed**.

2) Galvanized-steel sheet, factory primed for field-painted finish.
3) Stainless-steel sheet with No. 4 finish.
4) Aluminum-clad steel sheet with Class I, clear anodized **OR** Class II, clear anodized **OR** Class I, color anodized **OR** Class II, color anodized **OR** baked-enamel, **as directed**, finish.
5) Material: Extruded aluminum with Class I, clear anodized **OR** Class II, clear anodized **OR** Class I, color anodized **OR** Class II, color anodized **OR** baked-enamel, **as directed**, finish.

b. Profile: Manufacturer's standard **OR** Narrow, **as directed**, with minimum face dimension indicated.
c. Minimum Face Dimension: 2 inches (50 mm) **OR** 1-1/4 inches (32 mm) **OR** As indicated on Drawings, **as directed**.
d. Framing Depth:
1) Manufacturer's standard.
2) Adjustable for varying wall thicknesses by use of a two-piece, split frame that is attached to wall by clamping action induced by tightening screws.
3) As indicated on Drawings.
e. Framing Orientation: Vertical **OR** Incline subframe 5 degrees to vertical, with top of frame slanted away from protected side of window, **as directed**.

D. Fixed, Transaction Security Windows
1. Fixed, Transaction Security Windows: Provide fixed, framed transaction windows with operable sash or ventilator capable of allowing transfer of currency and documents.
2. Configuration: One fixed-glazed panel **OR** Multiple fixed-glazed panels **OR** As indicated on Drawings, **as directed**.
3. Ballistics Resistance:
a. Level 1 **OR** Level 2 **OR** Level 3 **OR** Level 4Level 5 **OR** Level 6 **OR** Level 7 **OR** Level 8, **as directed**, when tested according to UL 752.
b. HG1 **OR** HG2 **OR** HG3 **OR** HG4 **OR** SMG **OR** R1 **OR** R2 **OR** R3 **OR** R4-AP **OR** SH1 **OR** SH2, **as directed**, when tested according to ASTM F 1233.
c. A **OR** B **OR** C **OR** D **OR** E, **as directed**, when tested according to HPW-TP-0500.03.
d. S **OR** R **OR** AP **OR** SH, **as directed**, when tested according to SD-STD-01.01.
e. Level I **OR** Level IIA **OR** Level II **OR** Level IIIA **OR** Level III **OR** Level IV, **as directed**, when tested according to NIJ STD-0108.01.
4. Forced-Entry Resistance:
a. Level I **OR** Level II **OR** Level III **OR** Level IV **OR** Level V, **as directed**, when tested according to HPW-TP-0500.03.
b. Class I **OR** Class II **OR** Class III **OR** Class IV **OR** Class V, **as directed**, when tested according to ASTM F 1233.
c. Five **OR** 15 **OR** 60, **as directed**,-minute protection level when tested according to SD-STD-01.01.
5. Framing: Fabricate perimeter framing, mullions, and glazing stops from metal sheet as follows:
a. Material:
1) Cold-rolled steel sheet, factory primed for field-painted finish **OR** with baked-enamel finish, **as directed**.
2) Stainless-steel sheet with No. 4 finish.
3) Aluminum-clad steel sheet with Class I, clear anodized **OR** Class II, clear anodized **OR** Class I, color anodized **OR** Class II, color anodized **OR** baked-enamel, **as directed**, finish.
4) Extruded aluminum with Class I, clear anodized **OR** Class II, clear anodized **OR** Class I, color anodized **OR** Class II, color anodized **OR** baked-enamel, **as directed**, finish.
b. Profile: Manufacturer's standard **OR** Narrow, **as directed**, with minimum face dimension indicated.

c. Minimum Face Dimension: 2 inches (50 mm) **OR** 1-1/4 inches (32 mm) **OR** As indicated on Drawings, **as directed**.
d. Framing Depth:
1) Manufacturer's standard.
2) Adjustable for varying wall thicknesses by use of a two-piece, split frame that is attached to wall by clamping action induced by tightening screws.
3) As indicated on Drawings.
e. Provide thermally improved construction for aluminum framing.

6. Head and Jamb Framing: Designed for sealant glazing **OR** gasket glazing **OR** voice communication by speech at normal volume, **as directed**.
7. Channel-Frame Sill: Formed from stainless steel and designed for sealant glazing.
a. Transaction Counter: Stainless steel, 12 inches (305 mm) **OR** 18 inches (457 mm), **as directed**, deep by width of security window, with integral deal tray centered in opening **OR** as indicated on Drawings, **as directed**.
b. Transaction Counter: Stainless steel, 21 inches (533 mm) deep by width of security window, with operable deal tray centered in opening **OR** as indicated on Drawings, **as directed**.
8. Voice-Communication-Type Sill: Formed from stainless steel and designed to allow passage of speech at normal speaking volume without distortion.
a. Sill Depth: 12 inches (305 mm) deep **OR** 18 inches (457 mm) deep with 6-inch (152-mm) deep projection on nonsecure side **OR** 21 inches (533 mm) deep with 6-inch (152-mm) deep projection on both sides, **as directed**.
b. Transaction Counter: Stainless steel, 12 inches (305 mm) **OR** 18 inches (457 mm), **as directed**, deep by width of security window, with integral deal tray centered in opening **OR** as indicated on Drawings, **as directed**.
c. Integral Transaction-Drawer Sill: Formed from stainless steel **OR** framing to match head and jamb framing, **as directed**; with transaction drawer integrated into framing and contained in a stainless-steel housing that forms a transaction counter on secure side **OR** nonsecure side **OR** both sides, **as directed**, of opening. Drawer front shall be flush with housing when drawer is closed.

E. Sliding, Transaction Security Windows
1. Sliding, Transaction Security Windows: Provide horizontal-sliding, transaction security windows.
2. Configuration: One fixed-glazed panel and one horizontal-sliding glazed panel **OR** Two glazed panels that slide horizontally and meet at center of security window **OR** As indicated on Drawings, **as directed**.
3. Ballistics Resistance:
a. Level 1 **OR** Level 2 **OR** Level 3 **OR** Level 4 **OR** Level 5 **OR** Level 6 **OR** Level 7 **OR** Level 8, **as directed**, when tested according to UL 752.
b. HG1 **OR** HG2 **OR** HG3 **OR** HG4 **OR** SMG **OR** R1 **OR** R2 **OR** R3 **OR** R4-AP **OR** SH1 **OR** SH2, **as directed**, when tested according to ASTM F 1233.
c. A **OR** B **OR** C **OR** D **OR** E, **as directed**, when tested according to HPW-TP-0500.03.
d. S **OR** R **OR** AP **OR** SH, **as directed**, when tested according to SD-STD-01.01.
e. Level I **OR** Level IIA **OR** Level II **OR** Level IIIA **OR** Level III **OR** Level IV, **as directed**, when tested according to NIJ STD-0108.01.
4. Forced-Entry Resistance:
a. Level I **OR** Level II **OR** Level III **OR** Level IV **OR** Level V, **as directed**, when tested according to HPW-TP-0500.03.
b. Class I **OR** Class II **OR** Class III **OR** Class IV **OR** Class V, **as directed**, when tested according to ASTM F 1233.
c. Five **OR** 15 **OR** 60, **as directed**,-minute protection level when tested according to SD-STD-01.01.
5. Framing: Fabricate perimeter framing, mullions, and glazing stops from metal sheet as follows:
a. Material:
1) Cold-rolled steel sheet, factory primed for field-painted finish **OR** with baked-enamel finish, **as directed**.

2) Material: Stainless-steel sheet with No. 4 finish.
3) Material: Aluminum-clad steel sheet with Class I, clear anodized **OR** Class II, clear anodized **OR** Class I, color anodized **OR** Class II, color anodized **OR** baked-enamel, **as directed**, finish.
4) Material: Extruded aluminum with Class I, clear anodized **OR** Class II, clear anodized **OR** Class I, color anodized **OR** Class II, color anodized **OR** baked-enamel, **as directed**, finish.

b. Profile: Manufacturer's standard **OR** Narrow, **as directed**, with minimum face dimension indicated.
c. Minimum Face Dimension: 2 inches (50 mm) **OR** 1-1/4 inches (32 mm) **OR** As indicated on Drawings, **as directed**.
d. Framing Depth:
1) Manufacturer's standard.
2) Adjustable for varying wall thicknesses by use of a two-piece, split frame that is attached to wall by clamping action induced by tightening screws.
3) As indicated on Drawings.
e. Provide thermally improved construction for aluminum framing.

6. Head and Jamb Framing: Designed for sealant **OR** gasket, **as directed**, glazing.
7. Glazing Meeting Edges: Polished glazing.
8. Sill: Stainless-steel channel frame designed for sealant **OR** gasket, **as directed**, glazing.
a. Shelf: Stainless steel, 12 inches (305 mm) **OR** 18 inches (457 mm), **as directed**, deep by width of security window, with integral deal tray.
9. Sliding Window Hardware: Provide roller track designed for overhead support of two- or four-wheel carriage supporting horizontal-sliding glazed panel. Provide manufacturer's standard pull and lock with two keys for each horizontal-sliding glazed panel.
a. Provide weather stripping for exterior horizontal-sliding, transaction security windows.

F. Accessories
1. Recessed Deal Trays: Formed from stainless steel with sliding stainless-steel cover, **as directed**; fabricated in curved shape with exposed flanges for recessed installation into horizontal surface.
a. Clear Opening Size: 12 inches wide by 8 inches deep by 1-1/2 inches high (305 mm wide by 203 mm deep by 38 mm high) **OR** 12 inches wide by 11 inches deep by 1-1/2 inches high (305 mm wide by 279 mm deep by 38 mm high) **OR** 16 inches wide by 11 inches deep by 1-1/2 inches high (406 mm wide by 279 mm deep by 38 mm high), **as directed**.
2. Recessed, Nonricochet Deal Trays: Formed from stainless steel; fabricated with recessed bullet trap to ricochet bullets away from secure side, with exposed flanges for recessed installation into horizontal surface, and with sliding stainless-steel cover, **as directed**.
a. Clear Opening Size: 10 inches wide by 7 inches deep by 1-1/2 inches high (254 mm wide by 178 mm deep by 38 mm high) **OR** 12 inches wide by 8 inches deep by 1-1/2 inches high (305 mm wide by 203 mm deep by 38 mm high) **OR** 12 inches wide by 11 inches deep by 1-1/2 inches high (305 mm wide by 279 mm deep by 38 mm high) **OR** 16 inches wide by 11 inches deep by 1-1/2 inches high (406 mm wide by 279 mm deep by 38 mm high), **as directed**.
b. Bullet Trap Location: Secure side **OR** Both sides, **as directed**.
c. Ballistics Resistance: UL Level 1 **OR** UL Level 3 **OR** Same as security window, **as directed**.
d. Listed and labeled as bullet resisting according to UL 752.
3. Rotating Deal Trays: Formed from stainless steel, with rotating recessed deal tray on each side of secure opening and with handle that rotates deal trays 180 degrees.
a. Mounting: Drop in **OR** Countertop, **as directed**.
b. Ballistics Resistance: UL Level 1 **OR** UL Level 3 **OR** Same as security window, **as directed**.
c. Listed and labeled as bullet resisting according to UL 752.

4. Transaction Drawers: Formed from stainless steel **OR** steel **OR** bullet-resistant armoring, **as directed**; with ball-bearing, telescoping sliding mechanism; with cover on secure side of top of drawer that automatically closes when drawer is extended to nonsecure side.
   a. Inside Dimensions: 15-3/8 inches wide by 8-1/2 inches deep by 4-3/8 inches high (390 mm wide by 216 mm deep by 111 mm high) **OR** 13 inches wide by 22 inches deep by 6-1/2 inches high (330 mm wide by 559 mm deep by 165 mm high), **as directed**.
   b. Operation:
      1) Manual.
      2) Electric, with sliding handle for emergency manual operation during lack of power. Provide individual switches for power and drawer movement on secure side and call button on nonsecure side.
   c. Ballistics Resistance: UL Level 1 **OR** UL Level 3 **OR** Same as security window, **as directed**.
   d. Listed and labeled as bullet resisting according to UL 752.
5. Speaking Apertures: Fabricate from stainless steel **OR** security glazing, **as directed**, designed to allow passage of speech at normal speaking volume without distortion.
   a. Shape: Circular **OR** Square, **as directed**.
   b. Ballistics Resistance: UL Level 1 **OR** UL Level 3 **OR** Same as security window, **as directed**.
   c. Listed and labeled as bullet resisting according to UL 752.

G. Fabrication
1. General: Fabricate security windows to provide a complete system for assembly of components and anchorage of window units.
   a. Provide units that are reglazable from the secure side without dismantling the nonsecure side of framing.
   b. Prepare security windows for glazing unless preglazing at the factory is indicated.
2. Provide weep holes and internal water passages for exterior security windows to conduct infiltrating water to the exterior.
3. Framing: Miter or cope corners the full depth of framing; weld and dress smooth.
   a. Fabricate framing with manufacturer's standard, internal opaque armoring in thicknesses required for security windows to comply with ballistics-resistance performance indicated.
4. Glazing Stops: Finish glazing stops to match security window framing.
   a. Secure-Side (Exterior) Glazing Stops: Welded or integral to framing.
   b. Nonsecure-Side (Interior) Glazing Stops: Removable, coordinated with glazing indicated.
5. Welding: Weld components to comply with referenced AWS standard. To greatest extent possible, weld before finishing and in concealed locations to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
6. Metal Protection: Separate dissimilar metals to protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
7. Factory-cut openings in glazing for speaking apertures.
8. Preglazed Fabrication: Preglaze window units at factory, where required for applications indicated. Comply with requirements in Division 08 Section "Security Glazing".
9. Weather Stripping: Factory applied.

H. Aluminum Finishes
1. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
2. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
   a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black, **as directed**.
3. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

a. Color and Gloss: As selected from manufacturer's full range.

I. Metallic-Coated Steel Sheet Finishes
1. Surface Preparation: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas and apply galvanizing repair paint, complying with SSPC-Paint 20, to comply with ASTM A 780.
2. Factory Prime Finish: Apply an air-dried primer, complying with SSPC-Paint 5, immediately after cleaning and pretreating.
3. Baked-Enamel or Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard 2-coat, baked-on finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil (0.025 mm) for topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils (0.05 mm).
a. Color and Gloss: As selected from manufacturer's full range.

J. Stainless-Steel Finishes
1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
a. Run grain of directional finishes with long dimension of each piece.
b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
c. Directional Satin Finish: No. 4.

1.3 EXECUTION

A. Installation
1. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing security windows to in-place construction. Include threaded fasteners for concrete and masonry inserts, security fasteners, and other connectors.
a. Install an attached or integral flange to secure side of security windows extending over rough-in opening gap so that gap has same forced-entry-resistance and ballistics-resistance performance as security window.
2. Voice-Communication-Type Framing: Attach removable glass spacers to jambs and head of glazing, located not more than 6 inches (152 mm) from each corner and spaced not more than 12 inches (305 mm) o.c.
3. Glazed Framing: Provide sealant **OR** gasket, **as directed**,-glazed framing. Comply with installation requirements in Division 08 Section "Security Glazing".
4. Removable Glazing Stops and Trim: Fasten components with security fasteners.
5. Fasteners: Install security windows using fasteners recommended by manufacturer with head style appropriate for installation requirements, strength, and finish of adjacent materials. Provide stainless-steel fasteners in stainless-steel materials, **as directed**.
6. Sealants: Comply with requirements in Division 07 Section "Joint Sealants" for installing sealants, fillers, and gaskets.
a. Set continuous sill members and flashing in a full sealant bed to provide weathertight construction unless otherwise indicated.
b. Seal frame perimeter with sealant to provide weathertight construction unless otherwise indicated.
7. Metal Protection: Where dissimilar metals will contact each other, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended in writing by manufacturer for this purpose. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

B. Adjusting

1. Adjust horizontal-sliding, transaction security windows to provide a tight fit at contact points for smooth operation and a secure enclosure.
2. Adjust transaction drawers to provide a tight fit at contact points and weather stripping for smooth operation and weathertight and secure enclosure.
3. Remove and replace defective work, including security windows that are warped, bowed, or otherwise unacceptable.

C. Cleaning And Protection
1. Clean surfaces promptly after installation of security windows. Take care to avoid damaging the finish. Remove excess glazing and sealant compounds, dirt, and other substances.
   a. Lubricate sliding security window hardware.
   b. Lubricate transaction drawer hardware.
2. Clean glass of preglazed security windows promptly after installation. Comply with requirements in Division 08 Section "Security Glazing" for cleaning and maintenance.
3. Provide temporary protection to ensure that security windows are without damage at time of Substantial Completion.

END OF SECTION 08580

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Task	Specification	Specification Description
08580	08340	Detention Doors And Frames
08580	08520	Aluminum Windows
08590	08550	Wood Windows

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SECTION 08620 - UNIT SKYLIGHTS

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for unit skylights. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Self-flashing unit skylights with integral curb.
   b. Unit skylights mounted on prefabricated **OR** site-built, **as directed**, curbs.

C. Performance Requirements
1. AAMA/WDMA Performance Requirements: Provide unit skylights of performance class and grade indicated that comply with AAMA/WDMA 101/I.S.2/NAFS unless more stringent performance requirements are indicated.
   a. Performance Class and Grade:
      1) SKG-R15/15-1200x1200 **OR** SKP-R15/15-1200x1200, **as directed**.
      2) SKG-C30/30-1200x1200 **OR** SKP-C30/30-1200x1200, **as directed**.
      3) SKG-HC40/40-1200x2500 **OR** SKP-HC40/40-1200x2500, **as directed**.
      4) As indicated.
2. Windborne-Debris-Impact-Resistance Performance: Provide unit skylights that pass missile-impact and cyclic-pressure tests when tested according to ASTM E 1886 and testing information in ASTM E 1996 **OR** AAMA 506, **as directed**.
   a. Large-Missile Impact: For unit skylights located within 30 feet (9.1 m) of grade.
   b. Small-Missile Impact: For unit skylights located more than 30 feet (9.1 m) above grade.

D. Submittals
1. Product Data: For each type of unit skylight indicated.
2. Shop Drawings: For unit skylight work. Include plans, elevations, sections, details, and connections to supporting structure and other adjoining work.
   a. Unit Skylight Operating System: Show locations, mounting, and details for installing operator components and controls.
   b. Unit Skylight Operating System: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
   c. Wiring Diagrams: For power, signal, and control wiring for electric motors of operable unit skylights.
3. Samples: For each type of exposed finish required, in a representative section of each unit skylight in manufacturer's standard size.
4. Qualification Data.
5. Product Test Reports.
6. Field quality-control reports.
7. Maintenance Data: For unit skylights and unit skylight operating system to include in maintenance manuals.
8. Warranty: Sample of special warranty.

E. Quality Assurance
1. Manufacturer Qualifications: A manufacturer capable of fabricating unit skylights that meet or exceed performance requirements indicated and of documenting this performance by inclusion in lists and by labels, test reports, and calculations.

2. Installer Qualifications: An installer acceptable to unit skylight manufacturer for installation of units required for this Project.
3. Surface-Burning Characteristics of Plastic Glazing: Provide plastic glazing sheets identical to those tested for fire-exposure behavior per test method indicated below by a testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
   a. Self-Ignition Temperature: 650 deg F (343 deg C) or more for plastic sheets in thickness indicated when tested per ASTM D 1929.
   b. Smoke-Production Characteristics: Comply with either requirement below:
      1) Smoke-Developed Index: 450 or less when tested per ASTM E 84 on plastic sheets in manner indicated for use.
      2) Smoke Density: 75 or less when tested per ASTM D 2843 on plastic sheets in thickness indicated for use.
   c. Burning Characteristics: Tested per ASTM D 635.
      1) Acrylic Glazing: Class CC2, burning rate of 2-1/2 inches (64 mm) per minute or less for nominal thickness of 0.060 inch (1.5 mm) or thickness indicated for use.
      2) Polycarbonate Glazing: Class CC1, burning extent of 1 inch (25 mm) or less for nominal thickness of 0.060 inch (1.5 mm) or thickness indicated for use.
      3) Polycarbonate-Insulating-Panel Glazing: Class CC2, burning rate of 2-1/2 inches (64 mm) per minute or less for nominal thickness of 0.060 inch (1.5 mm) or thickness indicated for use.
4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
5. Unit Skylight Standard: Comply with AAMA/WDMA 101/I.S.2/NAFS, "North American Fenestration Standard Voluntary Performance Specification for Windows, Skylights and Glass Doors," for minimum standards of performance, materials, components, accessories, and fabrication. Comply with more stringent requirements if indicated.
   a. Provide AAMA-certified unit skylights with an attached label.
6. Preinstallation Conference: Conduct conference at Project site.

F. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of unit skylights that fail in materials or workmanship within five years from date of Substantial Completion.

1.2 PRODUCTS

A. Materials
1. Aluminum Components:
   a. Sheets: ASTM B 209 (ASTM B 209M), alloy and temper to suit forming operations and finish requirements but with not less than the strength and durability of alclad Alloy 3005-H25.
   b. Extruded Shapes: ASTM B 221 (ASTM B 221M), alloy and temper to suit structural and finish requirements but with not less than the strength and durability of Alloy 6063-T52.
2. Fasteners: Same metal as metal being fastened, nonmagnetic stainless steel, or other noncorrosive metal as recommended by manufacturer. Finish exposed fasteners to match material being fastened.
   a. Where removal of exterior exposed fasteners might allow access to building, provide nonremovable fastener heads.

B. Glazing
1. Acrylic Glazing: ASTM D 4802, thermoformable, monolithic sheet, category as standard with manufacturer, Finish 1 (smooth or polished), Type UVF (formulated with UV absorber).
   a. Single-Glazing Profile: Dome, 25 percent rise **OR** Pyramid, 30-degree slope, **as directed**.

1) Thickness: As indicated **OR** Not less than thickness required to exceed performance requirements, **as directed**.
2) Color: Colorless, transparent **OR** White, translucent **OR** Bronze-tinted, transparent **OR** Gray-tinted, transparent, **as directed**.

b. Double-Glazing Profile: Dome, 25 percent rise **OR** Pyramid, 30-degree slope, **as directed**.
1) Thicknesses: As indicated **OR** Not less than thicknesses required to exceed performance requirements, **as directed**.
2) Outer Glazing Color: Colorless, transparent **OR** White, translucent **OR** Bronze-tinted, transparent **OR** Gray-tinted, transparent, **as directed**.
3) Inner Glazing Color: Colorless, transparent **OR** White, translucent **OR** Bronze-tinted, transparent **OR** Gray-tinted, transparent, **as directed**.

2. Polycarbonate Glazing: Thermoformable, extruded monolithic sheets, UV resistant, burglar-resistance rated per UL 972, and with average impact strength of 12 to 16 ft-lb/in. (640 to 854 J/m) of width when tested per ASTM D 256, Test Method A (Izod).
a. Single-Glazing Profile: Dome, 25 percent rise **OR** Pyramid, 30-degree slope, **as directed**.
1) Thickness: As indicated **OR** Not less than thickness required to exceed performance requirements, **as directed**.
2) Color: As indicated by manufacturer's designations **OR** As selected from full range of industry colors, **as directed**.

b. Double-Glazing Profile: Dome, 25 percent rise **OR** Pyramid, 30-degree slope, **as directed**.
1) Thicknesses: As indicated **OR** Not less than thicknesses required to exceed performance requirements, **as directed**.
2) Inner Glazing Color: As indicated by manufacturer's designations **OR** As selected from full range of industry colors, **as directed**.
3) Outer Glazing Color: As indicated by manufacturer's designations **OR** As selected from full range of industry colors, **as directed**.

3. Insulating Glass: Clear, sealed units that comply with Division 08 Section "Glazing", in manufacturer's standard overall thickness.
a. Exterior Lite: 1/4-inch (6-mm) clear **OR** tinted, **as directed,** heat-strengthened **OR** fully tempered, **as directed**, glass.
b. Interior Lite:
1) Laminated glass; 2 plies of 1/8-inch (3-mm) clear heat-strengthened glass with 0.030-inch (0.762-mm) clear polyvinyl butyral interlayer.
2) 1/4-inch (6-mm) clear **OR** tinted, **as directed,** heat-strengthened **OR** fully tempered **OR** wire, **as directed**, glass.
c. Interspace Content: Air **OR** Argon, **as directed**.
d. Low-Emissivity Coating: Manufacturer's standard.

4. Polycarbonate-Insulating-Panel Glazing: Manufacturer's standard polycarbonate sheet with cellular cross section that provides isolated airspaces and that is coextruded with a UV-protective layer.
a. Thickness: As indicated **OR** Not less than thickness required to exceed performance requirements, **as directed**.
b. Color: As indicated by manufacturer's designations **OR** As selected from full range of industry colors, **as directed**.

5. Fiberglass-Sandwich-Panel Glazing: Manufacturer's standard with uniformly colored, translucent, fiberglass-reinforced-polymer face sheets permanently adhered to a grid core.
a. Thickness: As indicated **OR** Not less than thickness required to exceed performance requirements, **as directed**.
b. Color: As indicated by manufacturer's designations **OR** As selected from full range of industry colors, **as directed**.

6. Glazing Gaskets: Manufacturer's standard **OR** EPDM, neoprene, partially vulcanized butyl tape, or liquid-applied elastomeric sealant, **as directed**.

C. Installation Materials
1. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic, nominally free of sulfur and containing no asbestos fibers, formulated for 15-mil (0.4-mm) dry film thickness per coating.

2. Joint Sealants: As specified inDivision 07 Section "Joint Sealants".
3. Mastic Sealant: Polyisobutylene; nonhardening, nonskinning, nondrying, nonmigrating sealant.
4. Roofing Cement: ASTM D 4586, asbestos free, designed for trowel application or other adhesive compatible with roofing system.

D. Unit Skylights
1. General: Provide factory-assembled unit skylights that include glazing, extruded-aluminum glazing retainers, gaskets, and inner frames and that are capable of withstanding performance requirements indicated.
2. Integral Curb: Extruded-aluminum **OR** Vinyl **OR** Reinforced-thermoset-fiberglass profile, **as directed**, self-flashing type.
   a. Height: As indicated **OR** 8 inches (200 mm) **OR** 9 inches (225 mm) **OR** 12 inches (300 mm), **as directed**.
   b. Construction: Single **OR** Double, **as directed**, wall.
   c. Insulation: Manufacturer's standard rigid or semirigid type.
3. Prefabricated Curb: As specified in Division 07 Section "Roof Accessories".
4. Site-Built Curb: As indicated.
5. Unit Shape and Size: As indicated **OR** Square, 40-by-40-inch (1016-by-1016-mm) inside curb **OR** Rectangular, 40-by-48-inch (1016-by-1220-mm) inside curb **OR** Circular, 40-inch- (1016-mm-) diameter inside curb, **as directed**.
6. Condensation Control: Fabricate unit skylights with integral internal gutters and non-clogging weeps to collect and drain condensation to the exterior.
7. Thermal Break: Fabricate unit skylights with thermal barrier separating exterior and interior metal framing.
8. Operable Unit Skylight System: Equip vent-type unit skylights with manufacturer's standard hinges, chain-driven operating hardware, and weather-sealing gaskets.
   a. Manual Operator: Manufacturer's standard, rotary-crank extension device.
      1) Pole Operator: Manual, 60 inches (1524 mm) long **OR** Manual, telescoping to 144 inches (3658 mm) **OR** Rechargeable-motor power-driven type, telescoping to 144 inches (3658 mm), **as directed**.
   b. Motor Operator: Manufacturer's standard electronic control, including switch, transformer, low-voltage motor, cover, and mounting hardware.
      1) Provide motor of size and capacity recommended by unit skylight manufacturer to suit unit skylight indicated.
      2) Provide rain sensor that automatically closes venting unit when water is detected.
      3) Provide motor operator with portable remote-control device.
9. Security Grilles: 1/2-inch- (13-mm-) diameter, hardened steel bars spaced not more than 5 inches (130 mm) o.c. in 1 direction and 16 inches (400 mm) o.c. in other direction **OR** 5 inches (130 mm) o.c. in both directions, **as directed**.
10. Protective Screens: Manufacturer's standard to protect interior glazing lite from breakage **OR** personnel from falls **OR** against windborne debris **OR** against hail, **as directed**.

E. General Finish Requirements
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

F. Aluminum Finishes
1. Mill Finish: Manufacturer's standard.
2. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
3. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.

a. Color: As selected from full range of industry colors and color densities.

4. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
5. High-Performance Organic Finish: 2-coat fluoropolymer finish complying with AAMA 2604 **OR** AAMA 2605, **as directed**, and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
6. High-Performance Organic Finish: 3 **OR** 4, **as directed**,-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

1.3 EXECUTION

A. Installation
1. Coordinate installation of unit skylight with installation of substrates, vapor retarders, roof insulation, roofing membrane, and flashing as required to ensure that each element of the Work performs properly and that combined elements are waterproof and weathertight.
2. Comply with recommendations in AAMA 1607 and with manufacturer's written instructions for installing unit skylights.
3. Install unit skylights level, plumb, and true to line, without distortion.
4. Anchor unit skylights securely to supporting substrates.
5. Where metal surfaces of unit skylights will contact incompatible metal or corrosive substrates, including preservative-treated wood, apply bituminous coating on concealed metal surfaces, or provide other permanent separation recommended in writing by unit skylight manufacturer.
6. Set unit skylight flanges in thick bed of roofing cement to form a seal unless otherwise indicated.
7. Where cap flashing is indicated, install to produce waterproof overlap with roofing or roof flashing. Seal with thick bead of mastic sealant except where overlap is indicated to be left open for ventilation.

B. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. After completion of installation and nominal curing of sealant and glazing compounds but before installation of interior finishes, test for water leaks according to AAMA 501.2.
3. Perform test for total area of each unit skylight.
4. Work will be considered defective if it does not pass tests and inspections.
5. Additional testing and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

C. Cleaning
1. Clean exposed unit skylight surfaces according to manufacturer's written instructions. Touch up damaged metal coatings and finishes.
2. Remove excess sealants, glazing materials, dirt, and other substances.
3. Remove and replace glazing that has been broken, chipped, cracked, abraded, or damaged during construction period.
4. Protect unit skylight surfaces from contact with contaminating substances resulting from construction operations.

5. Unit Skylight Operating System: Clean and lubricate joints and hardware. Adjust for proper operation.

END OF SECTION 08620

SECTION 08630 - METAL-FRAMED SKYLIGHTS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for metal-framed skylights. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes aluminum-framed skylights with the following characteristics:
   a. Glazing is glass **OR** plastic, **as directed**.
   b. Glazing is retained by field-installed pressure caps on four sides **OR** field-installed structural sealant at horizontal members (purlins) and pressure caps at rafters **OR** factory-installed structural sealant on four sides, **as directed**.

C. Performance Requirements
1. Provide metal-framed skylights, including anchorage, capable of withstanding, without failure, the effects of the following:
   a. Structural loads.
   b. Thermal movements.
   c. Movements of supporting structure.
   d. Dimensional tolerances of building frame and other adjacent construction.
2. Failure includes the following:
   a. Deflection exceeding specified limits.
   b. Water leakage.
   c. Thermal stresses transferred to building structure.
   d. Noise or vibration created by wind and thermal and structural movements.
   e. Framing members transferring stresses, including those caused by thermal and structural movements, to glazing.
   f. Loosening or weakening of fasteners, attachments, and other components.
   g. Sealant failure.
3. Structural Loads:
   a. Wind Loads: As indicated by structural design data on Drawings **OR as directed**.
   b. Snow Loads: As indicated by structural design data on Drawings **OR as directed**.
   c. Concentrated Live Loads: 250 lbf (1112 N) applied to framing members at locations that will produce greatest stress or deflection.
   d. Seismic Loads: As indicated by earthquake design data on Drawings **OR as directed**.
   e. Load Combinations: Calculate according to requirements of applicable code indicated on Drawings **OR as directed**.
4. Deflection of Framing Members:
   a. Deflection Normal to Glazing Plane:
      1) Spans Up to 20 Feet (6 m): Limited to 1/175 **OR** 1/180, **as directed**, of clear span or 1 inch (25.4 mm), whichever is smaller.
      2) Spans Exceeding 20 Feet (6 m): Limited to 1/240 of clear span.
      3) Glass Edge Deflection: Limit edge deflection of individual glass lites to 3/4 inch (19 mm).
   b. Deflection Parallel to Glazing Plane: Limited to 1/360 of clear span or 1/8 inch (3.2 mm), whichever is smaller **OR** amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch (3.2 mm), **as directed**.

5. Lateral Bracing of Framing Members: Compression flanges of flexural members are laterally braced by cross members with minimum depth equal to 50 percent of flexural member that is braced. Glazing does not provide lateral support.
6. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
7. Structural-Sealant Glazing:
   a. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by metal-framed skylight assemblies without failing adhesively or cohesively. Sealant fails cohesively before sealant releases from substrate when tested for adhesive compatibility with each substrate and joint condition required.
      1) Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
      2) Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant's internal strength.
   b. Structural-Sealant Joints: Designed to produce tensile or shear stress in structural-sealant joints of less than 20 psi (138 kPa).
      1) Structural-sealant joints do not carry gravity loads of glazing.

D. Performance Testing
1. Provide metal-framed skylights that comply with test-performance requirements indicated, as evidenced by reports of tests performed on manufacturer's standard assemblies by a qualified independent testing agency.
2. Structural-Performance Test: ASTM E 330.
   a. Performance at Design Load: When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
   b. Performance at Maximum Test Load: When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main supporting members exceeding 0.2 percent of span.
   c. Test Durations: As required by design wind velocity but not less than 10 seconds.
3. Air-Infiltration Test: ASTM E 283.
   a. Minimum Static-Air-Pressure Difference: 1.57 lbf/sq. ft. (75 Pa) which is equivalent to a 25-mph (40-km/h) wind **OR** 6.24 lbf/sq. ft. (300 Pa) which is equivalent to a 50-mph (80-km/h) wind, **as directed**.
   b. Maximum Air Leakage: 0.06 cfm/sq. ft. (0.30 L/s per sq. m).
4. Test for Water Penetration under Static Pressure: ASTM E 331.
   a. Minimum Static-Air-Pressure Difference: 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa).
   b. Water Leakage: None.
5. Test for Water Penetration under Dynamic Pressure: AAMA 501.1.
   a. Dynamic Pressure: 20 percent of positive wind-load design pressure, but not less than 12 lbf/sq. ft. (574 Pa).
   b. Water Leakage: None, as defined by AAMA 501.1 **OR** No uncontrolled water penetrating systems or appearing on systems' normally exposed interior surfaces from sources other than condensation, **as directed**. Water controlled by flashing and gutters that is drained to exterior and cannot damage adjacent materials or finishes is not considered water leakage.

E. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:

a. Product Data for Credit EQ 4.1: For sealants used inside of the weatherproofing system, including printed statement of VOC content.

3. Shop Drawings: For metal-framed skylights. Include plans, elevations, sections, details, and attachments to other work.
   a. Include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
4. Samples: For each exposed finish.
5. Compatibility Test Reports: For structural-sealant-glazed skylights, preconstruction test reports from structural- and nonstructural-sealant manufacturer indicating that materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants. Include sealant manufacturer's interpretation of test results for sealant performance and written recommendations for primers and substrate preparation needed for adhesion.
6. Field quality-control test and inspection reports.
7. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for metal-framed skylights.
8. Structural-Sealant-Glazing, Quality-Control Program: Developed specifically for Project.
9. Structural-Sealant-Glazing, Quality-Control Program Reports: Documenting quality-control procedures and verifying results for metal-framed skylights.
10. Maintenance Data: For metal-framed skylights to include in maintenance manuals.
11. Warranties: Special warranties specified in this Section.

F. Quality Assurance
1. Installer Qualifications: Entity capable of assuming engineering responsibility and performing work of this Section and who is acceptable to manufacturer.
2. Compatibility Testing: For structural-sealant-glazed skylights, perform structural- and nonstructural-sealant manufacturer's standard preconstruction tests for compatibility and adhesion of sealants with each material that will come in contact with sealants and each condition required by metal-framed skylights.
3. Welding: Qualify procedures and personnel according to AWS D1.2, "Structural Welding Code - Aluminum."
4. Structural-Sealant Glazing: Comply with recommendations in ASTM C 1401, "Guide for Structural Sealant Glazing," for joint design and quality-control procedures.
   a. Joint designs are reviewed and approved by structural-sealant manufacturer.
5. Preinstallation Conference: Conduct conference at Project site.

G. Warranty
1. Special Assembly Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal-framed skylights that fail in materials or workmanship within specified warranty period.
   a. Failures include, but are not limited to, the following:
      1) Structural failures including, but not limited to, excessive deflection.
      2) Noise or vibration caused by thermal movements.
      3) Deterioration of metals, metal finishes, and other materials beyond normal weathering.
      4) Adhesive or cohesive sealant failures.
      5) Water leakage.
   b. Warranty Period: Two **OR** Five **OR** 10, **as directed**, years from date of Substantial Completion.
2. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes fail within specified warranty period. Warranty does not include normal weathering.
   a. Failures include, but are not limited to, checking, crazing, peeling, chalking, and fading of finishes.
   b. Warranty Period: Five **OR** 10 **OR** 20, **as directed**, years from date of Substantial Completion.

1.2 PRODUCTS

A. Framing Systems
1. Aluminum: Alloy and temper recommended in writing by manufacturer for type of use and finish indicated.
   a. Sheet and Plate: ASTM B 209 (ASTM B 209M).
   b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
   c. Extruded Structural Pipe and Tubes: ASTM B 429.
2. Pressure Caps: Manufacturer's standard aluminum components that mechanically retain glazing.
   a. Include snap-on aluminum trim that conceals fasteners.
3. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning skylight components.
4. Anchors, Fasteners, and Accessories: Manufacturer's standard, corrosion-resistant, nonstaining, and nonbleeding; compatible with adjacent materials.
   a. At pressure caps, use ASTM A 193/A 193M, 300 series stainless-steel screws.
   b. Where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
   c. Exposed Fasteners:
      1) Use exposed fasteners with countersunk Phillips screw heads.
   d. Finish exposed portions to match framing system.
   e. At movement joints, use slip-joint linings, spacers, and sleeves of material and type recommended in writing by manufacturer.
5. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.
6. Anchor Bolts: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), hot-dip zinc coating, ASTM A 153/A 153M, Class C **OR** mechanically deposited zinc coating, ASTM B 695, Class 50, **as directed**.
7. Concealed Flashing: Manufacturer's standard, corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials **OR** Dead-soft, 0.018-inch- (0.457-mm-) thick stainless steel, ASTM A 240/A 240M of type recommended in writing by manufacturer, **as directed**.
8. Exposed Flashing and Closures: Manufacturer's standard aluminum components not less than 0.030 inch (0.762 mm) **OR** 0.040 inch (1.016 mm) **OR** 0.060 inch (1.524 mm), **as directed**, thick.
9. Framing Gaskets: Manufacturer's standard.
10. Framing Sealants: As recommended in writing by manufacturer **OR** specified in Division 07 Section "Joint Sealants", **as directed**.
    a. Provide sealants for use inside of the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Glazing Systems
1. Glazing: As specified in Division 08 Section(s) "Glazing" OR "Plastic Glazing", **as directed**.
2. Spacers, Setting Blocks, and Gaskets: Manufacturer's standard elastomeric types **OR** As specified in Division 08 Section "Glazing", **as directed**.
3. Bond-Breaker Tape: Manufacturer's standard tetrafluoroethylene-fluorocarbon or polyethylene material to which sealants will not develop adhesion.
4. Glazing Sealants: As recommended in writing by manufacturer **OR** specified in Division 07 Section "Joint Sealants", **as directed**.
   a. Provide sealants for use inside of the weatherproofing system that have a VOC content as indicated when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   b. Structural Sealant: ASTM C 1184, neutral-curing silicone formulation compatible with system components with which it comes in contact, specifically formulated and tested for use as structural sealant, and approved by structural-sealant manufacturer for use in metal-framed skylights indicated.
      1) VOC Content: 100 g/L or less.
      2) Color: Black **OR** As selected from manufacturer's full range, **as directed**.

c. Weatherseal Sealant: ASTM C 920 for Type S, Grade NS, Class 25, Uses NT, G, A, and O; neutral-curing silicone formulation compatible with structural sealant and other components with which it comes in contact; and recommended in writing by structural- and weatherseal-sealant and metal-framed skylight manufacturers for this use.
   1) VOC Content: 250 g/L or less.
   2) Color: Matching structural sealant.

C. Accessory Materials
1. Insulating Materials: Specified in Division 07 Section "Building Insulation".
2. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.

D. Fabrication
1. Fabricate aluminum components before finishing.
2. Fabricate aluminum components that, when assembled, have the following characteristics:
   a. Profiles that are sharp, straight, and free of defects or deformations.
   b. Accurately fitted joints with ends coped or mitered.
   c. Internal guttering systems or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within skylight to exterior.
   d. Physical and thermal isolation of glazing from framing members.
   e. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
3. Fabricate aluminum sill closures with weep holes and for installation as continuous component.
4. Reinforce aluminum components as required to receive fastener threads.
5. Weld aluminum components in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
6. Factory-Glazed Units:
   a. Factory install glazing to comply with requirements in Division 08 Section(s) "Glazing" OR "Plastic Glazing", **as directed**.
   b. Prepare surfaces that will contact structural sealant according to structural-sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.
7. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

E. Aluminum Finishes
1. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
3. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.
4. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
5. Class I, Color Anodic Finish: AA-M12C22A42/A44 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
   a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** Match sample **OR** As selected from full range of industry colors and color densities, **as directed**.
6. High-Performance Organic Finish (2-Coat Fluoropolymer): AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coating; Organic Coating: manufacturer's standard 2-coat, thermocured system consisting of specially formulated inhibitive

primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2604 **OR** AAMA 2605, **as directed**, and with coating and resin manufacturers' written instructions.

7. High-Performance Organic Finish (3-Coat Fluoropolymer): AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coating; Organic Coating: manufacturer's standard 3-coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2605 and with coating and resin manufacturers' written instructions.
   a. Color and Gloss: As selected from manufacturer's full range.

F. Source Quality Control
   1. Structural-Sealant Glazing: Perform quality-control procedures complying with ASTM C 1401 recommendations including, but not limited to, material qualification procedures, sealant testing, and fabrication reviews and checks.

1.3 EXECUTION

A. Installation
   1. General:
      a. Comply with manufacturer's written instructions.
      b. Do not install damaged components.
      c. Fit joints between aluminum components to produce hairline joints free of burrs and distortion.
      d. Rigidly secure nonmovement joints.
      e. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
      f. Weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
      g. Seal joints watertight, unless otherwise indicated.
   2. Metal Protection: Where aluminum will contact dissimilar materials, protect against galvanic action by painting contact surfaces with bituminous paint or by installing nonconductive spacers as recommended in writing by manufacturer for this purpose.
   3. Install continuous aluminum sill closure with weatherproof expansion joints and locked and sealed or welded corners. Locate weep holes at rafters.
   4. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within skylight to exterior.
   5. Install components plumb and true in alignment with established lines and elevations.
   6. Install glazing as specified in Division 08 Section(s) "Glazing" OR "Plastic Glazing", **as directed**.
      a. Structural-Sealant Glazing:
         1) Prepare surfaces that will contact structural sealant according to structural-sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.
         2) Install weatherseal sealant according to Division 07 Section "Joint Sealants" and according to weatherseal-sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind weatherseal sealant as recommended in writing by weatherseal-sealant manufacturer.
   7. Install insulation materials as specified in Division 07 Section "Building Insulation".
   8. Erection Tolerances: Install metal-framed skylights to comply with the following maximum tolerances:

a. Alignment: Limit offset from true alignment to 1/32 inch (0.8 mm) where surfaces abut in line, edge to edge, at corners, or where a reveal or protruding element separates aligned surfaces by less than 3 inches (76 mm); otherwise, limit offset to 1/8 inch (3.2 mm).
b. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet (3.2 mm in 3.7 m) but no greater than 1/2 inch (13 mm) over total length.

B. Field Quality Control
a. Structural-Sealant Compatibility and Adhesion: Structural sealant shall be tested according to recommendations in ASTM C 1401.
1) Destructive test method, Method A, Hand Pull Tab (Destructive) in ASTM C 1401, Appendix X2, shall be used.
a) A minimum of one **OR** two, **as directed**, area(s) on each skylight face shall be tested.
b) Repair installation areas damaged by testing.
b. Structural-Sealant Glazing Inspection: After installation of metal-framed skylights is complete, structural-sealant glazing shall be inspected and evaluated according to ASTM C 1401 recommendations for quality-control procedures.
c. Water Penetration under Static Pressure: Before installation of interior finishes has begun, areas shall be tested according to ASTM E 1105.
1) Test Procedures: Test under uniform and cyclic static air pressure.
2) Water Penetration: None.
d. Water-Spray Test: Before installation of interior finishes has begun, skylights shall be tested according to AAMA 501.2 and shall not evidence water penetration.
2. Repair or remove work where test results and inspections indicate that it does not comply with specified requirements.
3. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

END OF SECTION 08630

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Task	Specification	Specification Description
08631	08620	Unit Skylights

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SECTION 08710 - DOOR HARDWARE

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for door hardware. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Commercial door hardware for the following:
1) Swinging doors.
2) Non-fire-rated sliding doors.
3) Non-fire-rated folding doors.
4) Other doors to the extent indicated.
b. Cylinders for doors specified in other Sections.
c. Electrified door hardware.
2. Products furnished, but not installed, under this Section include the following. Coordinating, purchasing, delivering, and scheduling remain requirements of this Section.
a. Pivots, thresholds, weather stripping, and cylinders for locks specified in other Sections.
b. Permanent cores to be installed by Owner.

C. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Details of electrified door hardware, including wiring diagrams.
3. Samples: For each exposed finish.
4. Product certificates and test reports.
5. Other Action Submittals:
a. Door Hardware Sets: Prepared by or under the supervision of Architectural Hardware Consultant, detailing fabrication and assembly of door hardware, as well as procedures and diagrams.
1) Format: Use same scheduling sequence and format and use same door numbers as in the Contract Documents.
2) Content: Include the following information:
a) Identification number, location, hand, fire rating, and material of each door and frame.
b) Type, style, function, size, quantity, and finish of each door hardware item. Include description and function of each lockset and exit device.
c) Complete designations of every item required for each door or opening including name and manufacturer.
d) Description of each electrified door hardware function, including location, sequence of operation, and interface with other building control systems.
b. Keying Schedule: Prepared by or under the supervision of Architectural Hardware Consultant, detailing Owner's final keying instructions for locks.

D. Quality Assurance
1. Installer Qualifications: An employer of workers trained and approved by lock manufacturer.
a. Installer's responsibilities include supplying and installing door hardware and providing a qualified Architectural Hardware Consultant available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying
2. Architectural Hardware Consultant Qualifications: A person who is currently certified by DHI as an Architectural Hardware Consultant and who is experienced in providing consulting services for

door hardware installations that are comparable in material, design, and extent to that indicated for this Project.

3. Source Limitations: Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.
4. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252 **OR** UBC Standard 7-2, **as directed**.
   a. Test Pressure: Test at atmospheric pressure **OR** After 5 minutes into the test, neutral pressure level in furnace shall be established at 40 inches (1016 mm) or less above the sill, **as directed**.
5. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
6. Keying Conference: Conduct conference at Project site. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:
   a. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
   b. Preliminary key system schematic diagram.
   c. Requirements for key control system.
   d. Address for delivery of keys.

E. Delivery, Storage, And Handling
1. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.
2. Deliver keys and permanent cores to Owner by registered mail or overnight package service.

F. Coordination
1. Templates: Distribute door hardware templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

G. Warranty
1. Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within Three years from date of Substantial Completion, except as follows:
   a. Electromagnetic or Delayed-Egress Locks: Five years from date of Substantial Completion.
   b. Exit Devices: Two years from date of Substantial Completion.
   c. Manual Closers: 10 years from date of Substantial Completion.
   d. Concealed Floor Closers: Five **OR** 10 **OR** 25, **as directed,** years from date of Substantial Completion.

1.2 PRODUCTS

A. Scheduled Door Hardware
1. General: Provide door hardware for each door to comply with requirements in this Section and door hardware sets indicated in door and frame schedule **OR** door hardware sets indicated in Part 1.3 "Door Hardware Sets" Article, **as directed**.
   a. Door Hardware Sets: Provide quantity, item, size, finish or color indicated.
   b. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.

2. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 1.3 "Door Hardware Sets" Article. Products are identified by using door hardware designations, as follows:
   a. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in Part 3 "Door Hardware Sets" Article.
   b. References to BHMA Standards: Provide products complying with these standards and requirements for description, quality, and function.

B. Hinges, General
   1. Quantity: Provide the following, unless otherwise indicated:
      a. Two Hinges: For doors with heights up to 60 inches (1524 mm).
      b. Three Hinges: For doors with heights 61 to 90 inches (1549 to 2286 mm).
      c. Four Hinges: For doors with heights 91 to 120 inches (2311 to 3048 mm).
      d. For doors with heights more than 120 inches (3048 mm), provide 4 hinges, plus 1 hinge for every 30 inches (750 mm) of door height greater than 120 inches (3048 mm).
   2. Template Requirements: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.
   3. Hinge Weight: Unless otherwise indicated, provide the following:
      a. Entrance Doors: Heavy-weight hinges.
      b. Doors with Closers: Antifriction-bearing hinges.
      c. Interior Doors: Standard-weight hinges.
   4. Hinge Base Metal: Unless otherwise indicated, provide the following:
      a. Exterior Hinges: Stainless steel, with stainless-steel pin **OR** Brass, with stainless-steel pin body and brass protruding heads, **as directed**.
      b. Interior Hinges: Brass, with stainless-steel pin body and brass protruding heads **OR** Steel, with steel pin **OR** Stainless steel, with stainless-steel pin, **as directed**.
      c. Hinges for Fire-Rated Assemblies: Steel, with steel pin **OR** Stainless steel, with stainless-steel pin, **as directed**.
   5. Hinge Options: Where indicated in door hardware sets or on Drawings:
      a. Hospital Tips: Slope ends of hinge barrel.
      b. Decorator Tips: Oval **OR** Ball **OR** Steeple **OR** Urn **OR** Acorn, **as directed**.
      c. Safety Stud: Designed for stud in one leaf to engage hole in opposing leaf.
      d. Maximum Security Pin: Fix pin in hinge barrel after it is inserted.
      e. Nonremovable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for outswinging exterior doors and outswinging corridor doors with locks.
      f. Corners: Square **OR** 5/32-inch (4-mm) radius **OR** 1/4-inch (6-mm) radius **OR** 5/8-inch (16-mm) radius, **as directed**.
   6. Electrified Functions for Hinges: Comply with the following:
      a. Power Transfer: Concealed PTFE-jacketed wires, secured at each leaf and continuous through hinge knuckle.
      b. Monitoring: Concealed electrical monitoring switch.
      c. Power Transfer and Monitoring: Concealed PTFE-jacketed wires, secured at each leaf and continuous through hinge knuckle, and with concealed electrical monitoring switch.
   7. Fasteners: Comply with the following:
      a. Machine Screws: For metal doors and frames. Install into drilled and tapped holes.
      b. Wood Screws: For wood doors and frames.
      c. Threaded-to-the-Head Wood Screws: For fire-rated wood doors.
      d. Screws: Phillips flat-head; machine screws (drilled and tapped holes) for metal doors, wood screws for wood doors and frames. Finish screw heads to match surface of hinges.

C. Hinges
   1. Butts and Hinges: Listed under Category A in BHMA's "Certified Product Directory."
   2. Template Hinge Dimensions: BHMA A156.7.

3. Antifriction-Bearing, Full-Mortise (Butt) Hinges: BHMA A156.1, heavy weight; Grade 1, with 4 ball bearings **OR** standard weight; Grade 2, with 2 ball bearings, **as directed**; button tips; nonrising removable pins; and base metal as follows:
   a. Base Metal: Cast, forged, or extruded brass or bronze **OR** Wrought brass or bronze **OR** Stainless steel **OR** Wrought, forged, or cast steel, or malleable iron, **as directed**.
4. Antifriction-Bearing, Swing-Clear, Full-Mortise (Butt) Hinges: BHMA A156.1, heavy weight; Grade 1, with 4 ball bearings **OR** standard weight; Grade 2, with 2 ball bearings, **as directed**; button tips; nonrising removable pins; reversible; with 3/32-inch (2.4-mm) swaging; wrought, forged, or cast steel, or malleable iron.
5. Plain-Bearing, Standard-Weight, Full-Mortise (Butt) Hinges: BHMA A156.1, Grade 3, button tips, nonrising removable pins, and base metal as follows:
   a. Base Metal: Cast, forged, or extruded brass or bronze **OR** Wrought brass or bronze **OR** Stainless steel **OR** Wrought, forged, or cast steel, or malleable iron, **as directed**.
6. Plain-Bearing, Swing-Clear, Standard-Weight, Full-Mortise (Butt) Hinges: BHMA A156.1, Grade 3, button tips, nonrising removable pins, reversible; wrought, forged, or cast steel, or malleable iron.
7. Friction-Type, Heavy-Weight, Full-Mortise (Butt) Hinges: BHMA A156.1, Grade 1, with adjustable friction discs or bearings; wrought, forged, or cast steel, or malleable iron, for use where doors are to be held open at any angle.
8. Antifriction-Bearing, Heavy-Weight, Full-Mortise, Slip-in-Type Hinges: BHMA A156.1, Grade 1, equipped with 4 ball bearings, with 5/16-inch (7.9-mm) swaging **OR** 3/16-inch (4.8-mm) swaging, handed, **as directed,** and base metal as follows:
   a. Base Metal: Wrought brass or bronze **OR** Wrought, forged, or cast steel, or malleable iron, **as directed**.
9. Antifriction-Bearing, Standard-Weight, Full-Mortise, Slip-in-Type Hinges: BHMA A156.1, Grade 2, equipped with 2 ball bearings, with 5/16-inch (7.9-mm) swaging **OR** 3/16-inch (4.8-mm) swaging, handed, **as directed,** and base metal as follows:
   a. Base Metal: Wrought brass or bronze **OR** Wrought, forged, or cast steel, or malleable iron, **as directed**.
10. Plain-Bearing, Standard-Weight, Full-Mortise, Slip-in-Type Hinges (not recommended for use with closers): BHMA A156.1, Grade 3, with 5/16-inch (7.9-mm) swaging **OR** 3/16-inch (4.8-mm) swaging, handed, **as directed,** and base metal as follows:
    a. Base Metal: Wrought brass or bronze **OR** Wrought, forged, or cast steel, or malleable iron, **as directed**.
11. Antifriction-Bearing, Half-Mortise Hinges: BHMA A156.1, heavy weight; Grade 1, with 4 ball bearings **OR** standard weight; Grade 2, with 2 ball bearings, **as directed**; button tips; nonrising removable pins; reversible; and base metal as follows:
    a. Base Metal: Wrought brass or bronze **OR** Stainless steel **OR** Wrought, forged, or cast steel, or malleable iron, **as directed**.
12. Antifriction-Bearing, Swing-Clear, Heavy-Weight, Half-Mortise Hinges: BHMA A156.1, Grade 1, button tips, nonrising removable pins, reversible, equipped with 4 ball bearings; wrought, forged, or cast steel, or malleable iron.
13. Plain-Bearing, Standard-Weight, Half-Mortise Hinges (should not be used with closers): BHMA A156.1, Grade 3, button tips, nonrising removable pins, reversible, and base metal as follows:
    a. Base Metal: Wrought brass or bronze **OR** Stainless steel **OR** Wrought, forged, or cast steel, or malleable iron, **as directed**.
14. Antifriction-Bearing, Full-Surface Hinges: BHMA A156.1, heavy weight; Grade 1, with 4 ball bearings **OR** narrow, heavy weight; Grade 1, with 4 ball bearings **OR** standard weight; Grade 2, with 2 ball bearings, **as directed**; button tips; nonrising removable pins; reversible; and base metal as follows:
    a. Base Metal: Wrought brass or bronze **OR** Stainless steel **OR** Wrought, forged, or cast steel, or malleable iron, **as directed**.

15. Antifriction-Bearing, Swing-Clear, Heavy-Weight, Full-Surface Hinges: BHMA A156.1, Grade 1, button tips, nonrising removable pins, reversible, equipped with 4 ball bearings; wrought, forged, or cast steel, or malleable iron.
16. Plain-Bearing, Standard-Weight, Full-Surface Hinges: BHMA A156.1, Grade 3, button tips, nonrising removable pins, and base metal as follows:
    a. Base Metal: Wrought brass or bronze **OR** Wrought, forged, or cast steel, or malleable iron, **as directed**.
17. Antifriction-Bearing, Half-Surface Hinges: BHMA A156.1, heavy weight; Grade 1, with 4 ball bearings **OR** standard weight; Grade 2, with 2 ball bearings, **as directed**; button tips; nonrising removable pins; reversible; and base metal as follows:
    a. Base Metal: Wrought brass or bronze **OR** Stainless steel **OR** Wrought, forged, or cast steel, or malleable iron, **as directed**.
18. Antifriction-Bearing, Swing-Clear, Heavy-Weight, Half-Surface Hinges: BHMA A156.1, Grade 1, button tips, nonrising removable pins, reversible, equipped with 4 ball bearings; wrought, forged, or cast steel, or malleable iron.
19. Plain-Bearing, Standard-Weight, Half-Surface Hinges: BHMA A156.1, Grade 3, button tips, nonrising removable pins, reversible, and base metal as follows:
    a. Base Metal: Wrought brass or bronze **OR** Wrought, forged, or cast steel, or malleable iron, **as directed**.
20. Pivot-Reinforced Hinge and Hinge Sets: BHMA A156.1, Grade 1; consisting of one pivot-reinforced hinge plus two full-mortise hinges; heavy weight, antifriction bearing, handed; nonremovable pins; and base metal as follows:
    a. Base Metal: Wrought brass or bronze **OR** Stainless steel **OR** Wrought, forged, or cast steel, or malleable iron, **as directed**.
21. Anchor Hinge and Hinge Sets: BHMA A156.1, Grade 1; consisting of one anchor hinge plus two full-mortise hinges; heavy weight, antifriction bearing, handed; nonremovable pins; and base metal as follows:
    a. Base Metal: Wrought brass or bronze **OR** Stainless steel **OR** Wrought, forged, or cast steel, or malleable iron, **as directed**.
22. Thrust-Pivot Unit and Hinge Sets: BHMA A156.1, Grade 1; consisting of one thrust-pivot unit plus three full-mortise hinges; heavy weight, antifriction bearing, handed; nonremovable pins; and base metal as follows:
    a. Base Metal: Wrought brass or bronze **OR** Stainless steel **OR** Wrought, forged, or cast steel, or malleable iron, **as directed**.
23. Olive-Knuckle Hinges: BHMA A156.1, antifriction bearing, full mortise, heavy weight; Grade 1 **OR** standard weight; Grade 2, as directed, equipped with bearing unit, handed; only knuckle visible when door is closed; and base metal as follows:
    a. Base Metal: Cast, forged, or extruded brass or bronze **OR** Wrought, forged, or cast steel, or malleable iron, **as directed**.
24. Antifriction-Bearing, Heavy-Weight, Pivot Hinges: BHMA A156.1, Grade 1, full mortise, equipped with concealed bearing unit, handed; only knuckle visible when door is closed; and base metal as follows:
    a. Base Metal: Cast, forged, or extruded brass or bronze **OR** Wrought steel, **as directed**.
25. Antifriction-Bearing, Standard-Weight, Pivot Hinges: BHMA A156.1, Grade 2, full mortise, equipped with concealed bearing unit, handed; only knuckle visible when door is closed; wrought steel.
26. Pocket Hinges: Heavy weight; antifriction bearing; BHMA A156.1, Grade 1; jamb leaf visible when door is closed and both leaves concealed when door is in pocket; type and size required for application indicated; and base metal as follows:
    a. Base Metal: Cast, forged, or extruded brass or bronze **OR** Stainless steel **OR** Wrought, forged, or cast steel, or malleable iron, **as directed**.

D. Spring Hinges
    1. Self-Closing Hinges: Listed under Category A in BHMA's "Certified Product Directory."
    2. Single-Acting, Full-Mortise, Spring Hinges: BHMA A156.17, Grade 1 **OR** Grade 2, **as directed**, wrought steel, with torsion spring; listed for use on fire doors, as applicable.

3. Single-Acting, Full-Surface, Spring Hinges: BHMA A156.17, Grade 1 **OR** Grade 2, **as directed**, wrought steel, with torsion spring.
4. Single-Acting, Half-Surface, Spring Hinges: BHMA A156.17, Grade 1 **OR** Grade 2, **as directed**, wrought steel, with torsion spring; listed for use on fire doors, as applicable.
5. Double-Acting, Mortised-in-Door, Spring Hinges: BHMA A156.17, Grade 1 **OR** Grade 2, **as directed**, surface applied to jamb; adjustable tension, torsion springs; wrought steel.
6. Double-Acting, Half-Surface, Spring Hinges: BHMA A156.17, Grade 1 **OR** Grade 2, **as directed**, adjustable tension, torsion springs; wrought steel.

E. Pivots And Pivot Hinges
1. Pivots: Listed under Category C in BHMA's "Certified Product Directory."
2. Self-Closing Pivots: Listed under Category A in BHMA's "Certified Product Directory."
3. Double-Acting Door Pivots: BHMA A156.4, Grade 2, consisting of one top and one bottom assembly with bearings; nonferrous bottom jamb bracket; wrought brass or bronze.
4. Double-Acting, Door Pivots: BHMA A156.4, Grade 2, stainless-steel or polycarbonate top and bottom, each a walking-type, cam-operated pivot; surface **OR** flush, **as directed,** mounted.
5. Single-Acting, Center-Hung, Door Pivots: BHMA A156.4, Grade 2 **OR** 3, **as directed**, wrought-brass or bronze top and bottom units, each containing rack-and-pinion assemblies permitting door to open 105 degrees; reversible.
6. Center Pivot Sets: BHMA A156.4, Grade 1, type and size required for application indicated; complying with the following:
   a. Top Pivots: Walking-beam type with retractable pin and oil-impregnated bronze bearing; mortised into door and frame.
   b. Bottom Pivots: Surface floor mounted **OR** Recessed in floor in cement case **OR** Mortised into jamb, **as directed,** and mortised into door; with thrust ball **OR** needle, **as directed** bearing.
   c. Base Metal: Brass **OR** Bronze **OR** Steel, **as directed**.
7. Offset Pivot Sets: BHMA A156.4, Grade 1 **OR** 2, **as directed**, type and size required for application indicated; complying with the following:
   a. Offset: 3/4 inch (19 mm) **OR** 1-1/2 inches (38 mm), **as directed**.
   b. Fire Rated: Listed for use with labeled fire doors where indicated.
   c. Top Pivots: Walking-beam type with retractable pin and oil-impregnated bronze bearing; mortised into door and frame; with asylum-type upper surface, **as directed**.
   d. Bottom Pivots: Surface floor mounted **OR** Recessed in floor in cement case **OR** Mortised into jamb, **as directed,** and mortised into door; with thrust ball **OR** needle, **as directed,** bearing.
   e. Base Metal: Brass **OR** Bronze **OR** Stainless steel **OR** Steel, **as directed**.
8. Intermediate Pivot Sets: BHMA A156.4, Grade 1, type and size required for application indicated; with oil-impregnated bronze bearing; complying with the following:
   a. Offset: 3/4 inch (19 mm) **OR** 1-1/2 inches (38 mm), **as directed**.
   b. Mounting: Full mortise **OR** Half mortise **OR** Half surface **OR** Full surface, **as directed**.
   c. Knuckle: Standard **OR** Asylum type, **as directed**.
   d. Fire Rated: Listed for use with labeled fire doors where indicated.
   e. Base Metal: Brass **OR** Bronze **OR** Stainless steel **OR** Steel, **as directed**.
   f. Electrified Functions: As follows:
      1) Power Transfer: Concealed PTFE-jacketed wires, secured at each leaf and continuous through hinge knuckle.
      2) Monitoring: Concealed electrical monitoring switch.
9. Double-Acting, Gate-Spring Pivot: BHMA A156.17, Grade 1, mortise application, adjustable **OR** fixed, **as directed,** tension, and base metal as follows:
   a. Base Metal: Cast, forged, or extruded brass or bronze **OR** Malleable iron, **as directed**.
10. Double-Acting, Gravity Pivot: BHMA A156.17, Grade 1, malleable iron, surface applied, adjustable **OR** fixed, **as directed,** tension.

F. Continuous Hinges

1. Standard: BHMA A156.26, Grade 1-150 **OR** Grade 1-300 **OR** Grade 1-600 **OR** Grade 2-150 **OR** Grade 2-300 **OR** Grade 2-600 **OR** Grade 3-150 **OR** Grade 3-300, **as directed**.
   a. Continuous Hinges: Listed under Category N in BHMA's "Certified Product Directory."
2. General: Minimum 0.120-inch- (3.0-mm-) thick, hinge leaves with minimum overall width of 4 inches (102 mm); fabricated to full height of door and frame and to template screw locations; with components finished after milling and drilling are complete.
   a. Fire Pins: Steel pins to hold labeled fire doors in place if required by tested listing.
3. Continuous, Barrel-Type Hinges: Hinge with knuckles formed around a pin that extends entire length of hinge.
   a. Base Metal for Exterior Hinges: Stainless steel.
   b. Base Metal for Interior Hinges: Stainless steel **OR** Steel **OR** Aluminum, **as directed**.
   c. Base Metal for Hinges for Fire-Rated Assemblies: Stainless steel **OR** Steel, **as directed**.
4. Continuous, Gear-Type Hinges: Extruded-aluminum, pinless, geared hinge leaves; joined by a continuous extruded-aluminum channel cap; with concealed, self-lubricating thrust bearings.
   a. Type: Fully concealed **OR** Swing clear **OR** Full surface, with removable continuous caps over fasteners **OR** Half surface, with removable continuous cap over fasteners, **as directed**.

G. Locks And Latches, General
1. Accessibility Requirements: Where indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)" **OR** ANSI A117.1 **OR** FED-STD-795, "Uniform Federal Accessibility Standards," **as directed**
   a. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf (22 N).
2. Latches and Locks for Means of Egress Doors: Comply with NFPA 101. Latches shall not require more than 15 lbf (67 N) to release the latch. Locks shall not require use of a key, tool, or special knowledge for operation.
3. Electrified Locking Devices: BHMA A156.25.
4. Lock Trim:
   a. Levers: Wrought **OR** Forged **OR** Cast, **as directed**.
   b. Knobs: Wrought **OR** Forged **OR** Cast, **as directed**.
   c. Escutcheons (Roses): Wrought **OR** Forged **OR** Cast, **as directed**.
   d. Dummy Trim: Match knob **OR** lever, **as directed,** lock trim and escutcheons.
   e. Lockset Designs: Provide design indicated on Drawings or, if sets are provided by another manufacturer, provide designs that match those designated.
5. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
   a. Bored Locks: Minimum 1/2-inch (13-mm) latchbolt throw.
   b. Mortise Locks: Minimum 3/4-inch (19-mm) latchbolt throw.
   c. Deadbolts: Minimum 1-inch (25-mm) bolt throw.
6. Rabbeted Meeting Doors: Provide special rabbeted front and strike on locksets for rabbeted meeting stiles.
7. Backset: 2-3/4 inches (70 mm), unless otherwise indicated.
8. Strikes: Manufacturer's standard strike with strike box for each latchbolt or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, and as follows:
   a. Strikes for Bored Locks and Latches: BHMA A156.2.
   b. Strikes for Mortise Locks and Latches: BHMA A156.13.
   c. Strikes for Interconnected Locks and Latches: BHMA A156.12.
   d. Strikes for Auxiliary Deadlocks: BHMA A156.5.
   e. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
   f. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
   g. Aluminum-Frame Strike Box: Manufacturer's special strike box fabricated for aluminum framing.

H. Mechanical Locks And Latches
1. Lock Functions: Function numbers and descriptions indicated in door hardware sets comply with the following:
   a. Bored Locks: BHMA A156.2.
   b. Mortise Locks: BHMA A156.13.
   c. Interconnected Locks: BHMA A156.12.
2. Bored Locks: BHMA A156.2, Grade 1 **OR** Grade 2, **as directed**; Series 4000. Listed under Category F in BHMA's "Certified Product Directory."
3. Mortise Locks: Stamped steel case with steel or brass parts; BHMA A156.13, Grade 1 **OR** Grade 2, **as directed**; Series 1000. Listed under Category F in BHMA's "Certified Product Directory."
4. Interconnected Locks: BHMA A156.12, Grade 1 **OR** Grade 2, **as directed**; Series 5000. Listed under Category F in BHMA's "Certified Product Directory."
5. Roller Latches: Rolling plunger that engages socket or catch, with adjustable roller projection, and as follows:
   a. Material: Brass **OR** Bronze, **as directed**.
   b. Mounting: Surface **OR** Mortise, **as directed**.
6. Push-Pull Latches: Consisting of paddle handles that retract latchbolt; capable of being mounted vertically or horizontally; and as follows:
   a. Lever and Escutcheon Material: Brass **OR** Bronze **OR** Stainless steel **OR** Aluminum, **as directed**.
   b. Latch Type: Bored **OR** Mortise, **as directed**.
   c. Lettering: Engrave with the words "Pull" and "Push."
   d. Lead Lining: 0.047 inch (1.2 mm) thick for escutcheon plate.

I. Auxiliary Locks And Latches
1. Auxiliary Locks: BHMA A156.5, Grade 1 **OR** Grade 2, **as directed**. Listed under Category E in BHMA's "Certified Product Directory."
   a. Bored Auxiliary Locks:
      1) Material: Aluminum **OR** Brass **OR** Bronze **OR** Stainless steel **OR** Zinc alloy, **as directed**.
      2) Deadlatches: Deadlocking latchbolt operated by key either side **OR** key outside and turn inside **OR** turn inside with no cylinder, **as directed**.
      3) Deadlocks: Deadbolt operated by key either side **OR** key outside and turn inside **OR** turn inside, no cylinder **OR** key outside, no trim inside, **as directed**.
   b. Mortise Auxiliary Locks:
      1) Material: Aluminum **OR** Brass **OR** Bronze **OR** Stainless steel **OR** Zinc alloy, **as directed**.
      2) Deadlocks: Deadbolt operated by key either side **OR** outside and turn inside **OR** one side, **as directed**.
      3) Deadlatches: Latchbolt and auxiliary deadlatch operated by key either side **OR** outside and turn inside, **as directed**.
      4) Deadlocks for Sliding Doors: Expanding- or interlocking-type deadbolt operated by key either side **OR** outside and turn inside **OR** one side, **as directed.**
      5) Deadlatches for Sliding Doors: Hook-type latchbolt operated by key either side **OR** outside and handle inside, **as directed**.
   c. Narrow Stile Auxiliary Locks:
      1) Material: Aluminum **OR** Brass **OR** Bronze **OR** Stainless steel **OR** Zinc alloy, **as directed**.
      2) Deadlock: Deadlocking bolt operated as follows:
         a) Operation: Key both sides **OR** outside and operating trim inside, **as directed**.
         b) Door Application: Swinging **OR** Sliding, **as directed,** door.
      3) Deadlatch: Latchbolt with auxiliary deadlatch operated by key outside and paddle or lever inside; for single swinging doors.
      4) Multipoint Lock: Deadlocking bolt for pairs of swinging doors; operated as follows:

a) Operation: Key both sides **OR** outside and turn, lever, or knob inside, **as directed**.
b) Type: Two **OR** Three, **as directed,** point.

5) Latch/Lock: Deadbolt and latchbolt; both operated by key both sides; inside handle operates only latchbolt.

d. Rim Auxiliary Locks:
1) Material: Aluminum **OR** Brass **OR** Bronze **OR** Stainless steel **OR** Zinc alloy, **as directed**.
2) Latchbolt: Operated by key outside and turn inside.
3) Deadlocking Latchbolt: Operated by key outside and turn inside.
4) Deadbolt: Operated by key outside and turn inside.
5) Rotary Deadbolt: Operated by key either side **OR** outside and turn inside **OR** outside, **as directed**.
6) Interlocking Deadbolt: Operated by key either side **OR** outside and turn inside **OR** outside, **as directed**.

2. Push-Button Combination Locks: BHMA A156.5, Grade 1 for cylindrical locks **OR** Grade 2 for mortise locks, **as directed**.
a. Lock opens by entering a one- to five-digit code by pushing correct buttons in correct sequence; automatically relocks when door is closed.
b. Lockset Configuration: Standard **OR** Privacy with inside push button, **as directed**.
c. Auxiliary Lock Configuration: Deadbolt **OR** Deadlocking latch **OR** Deadlocking rim latch, **as directed**.
d. Provide key override capability by means of cylinder.

J. Electromagnetic Locks
1. General: BHMA A156.23; electrically powered, of strength and configuration indicated; with electromagnet attached to frame and armature plate attached to door. Listed under Category E in BHMA's "Certified Product Directory."
a. Type: Full exterior or full interior, as required by application indicated.
b. Strength Ranking: 1500 lbf (6672 N) **OR** 1000 lbf (4448 N) **OR** 500 lbf (2224 N), **as directed**.
c. Inductive Kickback Peak Voltage: Not more than 53 V **OR** 0 V, **as directed**.
d. Residual Magnetism: Not more than 4 lbf (18 N) **OR** 0 lbf (0 N), **as directed,** to separate door from magnet.
2. Delayed-Egress Locks: BHMA A156.24. Listed under Category G in BHMA's "Certified Product Directory."
a. Means of Egress Doors: Lock releases within 15 seconds after applying a force not more than 15 lbf (67 N) for not more than 3 seconds, as required by NFPA 101.
b. Security Grade: Activated from secure side of door by initiating device.
c. Movement Grade: Activated by door movement as initiating device.
3. Configuration: Direct-hold type.
a. Mounting: Lock mounted on bottom of header; strike mounted flush on push side of door.
b. Mounting: Lock mounted on face of header; strike mounted on pull side of door with angle bracket.
c. Mounting: Lock mounted on side of jamb; strike mounted flush on push side of door.
4. Configuration: Shear type.
a. Mounting: Lock mounted on face of header; strike mounted on either side of door with angle bracket.
b. Mounting: Lock mortised in header; strike mortised in top of door.
c. Mounting: Lock mortised in jamb; strike mortised in edge of door.
d. Mounting: Lock mortised in bottom of door; strike mortised in floor.
e. Mounting: Lock mortised in floor; strike mortised in bottom of door.
5. Optional Features:
a. Magnetic bond sensor.
b. Continuous housing for full width of door.
c. Continuous housing for full height of door.

d. Single LED indicators.
e. Double LED indicators.
f. Adjustable time delay with automatic relock.
g. Integral door position switch.

K. Electromechanical Locks
1. General: Grade 1 **OR** Grade 2, **as directed**, for type of lock indicated; motor or solenoid driven.
2. Type: Bored **OR** Mortise latchbolt **OR** Mortise deadbolt **OR** Mortise deadlocking latchbolts, **as directed**.

L. Self-Contained Electronic Locks
1. General: Internal, battery-powered, self-contained electronic locks; consisting of complete lockset, motor-driven lock mechanism, and actuating device; enclosed in zinc-dichromate-plated, wrought-steel case. Provide key override, low-battery detection and warning, LED status indicators, and ability to program at the lock; type and function indicated.
a. Type: Bored **OR** Mortise, **as directed**.
b. Actuating Device: Digital keypad **OR** Magnetic-stripe card reader, **as directed**.
1) Card: Manufacturer's standard **OR** 0.030-inch- (0.76-mm-) thick PVC or polyester **OR** Custom, **as directed**.
c. Faceplate Material: Wrought brass **OR** Wrought bronze **OR** Stainless steel, **as directed**.
d. Trim: Lever **OR** Knob **OR** Match trim specified for mechanical locks, **as directed**.
2. Accessory: Card encoder and software.
3. Functions: Latch with **OR** Deadbolt with **OR** Latch without **OR** Deadbolt without, **as directed,** key.

M. Exit Locks And Exit Alarms
1. Exit Locks: BHMA A156.29, Grade 1, surface mounted; battery powered, housed in metal case; with red-and-white lettering reading "EMERGENCY EXIT PUSH TO OPEN--ALARM WILL SOUND." Include the following features:
a. Low-battery alert.
b. Outside key control.
c. Audible alarm that sounds when unauthorized use of door occurs.
d. Silent alarm with remote signal capability for connection to remote indicating panel.
e. Strike: Surface **OR** Mortise, **as directed**.
f. Single-Door Type: Activated by arm, push plate, or paddle **OR** horizontal bar, **as directed**.
g. Pairs-of-Door Type: Activated by arm, push plate, or paddle **OR** horizontal bar, **as directed**.
2. Stand-Alone Exit Alarms: BHMA A156.29, Grade 1, surface mounted on door **OR** mounted separate from door and activated by door movement switch, **as directed**. Include the following features:
a. Low-battery alert.
b. Outside key control.
c. Audible alarm that sounds when unauthorized use of door occurs.
d. Automatic rearming after authorized use, with adjustable time delay.
e. Remote signal capability for connection to remote indicating panel.

N. Door Bolts, General
1. Bolt Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
a. Half-Round Surface Bolts: Minimum 7/8-inch (22-mm) throw.
b. Interlocking Surface Bolts: Minimum 15/16-inch (24-mm) throw.
c. Fire-Rated Surface Bolts: Minimum 1-inch (25-mm) throw; listed and labeled for fire-rated doors.
d. Dutch-Door Bolts: Minimum 3/4-inch (19-mm) throw.
e. Mortise Flush Bolts: Minimum 3/4-inch (19-mm) throw.

2. Dustproof Strikes: BHMA A156.16, Grade 1.
3. Surface Bolts: BHMA A156.16, Grade 1 **OR** Grade 2, **as directed**.
   a. Flush Bolt Heads: Minimum of 1/2-inch- (13-mm-) diameter rods of brass, bronze, or stainless steel with minimum 12-inch- (305-mm-) long rod for doors up to 84 inches (2134 mm) in height. Provide longer rods as necessary for doors exceeding 84 inches (2134 mm).
4. Manual Flush Bolts: BHMA A156.16, Grade 1 **OR** Grade 2, **as directed**; designed for mortising into door edge.
5. Automatic and Self-Latching Flush Bolts: BHMA A156.3, Grade 1 **OR** Grade 2, **as directed**; designed for mortising into door edge.

O. Door Bolts
1. Half-Round Surface Bolts: 6-inch (152-mm) polished-brass or burnished-steel, half-round rod and knob; minimum 7/8-inch (22-mm) throw; with universal strike.
2. Interlocking Surface Bolts: 6-inch (152-mm) extruded-brass or aluminum, interlocking track and rod; minimum 15/16-inch (24-mm) throw; with universal or mortise strike.
3. Fire-Rated Surface Bolts: 8-inch (203-mm) steel bolt with 2 steel guides; minimum 1-inch (25-mm) throw; listed and labeled for fire-rated doors; with universal strike.
4. Dutch-Door Surface Bolts: Polished-brass bolt and knob, minimum 3/4-inch (19-mm) throw, with standard strike.
5. Automatic Flush Bolts: Fabricated from steel and brass components, with spring-activated bolts that automatically retract when active leaf is opened and that automatically engage when active door depresses bolt trigger; listed and labeled for fire-rated doors. Provide brass or stainless-steel cover plate, top and bottom strikes, guides, guide supports, wear plates, and shims.
6. Self-Latching Flush Bolts: Fabricated from steel and brass components, with spring-activated bolts that automatically engage when active door depresses trigger; listed and labeled for fire-rated doors. Bolts are manually retracted by a slide in the bolt face. Provide brass or stainless-steel cover plate, top and bottom strikes, guides, guide supports, wear plates, and shims.
7. Manual-Extension Flush Bolts: Fabricated from extruded brass or aluminum, with 12-inch (305-mm) rod actuated by flat lever; listed and labeled for fire-rated doors. Provide matching strike.
8. Slide Flush Bolts: Cast brass, with rod actuated by slide. Provide matching strike.
9. Tubular Bolts: Polished-brass or polished-bronze, oval turn knob and escutcheon; minimum 9/16-inch (14-mm) steel bolt with 1/2-inch (13-mm) throw.
10. Dustproof Strikes:
    a. Jamb Type: Polished wrought brass, with 3/4-inch- (19-mm-) diameter, spring-tension plunger.
    b. Floor Type: Polished wrought brass, with 3/4-inch- (19-mm-) diameter, spring-tension plunger.
    c. Locking Floor Type: Polished wrought brass, with 3/4-inch- (19-mm-) diameter, spring-tension plunger that can be locked in the up position by rotating plunger.

P. Exit Devices, General
1. Exit Devices: BHMA A156.3, Grade 1 **OR** Grade 2, **as directed**. Listed under Category G in BHMA's "Certified Product Directory."
2. Accessibility Requirements: Where handles, pulls, latches, locks, and other operating devices are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)" **OR** ANSI A117.1 **OR** FED-STD-795, "Uniform Federal Accessibility Standards," **as directed**
   a. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf (22 N).
3. Exit Devices for Means of Egress Doors: Comply with NFPA 101. Exit devices shall not require more than 15 lbf (67 N) to release the latch. Locks shall not require the use of a key, tool, or special knowledge for operation.
4. Panic Exit Devices: Listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.

5. Fire Exit Devices: Devices complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252.
6. Fire-Exit Removable Mullions: Provide removable mullions for use with fire exit devices complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252. Mullions shall be used only with exit devices for which they have been tested.
7. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
   a. Operation: Rigid **OR** Movable **OR** Movable with monitor switch, **as directed**.
8. Outside Trim: Lever **OR** Lever with cylinder **OR** Knob **OR** Knob with cylinder **OR** Pull **OR** Pull with cylinder **OR** Thumb turn with cylinder, **as directed**; material and finish to match locksets, unless otherwise indicated.
   a. Match design for locksets and latchsets, unless otherwise indicated.
9. Through Bolts: For exit devices and trim on metal doors **OR** non-fire-rated wood doors **OR** fire-rated wood doors, **as directed**.

Q. Exit Devices
1. Rim Exit Devices:
   a. Type: BHMA A156.3, Type 1, rim **OR** Type 4, narrow stile **OR** Type 28, incorporating a deadbolt, **as directed**.
   b. Actuating Bar: Cross bar **OR** Push pad **OR** Narrow-stile push pad, **as directed**.
   c. Material: Brass **OR** Bronze **OR** Stainless steel **OR** Aluminum **OR** Wrought steel, **as directed**.
2. Mortise Exit Devices:
   a. Type: BHMA A156.3, Type 3 **OR** Type 10, narrow stile, **as directed**.
   b. Actuating Bar: Cross bar **OR** Push pad **OR** Narrow-stile push pad, **as directed**.
   c. Material: Brass **OR** Bronze **OR** Stainless steel **OR** Aluminum **OR** Wrought steel, **as directed**.
3. Surface Vertical-Rod Exit Devices:
   a. Type: BHMA A156.3, Type 2 **OR** Type 5, narrow stile, **as directed**.
   b. Actuating Bar: Cross bar **OR** Push pad **OR** Narrow-stile push pad, **as directed**.
   c. Material: Brass **OR** Bronze **OR** Stainless steel **OR** Aluminum **OR** Wrought steel, **as directed**.
   d. Configuration: Top and bottom rods **OR** Top rod, **as directed**.
4. Concealed Vertical-Rod Exit Devices:
   a. Type: BHMA A156.3, Type 6, narrow stile **OR** Type 7, for wood doors **OR** Type 8, for metal doors, **as directed**.
   b. Actuating Bar: Cross bar **OR** Push pad **OR** Narrow-stile push pad, **as directed**.
   c. Material: Brass **OR** Bronze **OR** Stainless steel **OR** Aluminum **OR** Wrought steel, **as directed**.
5. Combination Exit Devices:
   a. Type: BHMA A156.3, Type 9, rim and surface vertical rod **OR** Type 11, mortise and surface vertical rod **OR** Type 12, mortise and concealed vertical rod, **as directed**.
   b. Actuating Bar: Cross bar **OR** Push pad **OR** Narrow-stile push pad, **as directed**.
   c. Material: Brass **OR** Bronze **OR** Stainless steel **OR** Aluminum **OR** Wrought steel, **as directed**.
6. Automatic Latching Bolts:
   a. Type: BHMA A156.3, Type 23, concealed **OR** Type 24, surface, **as directed**.
   b. Material: Brass **OR** Bronze **OR** Stainless steel, **as directed**.
7. Extension Flush Bolts:
   a. Type: BHMA A156.3, Type 25, automatic **OR** Type 27, self-latching, **as directed**.
   b. Material: Brass **OR** Bronze **OR** Stainless steel, **as directed**.
8. Electrified Exit Device Options: Types and functions indicated as follows:
   a. Request-for-Exit Function: Signal initiated when push bar is actuated.

b. Delayed Egress: Depressing push bar for more than 3 seconds initiates irreversible alarm and 15-second delay for egress. Fire alarm voids 15-second delay.
c. Electric Latch Retraction: Remote signal activates continuous-duty solenoid that retracts latch.
d. Electric Locking/Unlocking: Remote signal controls locking of outside trim; complying with the following:
1) Fail-Safe: Locked when energized, unlocked when de-energized and during power failure.
2) Fail-Secure: Unlocked when energized, locked when de-energized and during power failure.
3) Hold-Back Mechanism: Continuous-duty solenoid **OR** Magnet, **as directed**.
e. Push-Bar Monitor: Signal initiated to remote alarm when push bar is actuated.
f. Push-Bar Alarm: Signal initiated to audible, battery-powered, internal alarm when push bar is actuated.

9. Electronic Exit Bars: Nonlatching electronic releasing device, activated by an adjustable capacitance sensor, with no moving parts; listed and labeled as panic exit hardware. Fabricate bar from extruded aluminum, and provide door and frame transfer device and 16 feet (4.9 m) of cord to route wiring off the door frame.
10. Extruded-Aluminum Removable Mullions: BHMA A156.3, with malleable-iron top and bottom retainers, and prepared for strikes as follows:
a. Strikes: Two standard recessed strikes **OR** Two monitor strikes **OR** One standard and one electric strike, **as directed**.
11. Tube-Steel Removable Mullions: BHMA A156.3, with malleable-iron top and bottom retainers, and prepared for strikes as follows:
a. Strikes: Two standard recessed strikes **OR** Two monitor strikes **OR** One standard and one electric strike, **as directed**.

R. Lock Cylinders
1. Standard Lock Cylinders: BHMA A156.5, Grade 1 **OR** Grade 1A **OR** Grade 2, **as directed**.
2. High-Security Lock Cylinders: BHMA A156.30, Grade 1 **OR** Grade 2 **OR** Grade 3, **as directed**; M, mechanical **OR** E, electrical, **as directed**.
a. Key Control Level: Category A **OR** B **OR** C, **as directed**.
b. Destructive Test Level: Category A **OR** B **OR** C, **as directed**.
c. Surreptitious Entry Resistance Level: Category A **OR** B **OR** C, **as directed**.
3. Cylinders: Manufacturer's standard tumbler type, constructed from brass or bronze, stainless steel, or nickel silver, and complying with the following:
a. Number of Pins: Five **OR** Six **OR** Seven, **as directed**.
b. Mortise Type: Threaded cylinders with rings and straight- or clover-type cam.
c. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
d. Bored-Lock Type: Cylinders with tailpieces to suit locks.
1) High-Security Grade: BHMA A156.5, Grade 1A, listed and labeled as complying with pick- and drill-resistant testing requirements in UL 437 (Suffix A).
4. Permanent Cores: Manufacturer's standard; finish face to match lockset; complying with the following:
a. Interchangeable Cores: Core insert, removable by use of a special key; usable with other manufacturers' cylinders.
b. Removable Cores: Core insert, removable by use of a special key; for use only with core manufacturer's cylinder and door hardware.
5. Construction Keying: Comply with the following:
a. Construction Master Keys: Provide cylinders with feature that permits voiding of construction keys without cylinder removal. Provide 10 construction master keys.
b. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.
1) Replace construction cores with permanent cores as indicated in keying schedule **OR** directed by Owner, **as directed**.

2) Furnish permanent cores to Owner for installation.

6. Manufacturer: Same manufacturer as for locks and latches.

S. Keying

1. Keying System: Factory registered, complying with guidelines in BHMA A156.28, Appendix A. Incorporate decisions made in keying conference, and as follows:
   a. No Master Key System: Cylinders are operated by change keys only.
   b. Master Key System: Cylinders are operated by a change key and a master key.
   c. Grand Master Key System: Cylinders are operated by a change key, a master key, and a grand master key.
   d. Great-Grand Master Key System: Cylinders are operated by a change key, a master key, a grand master key, and a great-grand master key.
   e. Existing System: Master key or grand master key locks to Owner's existing system.
   f. Existing System: Re-key Owner's existing master key system into new keying system.
   g. Keyed Alike: Key all cylinders to same change key.
2. Keys: Nickel silver.
   a. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
      1) Notation: "DO NOT DUPLICATE" **OR** Information to be furnished by Owner, **as directed**.
   b. Quantity: In addition to one extra key blank for each lock, provide the following:
      1) Cylinder Change Keys: Three.
      2) Master Keys: Five.
      3) Grand Master Keys: Five.
      4) Great-Grand Master Keys: Five.

T. Key Control System

1. Key Control Cabinet: BHMA A156.5, Grade 1 **OR** Grade 2, **as directed**; metal cabinet with baked-enamel finish; containing key-holding hooks, labels, 2 sets of key tags with self-locking key holders, key-gathering envelopes, and temporary and permanent markers; with key capacity of 150 percent of the number of locks.
   a. Multiple-Drawer Cabinet: Cabinet with drawers equipped with key-holding panels and key envelope storage, and progressive-type ball-bearing suspension slides. Include single cylinder lock to lock all drawers.
   b. Wall-Mounted Cabinet: Cabinet with hinged-panel door equipped with key-holding panels and pin-tumbler cylinder door lock.
   c. Portable Cabinet: Tray for mounting in file cabinet, equipped with key-holding panels, envelopes, and cross-index system.
2. Cross-Index System: Multiple **OR** Single, **as directed,**-index system for recording key information. Include three receipt forms for each key-holding hook. Set up by key control manufacturer **OR** Installer, **as directed**.
3. Key Control System Software: BHMA A156.5, Grade 1; multiple-index system for recording and reporting key-holder listings, tracking keys and lock and key history, and printing receipts for transactions. Include instruction manual.
4. Key Lock Boxes: Designed for storage of two **OR** 10, **as directed,** keys, with tamper switches to connect to intrusion detection system.

U. Electric Strikes

1. Standard: BHMA A156.31, Grade 1 **OR** Grade 2, **as directed**.
2. General: Use fail-secure electric strikes with fire-rated devices.
   a. Material: Steel **OR** Forged stainless steel **OR** Cast stainless steel, **as directed**.
   b. Mounting: Mortised **OR** Semirim mounted **OR** Rim mounted, **as directed**.
   c. Monitoring: Mechanical latchbolt **OR** Infrared latchbolt **OR** Mechanical strike **OR** Infrared strike, **as directed**.

V. Operating Trim, General
   1. Standard: BHMA A156.6 and as illustrated on Drawings.
   2. Materials: Fabricate from aluminum **OR** brass **OR** bronze **OR** stainless steel, **as directed**, unless otherwise indicated.

W. Operating Trim
   1. Flat Push Plates: 0.050 inch (1.3 mm) thick, 4 inches wide by 16 inches high (102 mm wide by 406 mm high); with square corners and beveled edges, secured with exposed screws.
   2. Cold-Forged Push Plates: 0.050 inch (1.3 mm) thick, 4 inches wide by 16 inches high (102 mm wide by 406 mm high); with square corners and beveled edges, secured with exposed screws.
   3. Push-Pull Plates: 1/8 inch (3.2 mm) thick, 4 inches wide by 16 inches high (102 mm wide by 406 mm high); with square corners, beveled edges, and raised integral lip; secured with exposed screws.
   4. Straight Door Pulls: 3/4-inch (19-mm) constant-diameter pull, with minimum clearance of 1-1/2 inches (38 mm) from face of door; fastened at 8 inches (203 mm) o.c.
      a. Mounting: Surface applied with concealed fasteners **OR** Through bolted with oval-head machine screws and countersunk washers, **OR** Back to back with threaded sleeves, **as directed**.
   5. Offset Door Pulls: 3/4-inch (19-mm) constant-diameter pull, with minimum clearance of 1-1/2 inches (38 mm) from face of door and offset of 2 inches (51 mm); fastened at 8 inches (203 mm) o.c.
      a. Mounting: Surface applied with concealed fasteners **OR** Through bolted with oval-head machine screws and countersunk washers **OR** Back to back with threaded sleeves, **as directed**.
   6. Flush Door Pulls: Mortised 1/2 inch (13 mm) deep, fastened by screws, and as follows:
      a. Shape: Circular **OR** Rectangular with oval recess **OR** Rectangular with rectangular recess, **as directed**.
   7. Pull-Plate Door Pulls: 0.050-inch- (1.3-mm-) thick plate, 4 inches wide by 16 inches high (102 mm wide by 406 mm high), with square corners and beveled edges; 3/4-inch (19-mm) constant-diameter pull, with minimum clearance of 1-1/2 inches (38 mm) from face of door; fastened at 8 inches (203 mm) o.c.
      a. Mounting: Surface applied with concealed fasteners **OR** Through bolted with oval-head machine screws and countersunk washers **OR** Back to back with threaded sleeves, **as directed**.
   8. Straight Push-Pull Door Pulls: Push-pull plate minimum 5 inches wide by 12 inches high (125 mm wide by 300 mm high), with minimum clearance of 1-1/2 inches (38 mm) from face of door.
   9. Offset Push-Pull Door Pulls: Push-pull plate minimum 5 inches wide by 12 inches high (125 mm wide by 300 mm high), with minimum clearance of 1-1/2 inches (38 mm) from face of door, and offset 2 inches (50 mm).
   10. Single Push Bar: Horizontal bar, with minimum clearance of 1-1/2 inches (38 mm) from face of door, and as follows:
      a. Shape and Size: 1-inch (25-mm) constant-diameter round bar **OR** Minimum 3/8-by-1-1/4-inch (10-by-32-mm) flat bar, **as directed**.
      b. Mounting: Surface applied with concealed fasteners **OR** Through bolted with oval-head machine screws and countersunk washers, **as directed**.
   11. Double Pull Bar: Two horizontal bars connected by matching vertical pull bar and spaced at 8 inches (200 mm) o.c.; with minimum clearance of 1-1/2 inches (38 mm) from face of door, and as follows:
      a. Shape and Size: 1-inch (25-mm) constant-diameter round bars **OR** Minimum 3/8-by- 1-1/4-inch (10-by-32-mm) flat bars, **as directed**.
      b. Mounting: Surface applied with concealed fasteners **OR** Through bolted with oval-head machine screws and countersunk washers, **as directed**.

X. Accessories For Pairs Of Doors
   1. Carry-Open Bars: Provide carry-open bars for inactive leaves of pairs of doors unless automatic or self-latching bolts are used.

a. Material: Polished brass or bronze, with strike plate.

2. Flat Overlapping Astragals: Flat metal bar, surface mounted on face of door with screws; minimum 1/8 inch (3.2 mm) thick by 2 inches (50 mm) wide by full height of door; and base metal as follows:
   a. Base Metal: Primed steel **OR** Zinc-plated steel **OR** Aluminum **OR** Stainless steel Brass, **as directed**.
3. Rigid, Housed Astragals: Gasket material held in place by metal housing; fastened to face of door with screws.
   a. Gasket Material: Closed-cell sponge silicone **OR** Closed-cell sponge neoprene **OR** Neoprene **OR** Silicone bulb, **as directed**.
   b. Housing Material: Aluminum **OR** Copper alloy (brass or bronze), **as directed**.
4. Overlapping-with-Gasket Astragals: T-shaped metal, surface mounted on edge of door with screws; with integral gasket and base metal as follows:
   a. Base Metal: Primed steel **OR** Zinc-plated steel **OR** Aluminum **OR** Stainless steel, **as directed**.
   b. Gasket Material: Vinyl **OR** Silicone **OR** Sponge neoprene **OR** Brush pile **OR** Polypropylene, **as directed**.

Y. Closers, General
1. Accessibility Requirements: Where handles, pulls, latches, locks, and other operating devices are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)" **OR** ANSI A117.1 **OR** FED-STD-795, "Uniform Federal Accessibility Standards," **as directed.**
   a. Comply with the following maximum opening-force requirements:
      1) Interior, Non-Fire-Rated Hinged Doors: 5 lbf (22.2 N) applied perpendicular to door.
      2) Sliding or Folding Doors: 5 lbf (22.2 N) applied parallel to door at latch.
      3) Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
2. Door Closers for Means of Egress Doors: Comply with NFPA 101. Door closers shall not require more than 30 lbf (133 N) to set door in motion and not more than 15 lbf (67 N) to open door to minimum required width.
3. Hold-Open Closers/Detectors: Coordinate and interface integral smoke detector and closer device with fire alarm system.
4. Flush Floor Plates: Provide finish cover plates for floor closers unless thresholds are indicated. Match door hardware finish, unless otherwise indicated.
5. Recessed Floor Plates: Provide recessed floor plates with insert of floor finish material for floor closers unless thresholds are indicated. Provide extended closer spindle to accommodate thickness of floor finish.
6. Power-Assist Closers: As specified in Division 08 Section "Automatic Door Operators" for access doors for people with disabilities or where listed in door hardware sets.
7. Size of Units: Unless otherwise indicated, comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.
8. Surface Closers: BHMA A156.4, Grade 1 **OR** Grade 2, **as directed.** Listed under Category C in BHMA's "Certified Product Directory." Provide type of arm required for closer to be located on non-public side of door, unless otherwise indicated.
9. Concealed Closers: BHMA A156.4, Grade 1 **OR** Grade 2, **as directed**. Listed under Category C in BHMA's "Certified Product Directory."
10. Closer Holder Release Devices: BHMA A156.15. Listed under Category C in BHMA's "Certified Product Directory."
    a. Life-Safety Type: On release of hold open, door becomes self-closing. Automatic release is activated by smoke detection system **OR** loss of power, **as directed**.
11. Coordinators: BHMA A156.3.

Z. Closers

1. Traditional Surface Closers: Rack-and-pinion hydraulic type; with adjustable sweep and latch speeds controlled by key-operated valves; with forged-steel main arm; enclosed in a cast-aluminum alloy shell; complying with the following:
   a. Mounting: Hinge side **OR** Opposite hinge side **OR** Parallel arm **OR** Bracket, **as directed**.
   b. Type: Regular arm **OR** Fusible-link holder arm **OR** Two-point hold-open arm **OR** Delayed action closing, **as directed**.
   c. Backcheck: Factory preset **OR** Adjustable, **as directed**, effective between 60 and 85 degrees of door opening.
2. Modern-Type-without-Cover Surface Closers: Rack-and-pinion hydraulic type; with adjustable sweep and latch speeds controlled by key-operated valves; with forged-steel main arm; enclosed in a cast-aluminum alloy shell; complying with the following:
   a. Mounting: Hinge side **OR** Opposite hinge side **OR** Parallel arm **OR** Bracket **OR** Hinge side top jamb **OR** Opposite side top jamb, **as directed**.
   b. Type: Regular arm **OR** Fusible-link holder arm **OR** Slide track arm **OR** Delayed action closing, **as directed**.
   c. Backcheck: Factory preset **OR** Adjustable, **as directed**, effective between 60 and 85 degrees of door opening.
   d. Closing Power Adjustment: At least 50 **OR** 35 **OR** 15, **as directed,** percent more than minimum tested value.
3. Modern-Type-with-Cover Surface Closers: Rack-and-pinion hydraulic type; with adjustable sweep and latch speeds controlled by key-operated valves; with forged-steel main arm; enclosed in cover indicated; complying with the following:
   a. Mounting: Hinge side **OR** Opposite hinge side **OR** Parallel arm **OR** Bracket **OR** Hinge side, top jamb **OR** Opposite side, top jamb, **as directed**.
   b. Type: Regular arm **OR** Fusible-link holder arm **OR** Slide track arm **OR** Delayed action closing, **as directed**.
   c. Backcheck: Factory preset **OR** Adjustable, **as directed**, effective between 60 and 85 degrees of door opening.
   d. Cover Material: Aluminum **OR** Plated steel **OR** Molded plastic, **as directed**.
   e. Closing Power Adjustment: At least 50 **OR** 35 **OR** 15, **as directed,** percent more than minimum tested value.
4. Concealed-in-Door-Type Concealed Closers: Rack-and-pinion hydraulic type; with adjustable sweep and latch speeds controlled by key-operated valves; mortised into top rail of minimum 1-3/4-inch- (44-mm-) thick doors and track mortised into head frame; with double lever arm indicated; complying with the following:
   a. Type: Surface shoe **OR** Mortised soffit plate, **as directed**.
   b. Arm: Regular **OR** Hold open, **as directed**.
   c. Closing Power Adjustment: At least 50 **OR** 35 **OR** 15, **as directed,** percent more than minimum tested value.
5. Overhead Concealed Closers: Rack-and-pinion hydraulic type; with adjustable sweep and latch speeds controlled by key-operated valves; mortised into head frame; with cast-metal body and exposed cover plate; complying with the following:
   a. Type: Exposed arm with surface shoe, single acting **OR** Concealed arm and track, butt or pivot hung, single acting **OR** Concealed arm and track, center pivoted, single acting **OR** Concealed arm and track, center pivoted, double acting, **as directed**.
   b. Arm: Regular **OR** Automatic hold open **OR** Manually selected hold open **OR** Fusible-link holder arm, **as directed**.
   c. Track: Regular **OR** Automatic hold open **OR** Manually selected hold open, **as directed**.
   d. Cover Plate Material: Aluminum **OR** Plated steel, **as directed**.
   e. Backcheck: Factory preset **OR** Adjustable, **as directed**.
   f. Closing Power Adjustment: At least 50 **OR** 35, **as directed,** percent more than minimum tested value.
6. Floor Concealed Closers: Rack-and-pinion hydraulic type; with adjustable sweep and latch speeds controlled by key-operated valves; with cement case and cast-iron closer body case; for single-acting doors; complying with the following:

a. Type: Center pivoted **OR** Butt hinge hung or offset pivoted **OR** Offset pivoted, **as directed**.
b. Fire Rated: Listed for use with labeled fire doors where indicated.
c. Function: Regular **OR** Automatic hold open **OR** Manually selected hold open **OR** Delayed action closing, **as directed**.
d. Backcheck: Factory preset **OR** Adjustable, **as directed**.
e. Closing Power Adjustment: At least 50 **OR** 35, **as directed,** percent more than minimum tested value.
f. Case Depth: Regular, 4 inches (100 mm) **OR** Shallow, 2 inches (50 mm), **as directed**.
g. Cover Plate Material: Aluminum **OR** Plated steel, **as directed**.

7. Closer Holder Release Devices: Closer connected with separate or integral releasing and fire- or smoke-detecting devices. Door shall become self-closing on interruption of signal to release device. Comply with the following:
   a. Type: Single-point hold open **OR** Multiple-point hold open **OR** Free-swinging release, **as directed**.
   b. Mounting: Surface mounted on face of door **OR** Surface mounted on face of top jamb **OR** Surface mounted on stop **OR** Mortised into top rail of door **OR** Mortised into top jamb **OR** Recessed into floor, **as directed**.
   c. Options: Adjustable backcheck **OR** Integral smoke detector **OR** Adjustable spring power **OR** Adjustable hold-open manual release force, **as directed**.
8. Coordinators: Consisting of active-leaf, hold-open lever and inactive-leaf release trigger; fabricated from steel with nylon-coated strike plates; with built-in, adjustable safety release; and with internal override.

AA. Protective Trim Units, General
1. Size: 1-1/2 inches (38 mm) less than door width on push side and 1/2 inch (13 mm) less than door width on pull side, by height specified in door hardware sets.
2. Fasteners: Manufacturer's standard machine or self-tapping screws.
3. Metal Protective Trim Units: BHMA A156.6; beveled top and 2 sides; fabricated from material indicated in door hardware sets **OR** the following material, **as directed**:
   a. Material: 0.050-inch- (1.3-mm-) thick aluminum **OR** brass **OR** bronze **OR** stainless steel, **as directed**.
4. Plastic Protective Trim Units: BHMA A156.6; beveled 4 sides; fabricated from material indicated in door hardware sets **OR** the following material, **as directed**:
   a. Plastic Laminate: 1/8 inch (3.2 mm) thick; NEMA LD 3, Grade HGS.
   b. Rigid Plastic: 0.060-inch- (1.5-mm-) thick, PVC or acrylic-modified vinyl plastic.
   c. Acrylic: 1/8 inch (3.2 mm) thick.
   d. Color and Texture: As selected from manufacturer's full range.

BB. Protective Trim Units
1. Armor Plates: 36 inches (914 mm) high by door width, with allowance for frame stops.
2. Kick Plates: 12 inches (305 mm) high by door width, with allowance for frame stops.
3. Mop Plates: 6 inches (152 mm) high by 1 inch (25 mm) less than door width.
4. Stretcher Plates: 8 inches (203 mm) high by door width, with allowance for frame stops.
5. Nonmortise Angle Door Edging: Minimum 0.050-inch- (1.3-mm-) thick metal sheet formed into angle shape; with 1-1/4-inch (32-mm) length of leg on face of door; surface mounted on door.
   a. Leg Offset: For 0.050-inch- (1.3-mm-) thick metal **OR** 1/8-inch- (3.2-mm-) thick plastic, **as directed** plate.
   b. Material: Aluminum **OR** Brass **OR** Bronze **OR** Stainless steel, **as directed**.
   c. Height: 48 inches (1220 mm) **OR** 42 inches (1067 mm), **as directed**.
6. Mortise Angle Door Edging: Minimum 0.050-inch- (1.3-mm-) thick metal sheet formed into angle shape; with 7/8-inch (22-mm) length of leg on face of door; mortised into edge of door.
   a. Material: Aluminum **OR** Brass **OR** Bronze **OR** Stainless steel, **as directed**.
   b. Height: 48 inches (1220 mm) **OR** 42 inches (1067 mm), **as directed**.

7. Nonmortise Cap Door Edging: Minimum 0.050-inch- (1.3-mm-) thick metal sheet formed into "U" shape; with 1-1/4-inch (32-mm) length of leg on faces of door; surface mounted on door.
   a. Leg Offset: For 0.050-inch- (1.3-mm-) thick metal **OR** 1/8-inch- (3.2-mm-) thick plastic, **as directed**, plate.
   b. Material: Aluminum **OR** Brass **OR** Bronze **OR** Stainless steel, **as directed**.
   c. Height: 48 inches (1220 mm) **OR** 42 inches (1067 mm), **as directed**.
8. Mortise Cap Door Edging: Minimum 0.050-inch- (1.3-mm-) thick metal sheet formed into "U" shape; with 7/8-inch (22-mm) length of leg on faces of door; mortised into edge of door.
   a. Material: Aluminum **OR** Brass **OR** Bronze **OR** Stainless steel, **as directed**.
   b. Height: 48 inches (1220 mm) **OR** 42 inches (1067 mm), **as directed**.

CC. Stops And Holders, General
1. Stops and Bumpers: BHMA A156.16, Grade 1 **OR** Grade 2, **as directed**.
   a. Provide floor stops for doors unless wall or other type stops are scheduled or indicated. Do not mount floor stops where they will impede traffic. Where floor or wall stops are not appropriate, provide overhead holders.
2. Mechanical Door Holders: BHMA A156.16, Grade 1 **OR** Grade 2, **as directed**.
3. Combination Floor and Wall Stops and Holders: BHMA A156.8, Grade 1 **OR** Grade 2, **as directed**.
4. Combination Overhead Stops and Holders: BHMA A156.8, Grade 1 **OR** Grade 2, **as directed**.
5. Electromagnetic Door Holders: Coordinate with fire detectors and interface with fire alarm system for labeled fire door assemblies.
6. Listed under Category C in BHMA's "Certified Product Directory."
7. Silencers for Wood Door Frames: BHMA A156.16, Grade 1; neoprene or rubber, minimum 5/8 by 3/4 inch (16 by 19 mm); fabricated for drilled-in application to frame.
8. Silencers for Metal Door Frames: BHMA A156.16, Grade 1; neoprene or rubber, minimum diameter 1/2 inch (13 mm); fabricated for drilled-in application to frame.

DD. Stops And Holders
1. Chain Door Stops: Welded chain, each end attached to compression springs, both covered with protective sleeve; surface-screw application.
2. Rigid Wall Stops: Polished cast brass, bronze, or aluminum; 3-1/2 inches (89 mm) long, with rubber bumper; surface-screw **OR** expansion-shield, **as directed,** application.
3. Wall Bumpers: Polished cast brass or aluminum with rubber bumper; 2-1/2-inch (64-mm) diameter, minimum 3/4-inch (19-mm) projection from wall, with backplate for concealed fastener installation; with convex **OR** concave, **as directed,** bumper configuration.
4. Roller-Type Bumpers: Polished cast brass or bronze; minimum 4-3/8-inch (111-mm) projection from wall; attached by surface screws.
5. Rigid Floor Stops: Polished cast brass, bronze, or aluminum, with rubber bumper; surface-screw **OR** expansion-shield, **as directed,** application.
6. Dome-Type Floor Stops: Polished cast brass, bronze, or aluminum, with rubber bumper; and as follows:
   a. Height: Minimum 1 inch (25 mm) high, for doors without threshold **OR** 1-3/8 inches (35 mm) high, for doors with threshold, **as directed**.
   b. Riser: Extruded aluminum for carpet installations.
7. Lever-Type Door Holders: Polished cast brass, bronze, or aluminum; minimum 4-inch- (102-mm-) long arm that swings up and remains in vertical position; with replaceable rubber tip; surface-screw application.
8. Plunger-Type Door Holders: Polished cast brass, bronze, or aluminum; minimum 1-1/8-inch (29-mm) plunger throw; with replaceable rubber tip; surface-screw application.
9. Electromagnetic Door Holders: BHMA A156.15, Grade 1; electromagnet attached to wall or floor as indicated, and strike plate attached to swinging door.
   a. Configuration: Wall-mounted single **OR** Floor-mounted single **OR** Floor-mounted double, **as directed,** unit.
10. Combination Floor Stop and Holders: Polished cast brass, bronze, or aluminum; encased spring bumper with metal plunger and stop; and as follows:

a. Operation: Semiautomatic hold open **OR** Automatic hold open and release by pushing door, **as directed**.
b. Application: Surface screw **OR** Expansion shield, **as directed**.

11. Manual Combination Floor Stop and Holders: Polished cast brass, bronze, or aluminum; 3-1/2 inches (89 mm) long, with holder, keeper, and rubber bumper; surface-screw **OR** expansion-shield, **as directed,** application.
12. Combination Wall Stop and Holders: Polished cast brass, bronze, or aluminum; encased spring bumper with metal plunger and stop; surface-screw application; and as follows:
    a. Operation: Semiautomatic hold open **OR** Automatic hold open and release by pushing door, **as directed**.
13. Manual Combination Wall Stop and Holders: Polished cast brass, bronze, or aluminum; 3-1/2 inches (89 mm) long, with holder, keeper, and rubber bumper; surface-screw **OR** expansion-shield, **as directed,** application.

EE. Overhead Stops And Holders

1. Overhead Concealed Slide Holders: BHMA A156.8, Type 1; hold open and release by push and pull of door unless control is set in inactive position; with stop and shock absorber; adjustable holding pressure; for single **OR** double, **as directed,**-acting doors opening 110 degrees.
2. Overhead Concealed Slide Stops: BHMA A156.8, Type 1; release by push and pull of door unless control is set in inactive position; with stop and shock absorber; adjustable holding pressure; for single **OR** double, **as directed,**-acting doors opening 110 degrees.
3. Overhead Surface-Mounted Slide Holders: BHMA A156.8, Type 2; hold open and release by push and pull of door unless control is set in inactive position; with stop and shock absorber; adjustable holding pressure; for single-acting doors opening 110 degrees.
4. Overhead Surface-Mounted, Concealed Slide Stops: BHMA A156.8, Type 2; release by push and pull of door unless control is set in inactive position; with stop and shock absorber; adjustable holding pressure; for single-acting doors opening 110 degrees.
5. Overhead Surface-Mounted, Jointed-Arm Holders: BHMA A156.8, Type 3; hold open and release by push and pull of door; control capable of being set in inactive position; with stop and shock absorber; for single-acting doors opening 110 degrees.
6. Overhead Surface-Mounted, Jointed-Arm Stops: BHMA A156.8, Type 3; release by push and pull of door; control capable of being set in inactive position; with stop and shock absorber; for single-acting doors opening 110 degrees.
7. Overhead Concealed, Friction Slide Holders: BHMA A156.8, Type 4; consisting of frictional element held under adjustable pressure; with free-acting shoulder pivots and shock absorber; for single **OR** double, **as directed,**-acting doors opening 110 degrees.
8. Overhead Concealed, Nonfriction Slide Stops: BHMA A156.8, Type 4; consisting of nonfrictional element held under adjustable pressure; with shock absorber; for single **OR** double, **as directed,**-acting doors opening 110 degrees.
9. Overhead Concealed, Nonfriction Slide Holders: BHMA A156.8, Type 4; consisting of nonfrictional element held under adjustable pressure; with automatic hold-open and shock absorber; for single **OR** double, **as directed,**-acting doors opening 110 degrees.
10. Overhead Surface-Mounted, Friction Slide Holders: BHMA A156.8, Type 5; consisting of frictional element held under adjustable pressure; with free-acting shoulder pivots and shock absorber; for single-acting doors opening 110 degrees.
11. Overhead Surface-Mounted, Nonfriction Slide Stops: BHMA A156.8, Type 5; consisting of nonfrictional element held under adjustable pressure; with shock absorber; for single-acting doors opening 110 degrees.
12. Overhead Surface-Mounted, Nonfriction Slide Holders: BHMA A156.8, Type 5; consisting of nonfrictional element held under adjustable pressure; with automatic hold-open and shock absorber; for single-acting doors opening 110 degrees.
13. Overhead Surface-Mounted Rod Holders: BHMA A156.8, Type 8; hold open and release by push and pull of door unless roller cam is set in inactive position; with stop and shock absorber; adjustable spring tension; for single-acting doors opening 110 degrees.

14. Overhead Surface-Mounted Rod Stops: BHMA A156.8, Type 8; release by push and pull of door unless roller cam is set in inactive position; with stop and shock absorber; adjustable spring tension; for single-acting doors opening 110 degrees.
15. Overhead Surface-Mounted Cantilever Holders: BHMA A156.8, Type 9; hold open and release by push and pull of door or thumb turn; with stop and shock absorber; for single-acting doors opening 110 degrees.
16. Overhead Surface-Mounted Cantilever Stops: BHMA A156.8, Type 9; release by push and pull of door or thumb turn; with stop and shock absorber; for single-acting doors opening 110 degrees.

FF. Door Gasketing, General
1. Standard: BHMA A156.22. Listed under Category J in BHMA's "Certified Product Directory."
2. General: Provide continuous weather-strip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated or scheduled. Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.
   a. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
   b. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
   c. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.
3. Air Leakage: Not to exceed 0.50 cfm per foot (0.000774 cu. m/s per m) of crack length for gasketing other than for smoke control, as tested according to ASTM E 283.
4. Smoke-Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke-control ratings indicated, based on testing according to UL 1784.
   a. Provide smoke-labeled gasketing on 20-minute-rated doors and on smoke-labeled doors.
5. Fire-Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252 **OR** UBC Standard 7-2, **as directed**.
   a. Test Pressure: Test at atmospheric pressure **OR** After 5 minutes into the test, neutral pressure level in furnace shall be established at 40 inches (1016 mm) or less above the sill, **as directed**.
6. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated, based on testing according to ASTM E 1408.
7. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
8. Gasketing Materials: ASTM D 2000 and AAMA 701/702.

GG. Door Gasketing
1. Adhesive-Backed Perimeter Gasketing: Gasket material applied to frame rabbet with self-adhesive.
   a. Gasket Material: Vinyl bulb **OR** Sponge silicone **OR** Silicone **OR** Neoprene bulb **OR** Sponge neoprene, **as directed**.
2. Spring-Metal Perimeter Gasketing: Metal gasket material fastened to frame rabbet with nails or screws.
   a. Gasket Material: Minimum 0.008-inch- (0.20-mm-) thick brass or bronze **OR** 0.008-inch- (0.20-mm-) thick stainless steel **OR** 0.012-inch- (0.30-mm-) thick aluminum, **as directed**.
3. Rigid, Housed, Perimeter Gasketing: Gasket material held in place by metal housing; fastened to frame stop with screws.
   a. Gasket Material: Sponge silicone **OR** Sponge neoprene **OR** Silicone bulb **OR** Polyurethane bulb **OR** Vinyl bulb **OR** Vinyl brush **OR** Nylon brush **OR** Thermoplastic elastomer, **as directed**.
   b. Housing Material: Aluminum **OR** Brass or bronze **OR** Stainless steel, **as directed**.
4. Adjustable, Housed, Perimeter Gasketing: Screw-adjustable gasket material held in place by metal housing; fastened to frame stop with screws.
   a. Gasket Material: Sponge silicone **OR** Sponge neoprene **OR** Silicone bulb **OR** Polyurethane bulb **OR** Vinyl bulb **OR** Vinyl brush **OR** Nylon brush **OR** Thermoplastic elastomer, **as directed**.

b. Housing Material: Aluminum **OR** Brass or bronze **OR** Stainless steel, **as directed**.

5. Interlocking Perimeter Gasketing: Metal gasket material consisting of two pieces, one fastened to door and one fastened to frame, that interlock when door is closed; mounted with screws.
   a. Gasket Material: Minimum 0.018-inch- (0.46-mm-) thick zinc **OR** 0.015-inch- (0.38-mm-) thick bronze, **as directed**.
6. Overlapping Astragals for Meeting Stiles: Gasket material held in place by metal housing and overlapping when doors are closed; mounted to face of meeting stile with screws.
   a. Gasket Material: EPDM strip **OR** Vinyl strip **OR** Nylon brush, **as directed**.
   b. Housing Material: Aluminum **OR** Bronze, **as directed**.
   c. Mounting: Surface mounted to each **OR** one, **as directed,** door.
7. Meeting Astragals for Meeting Stiles: Gasket material held in place by metal housing; mounted with screws.
   a. Gasket Material: Silicone bulb **OR** Neoprene bulb **OR** Vinyl bulb **OR** Nylon brush **OR** Brush pile **OR** Thermoplastic elastomer, **as directed**.
   b. Housing Material: Aluminum **OR** Bronze, **as directed**.
   c. Mounting: Surface mounted on face of each door **OR** Surface mounted on face of one door **OR** Semimortised into edge of each door **OR** Semimortised into edge of one door **OR** Mortised into edge of each door **OR** Mortised into edge of one door, **as directed**.
8. Adjustable Astragals for Meeting Stiles: Screw-adjustable gasket material held in place by metal housing; mounted with screws.
   a. Gasket Material: Silicone **OR** Neoprene **OR** Vinyl **OR** Vinyl-covered magnet **OR** Brush pile **OR** Thermoplastic elastomer, **as directed**.
   b. Housing Material: Aluminum **OR** Bronze, **as directed**.
   c. Mounting: Surface mounted on face **OR** Semimortised into edge **OR** Mortised into edge, **as directed,** of each door.
9. Door Sweeps: Gasket material held in place by flat metal housing or flange; surface mounted to face of door with screws.
   a. Gasket Material: Neoprene **OR** Vinyl **OR** Nylon brush **OR** Polyurethane **OR** Silicone, **as directed**.
   b. Housing Material: Aluminum **OR** Bronze, **as directed**.
10. Door Shoes: Gasket material held in place by metal housing; mounted to bottom edge of door with screws.
    a. Gasket Material: Vinyl **OR** Thermoplastic elastomer **OR** Neoprene **OR** Brush pile, **as directed**.
    b. Housing Material: Aluminum **OR** Bronze, **as directed**.
    c. Extended Housing: One side **OR** Both sides, **as directed,** of door.
    d. Mounting: Surface mounted on **OR** Mortised into, **as directed,** bottom edge of door.
11. Automatic Door Bottoms: Gasket material held in place by metal housing that automatically drops to form seal when door is closed; mounted to bottom edge of door with screws.
    a. Gasket Material: Sponge neoprene **OR** Sponge silicone **OR** Thermoplastic elastomer **OR** Nylon brush, **as directed**.
    b. Housing Material: Aluminum **OR** Bronze **OR** Aluminum with 0.047-inch (1.2-mm) lead lining, **as directed**.
    c. Mounting: Surface mounted on face **OR** Semimortised into bottom **OR** Mortised into bottom, **as directed,** of door.
    d. Type: Low-closing-force type for doors required to meet accessibility requirements.

HH. Thresholds, General
1. Standard: BHMA A156.21. Listed under Category J in BHMA's "Certified Product Directory."
2. Accessibility Requirements: Where thresholds are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)" **OR** ANSI A117.1 **OR** FED-STD-795, "Uniform Federal Accessibility Standards," **as directed**

a. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch (13 mm) high **OR** 3/4 inch (19 mm) high for exterior sliding doors, **as directed**.

3. Thresholds for Means of Egress Doors: Comply with NFPA 101. Maximum 1/2 inch (13 mm) high.

II. Thresholds

1. Compressing-Top Thresholds: Metal member with compressible vinyl seal on top of threshold that seals against bottom of door; and base metal of aluminum **OR** extruded bronze **OR** stainless steel, **as directed**.
2. Saddle Thresholds: Type and base metal as follows:
   a. Type: Smooth top **OR** Fluted top **OR** Fluted top and offset **OR** Thermal break and fluted top **OR** Applied gasketed stop and fluted top **OR** Carpet separator with fluted top, **as directed**.
   b. Base Metal: Aluminum **OR** Extruded bronze **OR** Stainless steel, **as directed**.
3. Half-Saddle Thresholds: Fluted-top metal member; and base metal of aluminum **OR** extruded bronze, **as directed**.
4. Interlocking Thresholds: Fluted-top metal member with integral lip designed to engage a hook strip applied to door; type and base metal as follows:
   a. Type: Single lip **OR** Double lip **OR** Double-lip water return **OR** Double-lip water return with aluminum pan **OR** Single lip with thermal barrier, **as directed**.
   b. Base Metal: Aluminum **OR** Extruded bronze, **as directed**.
5. Latching/Rabbeted Thresholds: Type and base metal as follows:
   a. Type: Fluted **OR** Smooth **OR** Offset with fluted, **as directed,** top.
   b. Base Metal: Aluminum **OR** Extruded bronze, **as directed**.
6. Latching/Rabbeted Thresholds with Gasket: Fluted-top metal member with gasket; type and base metal as follows:
   a. Type: Offset **OR** Thermal barrier, **as directed**.
   b. Base Metal: Aluminum **OR** Extruded bronze, **as directed**.
   c. Gasket Material: Vinyl **OR** Silicone **OR** Neoprene **OR** Brush pile **OR** Closed-cell sponge neoprene, **as directed**.
7. Plate Thresholds: Solid metal plate; and base metal as follows:
   a. Top Surface: Fluted **OR** Fluted with slip-resistant abrasive, **as directed**.
   b. Base Metal: Aluminum **OR** Extruded brass or bronze **OR** Stainless steel, **as directed**.
8. Ramped Thresholds: Modular, interlocking, sloped, fluted-top metal assemblies with closed return ends; 1:12 slope; and base metal as follows:
   a. Top Surface: Fluted **OR** Fluted with slip-resistant abrasive, **as directed**.
   b. Base Metal: Aluminum **OR** Extruded bronze, **as directed**.
9. Saddle Thresholds for Floor Closers: Fluted top; type and base metal as follows:
   a. Type: Type A, for center-hung doors; ends not mitered **OR** Type B, for offset-hung doors; ends not mitered **OR** Type C, for center-hung doors; ends mitered **OR** Type D, for offset-hung doors; ends mitered, **as directed**.
   b. Base Metal: Aluminum **OR** Extruded bronze, **as directed**.

JJ. Sliding Door Hardware, General

1. General: BHMA A156.14; consisting of complete sets including rails, hangers, supports, bumpers, floor guides, and accessories indicated.
   a. Exterior Door Hardware: Galvanized steel or anodized aluminum.
2. Horizontal Sliding Door Hardware: Grade 1; rated for minimum door weight of 240 lb (109 kg) **OR** 320 lb (145 kg) **OR** 450 lb (205 kg) **OR** 560 lb (254 kg) **OR** 640 lb (290 kg) **OR** 800 lb (363 kg) **OR** 1000 lb (455 kg) **OR** 1500 lb (681 kg), **as directed**.
3. Bypassing Sliding Door Hardware: Rated for doors weighing up to 200 lb (91 kg) **OR** 125 lb (57 kg) **OR** 75 lb (34 kg), **as directed**.
4. Pocket Sliding Door Hardware: Rated for doors weighing up to 200 lb (91 kg) **OR** 125 lb (57 kg) **OR** 75 lb (34 kg), **as directed**.

KK. Sliding Door Hardware
1. Horizontal Sliding Door Hardware: Wrought steel, unless otherwise indicated.
   a. Box Rail: Without mounting brackets **OR** With attached mounting brackets **OR** With attached flashing, **as directed**.
   b. Round Rail: Without **OR** With attached, **as directed,** mounting brackets.
   c. Rail Supports:
      1) Single Side-Wall Style: Intermediate **OR** End **OR** Splice, **as directed,** type.
      2) Double Side-Wall Style: Intermediate **OR** End **OR** Splice, **as directed,** type.
      3) Triple Side-Wall Style: Intermediate **OR** End **OR** Splice, **as directed,** type.
      4) Single Overhead Style: Intermediate **OR** End **OR** Splice, **as directed,** type.
      5) Single Overhead Parallel Style: Intermediate **OR** Splice, **as directed,** type.
      6) Single Overhead Cross-Ear Style: Intermediate **OR** Splice, **as directed,** type.
      7) Double Overhead Cross-Ear Style: Intermediate **OR** Splice, **as directed,** type.
      8) Triple Overhead Cross-Ear Style: Intermediate **OR** Splice, **as directed,** type.
   d. Hanger Configuration: Four-wheel truck **OR** hanger assembly with top mounting plate **OR** hanger assembly with drop bolt **OR** hanger assembly with single drop strap **OR** hanger assembly with double drop strap, **as directed**.
      1) Wheel Assembly: Steel wheels with ball bearings.
   e. Accessories:
      1) Continuous bottom guide.
      2) Guide rail.
      3) Bow Handle: Minimum 6 inches (150 mm) in overall length.
      4) Flush Pull: Minimum 4 by 5-1/2 by 3/4 inch (100 by 140 by 19 mm), mortised into door.
      5) Cane Bolt: Minimum 1/2-inch (13-mm) diameter by 12 inches (305 mm) long.
      6) Stay Roller: Minimum 2-inch- (50-mm-) diameter wheel.
      7) Floor Center Stop: Cast iron.
      8) End guide and stop.
      9) Parallel door floor guides.
      10) Door stop.
      11) Sliding door latch.
      12) Bumper Shoe: Minimum 0.0598-inch (1.5-mm) thickness.
      13) Cremone Bolt: With lever handle, minimum 1/2-inch- (13-mm-) diameter oval or round rod, and rod guides at 24 inches (610 mm) o.c.
      14) Top Spring Bolt: Malleable iron; with angle or surface strike and 24-inch (610-mm) chain.
      15) Foot Bolt: Wrought steel, cast iron, or malleable iron; minimum 6 inches (150 mm) **OR** 8 inches (200 mm), **as directed**.
2. Bypassing Sliding Door Hardware: Rails and door hardware that allow vertical adjustment.
   a. Rail Material: Galvanized wrought steel **OR** Extruded aluminum, **as directed**.
   b. Rail Configuration: V-grooved double leg **OR** V-grooved double leg with fascia **OR** I-beam, **as directed**.
   c. Mounting: Top hung **OR** Bottom supporting with overhead guide, **as directed**.
   d. Wheel Assembly: Two wheel or four wheel, with ball **OR** roller, **as directed,** bearings.
   e. Wheel Material: Steel **OR** Nylon, **as directed**.
   f. Accessories:
      1) Bumper Stops: Wrought steel.
      2) Pulls: Flush, mortised into door **OR** Cast, forged, or extruded brass or bronze surface-applied type **OR** Wrought brass or bronze edge type, mortised into edge of door **OR** Sliding door latch **OR** Sliding door lock with emergency release, **as directed**.
3. Pocket Sliding Door Hardware: Overhead box rails and door hardware that allows vertical adjustment.
   a. Rail Material: Galvanized wrought steel **OR** Extruded aluminum, **as directed**.
   b. Door Type: Single **OR** Biparting, **as directed**.

c. Rail Configuration: V-grooved double leg **OR** I-beam, **as directed**.
d. Wheel Assembly: Two wheel or four wheel, with ball **OR** roller, **as directed,** bearings.
e. Wheel Material: Steel **OR** Nylon, **as directed**.
f. Accessories:
1) Bumper Stops: Wrought steel.
2) Pulls: Flush, mortised into door **OR** Cast, forged, or extruded brass or bronze surface-applied type **OR** Wrought brass or bronze edge type, mortised into edge of door **OR** Sliding door latch **OR** Sliding door lock with emergency release, **as directed**.

LL. Folding Door Hardware, General
1. General: BHMA A156.14; consisting of complete sets including overhead rails, hangers, supports, bumpers, floor guides, and accessories indicated.
a. Interior Doors: Provide door hardware for interior bifolding doors when not furnished as part of door package.
2. Bifolding Door Hardware: Rated for door panels weighing up to 125 lb (57 kg) **OR** 50 lb (23 kg), **as directed**.
3. Multiple Folding Door Hardware: Rated for door panels weighing up to 75 lb (34 kg) **OR** 30 lb (14 kg), **as directed**.

MM. Folding Door Hardware
1. Bifolding Door Hardware: Rails and door hardware that allow horizontal and vertical adjustment.
a. Rail Material: Galvanized wrought steel **OR** Extruded aluminum, **as directed**.
b. Rail Configuration: V-grooved double leg **OR** V-grooved double leg with fascia **OR** I-beam, **as directed**.
c. Mounting: Surface mounted overhead **OR** Top and bottom hung, **as directed**.
d. Wheel Assembly: Two wheel or four wheel, with ball **OR** roller, **as directed,** bearings.
e. Wheel Material: Steel **OR** Nylon, **as directed**
2. Multiple Folding Door Hardware: Rails and door hardware that allows horizontal and vertical adjustment.
a. Rail Material: Galvanized wrought steel **OR** Extruded aluminum, **as directed**.
b. Rail Configuration: V-grooved double leg **OR** V-grooved double leg with fascia **OR** I-beam, **as directed**.
c. Mounting: Surface mounted overhead **OR** Top and bottom hung, **as directed**.
d. Wheel Assembly: Two wheel or four wheel, with ball **OR** roller, **as directed,** bearing.
e. Wheel Material: Steel **OR** Nylon, **as directed**.

NN. Miscellaneous Door Hardware, General
1. Boxed Power Supplies: Modular unit in NEMA ICS 6, Type 4 enclosure; filtered and regulated; voltage rating and type matching requirements of door hardware served; and listed and labeled for use with fire alarm systems.
2. Monitor Strikes: Cast strike with toggle **OR** Dustbox monitor for installation under standard strike, **as directed**.
3. Auxiliary Hardware: BHMA A156.16, Grade 1 **OR** Grade 2 **OR** Grade 3, **as directed**.

OO. Miscellaneous Door Hardware
1. Cardholders: Cast rectangular holder, surface mounted, size as indicated:
a. Card Size: 2 by 3-1/2 inches (51 by 89 mm) **OR** 3-1/2 by 5 inches (89 by 127 mm) **OR** 5 by 8 inches (127 by 203 mm), **as directed**.
b. Material: Brass **OR** Bronze **OR** Stainless steel, **as directed**.
2. Chain Door Guards: Polished cast brass or bronze or extruded brass; consisting of plate slotted to receive 6-inch- (150-mm-) long welded chain secured to an anchor plate. Guard shall allow door to be opened 3 inches (75 mm) with chain engaged in slotted plate. Equip with chain holder.
3. Coat Hooks: Two curved hooks with rounded ends; 3-inch (76-mm) projection from wall; surface-screw applied; fabricated from polished cast brass **OR** polished cast bronze **OR** burnished cast aluminum, **as directed**.

4. Rod-Type Door Guards: Straight door-mounted rod that engages U-shaped, jamb-mounted rod. U-shaped rod can swing 180 degrees away from door; guard allows door to be slightly opened when engaged. Fabricated from polished cast brass **OR** bronze **OR** aluminum, **as directed**.
5. Door Knockers: BHMA A156.16, Grade 1; solid brass, with engraved number and nameplates.
6. Door Position Switches: Magnetically operated reed switch designed for concealed mounting.
7. Garment Hooks: One long hat hook and one small coat hook; 3-3/4-inch (95-mm) projection from wall with 7-inch (178-mm) overall height; surface-screw applied; fabricated from polished cast brass **OR** burnished cast aluminum, **as directed**.
8. House Numbers: BHMA A156.16, Grade 1; wrought, cast, or forged brass; 4 inches (102 mm) high; secured with brass screws.
9. Letter Box Plates: Spring-loaded front plate with brass spring; inside covered gravity flap or hood; fabricated from wrought brass **OR** wrought bronze **OR** aluminum, **as directed**; of the following type:
    a. Regular Size, Inswinging: Minimum 0.036-inch (0.9-mm) metal thickness, with minimum 7-by-1-5/8-inch (178-by-41-mm) opening.
    b. Regular Size, Outswinging: Minimum 0.036-inch (0.9-mm) metal thickness, with minimum 7-by-1-1/2-inch (178-by-38-mm) opening.
    c. Magazine Size, Outswinging: Minimum 0.051-inch (1.3-mm) metal thickness, with minimum 11-by-1-7/8-inch (279-by-48-mm) opening.
10. Door and Frame Transfer Devices: Steel housing for mortise in hinge stile of door, with flexible tube for wiring bundle; accommodating doors that swing open to 120 degrees.
11. Wide-Angle Door Viewers: Solid brass, with optical glass lenses; adjustable to door thickness, and permitting 1-way observation with minimum 190-degree viewing angle.
12. Fire-Rated Door Viewers: Solid brass, with optical glass lenses; listed and labeled; adjustable to door thickness, and permitting 1-way observation with minimum 120 **OR** 150 **OR** 190, **as directed,**-degree viewing angle.

PP. Fabrication
1. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rated labels and as otherwise approved.
    a. Manufacturer's identification is permitted on rim of lock cylinders only.
2. Base Metals: Produce door hardware units of base metal, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18. Do not furnish manufacturer's standard materials or forming methods if different from specified standard.
3. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.
    a. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
    b. Steel Machine or Wood Screws: For the following fire-rated applications:
        1) Mortise hinges to doors.
        2) Strike plates to frames.
        3) Closers to doors and frames.
    c. Steel Through Bolts: For the following fire-rated applications unless door blocking is provided:
        1) Surface hinges to doors.
        2) Closers to doors and frames.

3) Surface-mounted exit devices.

d. Spacers or Sex Bolts: For through bolting of hollow-metal doors.

e. Fasteners for Wood Doors: Comply with requirements in DHI WDHS.2, "Recommended Fasteners for Wood Doors."

QQ. Finishes

1. Standard: BHMA A156.18, as indicated in door hardware sets.
2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
3. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

1.3 EXECUTION

A. Preparation

1. Steel Doors and Frames: Comply with DHI A115 Series.
   a. Surface-Applied Door Hardware: Drill and tap doors and frames according to ANSI A250.6.
2. Wood Doors: Comply with DHI A115-W Series.

B. Installation

1. Mounting Heights: Mount door hardware units at heights indicated on Drawings **OR** as follows, **as directed,** unless otherwise indicated or required to comply with governing regulations.
   a. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
   b. Custom Steel Doors and Frames: DHI's "Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames."
   c. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
2. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 09. Do not install surface-mounted items until finishes have been completed on substrates involved.
   a. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
   b. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
3. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.
4. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings **OR** in equipment room, **as directed**. Verify location.
   a. Configuration: Provide one power supply for each door opening.
   b. Configuration: Provide the least number of power supplies required to adequately serve doors with electrified door hardware.
5. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants".

C. Field Quality Control

1. Independent Architectural Hardware Consultant: Engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.

a. Independent Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

D. Adjusting
1. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
   a. Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 30 degrees.
   b. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
   c. Door Closers: Unless otherwise required by authorities having jurisdiction, adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches (75 mm) from the latch, measured to the leading edge of the door.
2. Occupancy Adjustment: Approximately three **OR** six, **as directed,** months after date of Substantial Completion, Installer's Architectural Hardware Consultant shall examine and readjust, including adjusting operating forces, each item of door hardware as necessary to ensure function of doors, door hardware, and electrified door hardware.

E. Cleaning And Protection
1. Clean adjacent surfaces soiled by door hardware installation.
2. Clean operating items as necessary to restore proper function and finish.
3. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

END OF SECTION 08710

SECTION 08710a - DETENTION DOOR HARDWARE

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for detention door hardware. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Detention door hardware for the following:
1) Swinging detention doors.
2) Sliding detention doors.
b. Detention cylinders for doors specified in other Sections.

C. Performance Requirements
1. Swinging Detention Door Assemblies: Provide detention door hardware as part of a detention door assembly that complies with security grade indicated, when tested according to ASTM F 1450, based on testing manufacturer's standard units in assemblies similar to those indicated for this Project.
a. Bullet Resistance: Comply with Level 3 rating when tested according to UL 752; where indicated.
1) Listed and labeled as bullet resisting by a testing agency acceptable to authorities having jurisdiction.
b. Tool-Attack Resistance: Comply with small-tool-attack-resistance rating when tested according to UL 1034 and UL 437.
2. Detention Door Hardware Functional Performance: Provide detention door hardware with features, functions, and internal equipment required to perform control and monitoring functions indicated in Division 13 Section "Plc Electronic Detention Monitoring And Control Systems".

D. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: For each type of detention door hardware.
a. Wiring Diagrams: For power, signal, and control wiring; differentiate between manufacturer-installed and field-installed wiring for electrified and pneumatic, **as directed**, detention door hardware.
b. Compressed-Air System Diagrams: For compressed-air piping for door control systems; differentiate between manufacturer-installed and field-installed piping for pneumatic detention door hardware.
c. Detail interface between electrified detention door hardware and perimeter security, detention monitoring and control, fire-alarm, and building control, **as directed**, system.
d. Detail interface between pneumatic detention door hardware and perimeter security, detention monitoring and control, fire-alarm, and building control, **as directed**, system.
3. Other Action Submittals:
a. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with detention doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
1) Integrate detention door hardware indicated in "Detention Door Hardware Sets" Article into the Door Hardware Schedule, and indicate complete designations of every item required for each door and opening.

b. Keying Schedule: Comply with requirements specified in Division 08 Section "Door Hardware". Coordinate detention keying with other door hardware in the final Keying Schedule.
   1) Indicate each lock and type of key using the following prefixes: "P" for paracentric, "M" for mogul, "HS" for high security, and "C" for commercial.

c. Operation and Maintenance Data: For electrified and pneumatic, **as applicable**, detention door hardware to include in emergency, operation, and maintenance manuals.

4. Warranties: Sample of special warranties.

E. Quality Assurance

1. Installer Qualifications: An employer of workers trained and approved by manufacturer and an authorized representative of detention door hardware manufacturer for installation and maintenance of units required for this Project.
2. Supplier Qualifications: Detention door hardware supplier with warehousing facilities in Project's vicinity and who is or employs a qualified Architectural Hardware Consultant, available during the course of the Work to consult with Contractor, Architect, and Owner about detention door hardware and keying.
   a. Detention Door Hardware Supplier Qualifications: An experienced detention door hardware supplier who has completed projects with electrified and pneumatic, **as directed**, detention door hardware similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance, and who is acceptable to manufacturer of primary materials.
      1) Engineering Responsibility: Prepare data for electrified and pneumatic, **as directed**, detention door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
   b. Scheduling Responsibility: Preparation of door hardware and keying schedules.
3. Architectural Hardware Consultant Qualifications: A person who is currently certified by DHI as an Architectural Hardware Consultant and who is experienced in providing consulting services for detention door hardware installations that are comparable in material, design, and extent to that indicated for this Project.
   a. Detention Door Hardware Consultant Qualifications: Experienced in providing consulting services for electrified and pneumatic, **as directed**, detention door hardware installations.
4. Source Limitations for Detention Door Hardware: Obtain each type of detention door hardware from single source from single manufacturer.
   a. Provide electrified and pneumatic, **as directed**, detention door hardware from same manufacturer as mechanical detention door hardware unless otherwise indicated.
5. Regulatory Requirements: Comply with provisions of the following:
   a. Where indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1, **as directed**, as follows:
      1) Handles, Pulls, Latches, Locks, and other Operating Devices: Shape that is easy to grasp with one hand and does not require tight grasping, tight pinching, or twisting of the wrist.
      2) Security Door Closers: Comply with the following maximum opening-force requirements indicated:
         a) Interior Hinged Doors: 5 lbf (22 N) applied perpendicular to door.
         b) Sliding Doors: 5 lbf (22 N) applied parallel to door at latch.
         c) Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
   b. NFPA 101: Comply with the following for means-of-egress doors:
      1) Latches and Locks: Not more than 15 lbf (67 N) to release the latch.
      2) Security Door Closers: Not more than 30 lbf (133 N) to set door in motion and not more than 15 lbf (67 N) to open door to minimum required width.

3) Sliding Detention Door Devices: Not more than 50 lbf (222 N) to slide door to its fully open position with a perpendicular force of 50 lbf (222 N) against door.

c. Electrified and Pneumatic, **as directed**, Door Hardware: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

6. Fire-Rated Detention Door Assemblies: Provide detention door hardware for assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure **OR** as close to neutral pressure as possible, **as directed**, according to NFPA 252 **OR** UBC Standard 7-2 **OR** UL 10B **OR** UL 10C, **as directed**.
7. Keying Conference: Conduct conference at Project site Incorporate keying conference decisions into the final Keying Schedule after reviewing detention door hardware keying system including, but not limited to, the following:
   a. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
   b. Preliminary key system schematic diagram.
   c. Requirements for key-control system including key exclusivity and duplication control.
   d. Address for delivery of keys.
8. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Inventory detention door hardware on receipt and provide secure lockup for detention door hardware delivered to Project site.
2. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
3. Deliver keys to Owner by registered mail or overnight package service**.**

G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of detention door hardware that fail in materials or workmanship within specified warranty period.
   a. Failures include, but are not limited to, the following:
      1) Structural failures including excessive deflection, cracking, or breakage.
      2) Faulty operation of operators and detention door hardware.
      3) Deterioration of metals, metal finishes, and other materials beyond normal weathering or detention use.
2. Warranty Period: Three years from date of Substantial Completion.
3. Warranty Period for Continuous-Pin Detention Hinges: 10 years from date of Substantial Completion.
4. Warranty Period for Security Door Closers: 10 years from date of Substantial Completion.

H. Maintenance Service
1. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of detention door hardware.
2. Initial Maintenance Service: Beginning at Substantial Completion, provide three **OR** six **OR** nine **OR** 12, **as directed**, months' full maintenance by skilled employees of detention door hardware Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper detention door hardware operation. Provide parts and supplies the same as those used in the manufacture and installation of original equipment.

1.2 PRODUCTS

A. Security Fasteners

1. General: Operable only by tools produced for use on specific type of fastener by fastener manufacturer or other licensed fabricator. Drive-system type, head style, material, and protective coating as required for assembly, installation, and strength, and as follows:
   a. Drive-System Types: Pinned Torx-Plus **OR** Pinned Torx, **as directed**.
   b. Fastener Strength: 120,000 psi (827 MPa).
   c. Socket Button Head Fasteners:
      1) Heat-treated alloy steel, ASTM F 835 (ASTM F 835M).
      2) Stainless steel, ASTM F 879 (ASTM F 879M), Group 1 CW.
   d. Socket Flat Countersunk Head Fasteners:
      1) Heat-treated alloy steel, ASTM F 835 (ASTM F 835M).
      2) Stainless steel, ASTM F 879 (ASTM F 879M), Group 1 CW.
   e. Socket Head Cap Fasteners:
      1) Heat-treated alloy steel, ASTM A 574 (ASTM A 574M).
      2) Stainless steel, ASTM F 837 (ASTM F 837M), Group 1 CW.
   f. Protective Coatings for Heat-Treated Alloy Steel:
      1) Zinc and clear trivalent chromium where indicated.
      2) Zinc phosphate with oil, ASTM F 1137, Grade I, or black oxide unless otherwise indicated.

B. Detention Hinges, General
   1. Standard for Electric Detention Hinges: UL 634.
   2. Quantity: Provide the following unless otherwise indicated:
      a. Two Detention Hinges: For detention doors with heights up to 60 inches (1524 mm).
      b. Three Detention Hinges: For detention doors with heights 61 to 90 inches (1549 to 2286 mm).
      c. Four Detention Hinges: For detention doors with heights 91 to 120 inches (2311 to 3048 mm).
      d. For detention doors with heights more than 120 inches (3048 mm), provide four detention hinges, plus one detention hinge for every 30 inches (762 mm) of detention door height greater than 120 inches (3048 mm).
   3. Size: Provide the following, unless otherwise indicated, with detention hinge widths sized for 2-inch (51-mm) detention door thickness and clearances required:
      a. Doors up to 42 Inches (1067 mm) Wide: Minimum 4-1/2 inches (114 mm) wide by 0.180 inches (4.6 mm) thick or 5 inches (127 mm) wide by 0.190 inches (4.8 mm) thick.
      b. Doors Greater Than 42 Inches (1067 mm) Wide: Minimum 6 inches (152 mm) wide by 0.203 inches (5.2 mm) thick.
   4. Detention Doors with Security Closers: Unless otherwise indicated, provide antifriction-bearing detention hinges.
   5. Detention Hinge Base Metal: Unless otherwise indicated, provide the following:
      a. Exterior Detention Hinges: Stainless steel, with stainless-steel pin.
      b. Interior Detention Hinges: Steel, with steel pin **OR** Stainless steel, with stainless-steel pin, **as directed**.
      c. Detention Hinges for Fire-Rated Assemblies: Steel, with steel pin **OR** Stainless steel, with stainless-steel pin, **as directed**.
   6. Electrified Functions for Detention Hinges: Comply with the following:
      a. Electrical Contact: Exposed electrical contacts for transfer of power.
      b. Power Transfer: Concealed PTFE-jacketed wires, secured at each leaf and continuous through detention hinge knuckle.
      c. Monitoring: Concealed electrical monitoring switch.
   7. Fastening: Comply with the following:
      a. Welding: Where indicated, weld hinges to detention doors and frames with continuous fillet weld around three sides of hinge perimeter.
      b. Security Fasteners: Provide socket flat countersunk head machine screws; finish screw heads to match surface of detention hinges. Install into drilled and tapped holes.

C. Detention Hinges
1. Utility-Door Detention Hinges DH-1: Heavy weight, plain bearing; fabricated from cast iron or steel; 3/8-inch- (9.5-mm-) diameter, case-hardened, fully welded, **as directed**, steel hinge pin; full surface.
   a. Leaves: Drilled for countersunk security fasteners **OR** Solid, **as directed**.
   b. Size: Minimum 3 by 4 inches by 0.200 inch (75 by 100 by 5 mm).
   c. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**, according to ASTM F 1758.
   d. Finish: BHMA 600.
2. Food-Pass Detention Hinges DH-2: Heavy weight, plain bearing; fabricated from cast iron or steel; 3/8-inch- (9.5-mm-) diameter, case-hardened, fully welded, **as directed**, steel hinge pin; with applied stop preventing door from opening more than 90 degrees and supporting door in horizontal position as a shelf; full surface.
   a. Leaves: Drilled for countersunk security fasteners **OR** Solid, **as directed**.
   b. Size: Minimum 3 by 4 inches by 0.200 inch (75 by 100 by 5 mm).
   c. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**, according to ASTM F 1758.
   d. Finish: BHMA 600.
3. Full-Surface Detention Hinges DH-3: Extra heavy weight; two heavy-duty thrust bearings with hardened-steel ball bearings; fabricated from steel plate; 3/4-inch- (19-mm-) diameter, case-hardened, fully welded, steel hinge pin.
   a. Leaves: Drilled for countersunk security fasteners **OR** Solid, **as directed**.
   b. Size: Minimum 5 by 5-1/4 inches by 1/2 inch (127 by 133 by 13 mm).
   c. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**, according to ASTM F 1758.
   d. Finish: BHMA 600.
4. Half-Surface Detention Hinges DH-4: Extra heavy weight; two heavy-duty thrust bearings with hardened-steel ball bearings; fabricated from steel plate; 3/4-inch- (19-mm-) diameter, case-hardened, fully welded, steel hinge pin.
   a. Leaves: Drilled for countersunk security fasteners **OR** Solid, **as directed**.
   b. Size: Minimum 5 by 5-1/4 inches by 1/2 inch (127 by 133 by 13 mm).
   c. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**, according to ASTM F 1758.
   d. Finish: BHMA 600.
5. Gap-Mounted Detention Hinges DH-5: Extra heavy weight; two heavy-duty thrust bearings with hardened-steel ball bearings; fabricated from steel plate; 3/4-inch- (19-mm-) diameter, case-hardened, fully welded, steel hinge pin.
   a. Leaves: Drilled for countersunk security fasteners **OR** Solid, **as directed**.
   b. Size: Minimum 5 by 6 inches by 1/2 inch (127 by 152 by 13 mm).
   c. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**, according to ASTM F 1758.
   d. Finish: BHMA 600.
6. Continuous-Pin Detention Hinges DH-6: Minimum 0.109-inch- (2.78-mm-) thick, stainless-steel hinge leaves with minimum overall width of 4 inches (100 mm); with 1/4-inch- (6-mm-) diameter continuous pin; fabricated to full height of detention door and frame. Finish components after milling and drilling are complete. Fabricate continuous-pin detention hinges to template screw locations.
   a. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**, according to ASTM F 1758.

D. Detention Locks And Latches, General
1. Swinging Detention Door Lock and Latch Performance: Provide detention door locks and latches that comply with security grade indicated, when tested according to ASTM F 1577, based on testing manufacturer's standard units in assemblies similar to those indicated for this Project.
2. Detention Lock Functions: Provide function numbers and descriptions indicated in detention door hardware sets complying with ASTM F 1577.
3. Detention Lock Construction: Fabricate detention lock case and cover plate from steel plate. Fabricate bolts from solid sections; laminated construction unacceptable.
4. Detention Lock Throw: Comply with testing requirements for length of bolts to comply with labeled fire door requirements, and as follows:
   a. Latchbolts for Detention Food Pass **OR** Security Access Doors, **as directed**: Minimum 5/8-inch (16-mm) latchbolt throw.

b. Latchbolts: Minimum 3/4-inch (19-mm) latchbolt throw.
c. Deadbolts: Minimum 1-inch (25-mm) bolt throw.

5. Detention Lock Trim:
   a. Levers: Solid stainless steel.
   b. Knobs: Stainless steel **OR** Brass, **as directed**.
   c. Escutcheons for Paracentric Locks: 0.125-inch- (3.18-mm-) thick, 3-inch- (75-mm-) diameter stainless steel with BHMA 626 **OR** brass with BHMA 606, **as directed**, finish. Attach with security fasteners.
      1) Style: Single wing **OR** Double wing **OR** Single or double wing as required by lock function **OR** As indicated, **as directed**.
      2) Provide escutcheons unless otherwise **OR** where, **as directed**, indicated.
   d. Cylinder Shields for Paracentric Locks: 0.125-inch- (3.18-mm-) thick, 3-inch- (75-mm-) diameter stainless steel with BHMA 626 **OR** brass with BHMA 606, **as directed**, finish and swinging cover to protect keyhole. Attach with security fasteners.
      1) Style: Single wing **OR** Double wing **OR** Single or double wing as required by lock function **OR** As indicated, **as directed**.
      2) Provide cylinder shields unless otherwise **OR** where, **as directed**, indicated.
6. Pneumatic Detention Locks and Latches: Operate when supplied with air between 40 psig (275 kPa) minimum and 100 psig (690 kPa) maximum. Factory install quick-connect air fitting and factory-wired plug connector with 6-inch (150-mm) wire pigtail.
   a. Provide security ring for installation of pneumatic detention lock in hollow-metal detention frame, welded to frame or access cover unless otherwise **OR** where, **as directed**, indicated.

E. Mechanical Detention Locks And Latches
1. General: Provide mechanical detention lock mountings as follows:
   a. Hollow-Metal Detention Doors: Mount detention lock to back of 0.179-inch (4.56-mm) nominal-thickness steel **OR** 0.183-inch (4.65-mm) nominal-thickness galvanized-steel, **as directed**, cover plate for installation in lock pocket fabricated into detention door. Attach cover plate to hollow-metal detention door with security fasteners.
   b. Bar-Grille Detention Doors: Mount detention lock to back of galvanized, **as directed**, steel enclosure welded to flat horizontal bars of bar-grille detention door; cover with 0.179-inch (4.56-mm) nominal-thickness steel **OR** 0.183-inch (4.65-mm) nominal-thickness galvanized-steel, **as directed**, plate. Attach plate with security fasteners.
   c. Steel-Plate Detention Doors: Mount detention lock to inside surface of 0.179-inch (4.56-mm) nominal-thickness steel **OR** 0.134-inch (3.42-mm) nominal-thickness steel **OR** 0.183-inch (4.65-mm) nominal-thickness galvanized-steel **OR** 0.138-inch (3.50-mm) nominal-thickness galvanized-steel, **as directed**, enclosure with integrally formed mounting flanges. Attach enclosure to steel-plate detention door with security fasteners **OR** rivets, **as directed**.
2. Utility-Door Mechanical Deadlocks, Paracentric ML-1: For use on small swinging doors, such as access panels, plumbing space doors, electric panel doors, and hatches that are infrequently used.
   a. Function: Lockbolt retracted and extended by five **OR** six, **as directed**,-tumbler paracentric cylinder; keyed one side **OR** two sides, **as directed**.
   b. Lockbolt: 1-1/2 inches high by 3/4 inch (38 mm high by 19 mm) thick; 5/8-inch (16-mm) throw.
   c. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.
3. Utility-Door Mechanical Deadlocks, Mogul ML-2: For use on small swinging doors, such as access panels, plumbing space doors, electric panel doors, and hatches that are infrequently used.
   a. Function: Lockbolt retracted and extended by mogul cylinder; keyed one side **OR** two sides, **as directed**.
   b. Lockbolt: 1-1/2 inches high by 3/4 inch (38 mm high by 19 mm) thick; 5/8-inch (16-mm) throw.

c. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.

4. Mechanical Snaplatches, Paracentric ML-3: For use on small swinging doors, such as food-pass doors, observation panels, gun locker doors, and other small doors where snaplocking is needed and deadlocking is not required.
   a. Function: Automatic snaplatch when door is closed; latchbolt retracted by five **OR** six, **as directed**,-tumbler paracentric cylinder; keyed one side **OR** two sides, **as directed**.
   b. Latchbolt: 1 inch high by 7/16 inch (25 mm high by 11 mm) thick; 5/16-inch (8-mm) throw.
   c. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.
5. Mechanical Snaplatches, Mogul ML-4: For use on small swinging doors, such as food-pass doors, observation panels, gun locker doors, and other small doors where snaplocking is needed and deadlocking is not required
   a. Function: Automatic snaplatch when door is closed; latchbolt retracted by mogul cylinder; keyed one side **OR** two sides, **as directed**.
   b. Latchbolt: 1 inch high by 7/16 inch (25 mm high by 11 mm) thick; 5/16-inch (8-mm) throw.
   c. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.
6. Mechanical Concealed Snaplatches ML-5: For use on small swinging doors, such as observation panels, wickets, covers, and other small doors.
   a. Function: Automatic snaplatch when door is closed; latchbolt retracted by five-tumbler paracentric cylinder; keyed one side. When closed, latch is concealed within lock case.
   b. Latchbolt: 1 inch high by 7/16 inch (25 mm high by 11 mm) thick; 7/16-inch (11-mm) throw.
   c. Provide angled strike.
   d. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.
7. Sliding Door Mechanical Deadlatches ML-6: For use on sliding doors, such as entrance, safety vestibule, and corridor doors.
   a. Function: Hookbolt snaplatches and automatically deadlocks through action of plunger pin when door is closed (slam locking); hookbolt raised by five **OR** six, **as directed**,-tumbler paracentric cylinder; keyed one side **OR** two sides, **as directed**.
   b. Hookbolt: 1/2-inch- (13-mm-) thick, case-hardened steel; 5/8-inch (16-mm) lift.
   c. Provide case-hardened-steel deadlock plunger pin.
   d. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.
8. Sliding Door Mechanical Deadlocks ML-7: For use on sliding doors, such as entrance, safety vestibule, corridor, and inmate cell doors.
   a. Function: Hookbolt raised and lowered by five **OR** six, **as directed**,-tumbler paracentric cylinder (no slam locking); keyed one side **OR** two sides, **as directed**.
   b. Hookbolt: 1/2-inch- (13-mm-) thick, case-hardened steel; 5/8-inch (16-mm) lift.
   c. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.
9. Mechanical Snaplatches ML-8: For use on swinging doors, such as corridor, dining room, and recreational area doors.
   a. Function: Automatic snaplatch when door is closed (slam locking); latchbolt retracted by half turn and extended by full turn in opposite direction of five **OR** six, **as directed**,-tumbler paracentric cylinder; keyed one side **OR** two sides, **as directed**.
      1) Knob operation retracts latchbolt unless deadlocked. Locate knobs on one side **OR** two sides, **as directed**.
   b. Latchbolt: 2-inch-high by 3/4-inch- (50-mm-high by 19-mm-) thick steel, with two case-hardened-steel insert pins; 3/4-inch (19-mm) throw; 1/2-inch (13-mm) **OR** 1-1/4-inch (32-mm), **as directed**, bolt projection when retracted.
   c. Listed and labeled for use on fire doors.
   d. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.
10. Mechanical Deadlatches/Deadlocks ML-9: For use on swinging doors, such as day room, dining room, and recreational area doors.
    a. Function: Automatic snaplatch and automatic deadlock through action of actuator when door is closed (slam locking); latchbolt retracted by five **OR** six, **as directed**,-tumbler paracentric cylinder; keyed one side **OR** two sides, **as directed**.
    b. Latchbolt: 2-inch-high by 3/4-inch- (50-mm-high by 19-mm-) thick steel, with two case-hardened-steel insert pins; 3/4-inch (19-mm) throw; 1/2-inch (13-mm) **OR** 1-1/4-inch (32-mm), **as directed**, bolt projection when retracted.

c. Deadlock Actuator: 3/4-inch-high by 3/4-inch- (19-mm-high by 19-mm-) thick steel; 1/2-inch (13-mm) throw.
d. Listed and labeled for use on fire doors.
e. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.

11. Mechanical Deadlocks ML-10: For use on swinging doors where slam locking is not required, such as holding cell, segregation cell, control room, armory, key cabinet, storage, utility, and hollow-metal access doors.
    a. Function: Deadlocked in both locked and unlocked position; latchbolt retracted and extended by five **OR** six, **as directed**,-tumbler paracentric cylinder; keyed one side **OR** two sides, **as directed**.
    b. Latchbolt: 2-inch-high by 3/4-inch- (50-mm-high by 19-mm-) thick steel, with two case-hardened-steel insert pins; 3/4-inch (19-mm) throw; 1/2-inch (13-mm) **OR** 1-1/4-inch (32-mm), **as directed**, bolt projection when retracted.
    c. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.
12. Cremone Bolt Mechanical Snaplatches ML-11: For use on swinging doors or active leaf of pairs of swinging doors where slam locking is needed.
    a. Function: Automatic snaplatch and deadlocking when door is closed (slam locking); latchbolt retracted and extended by five-tumbler paracentric cylinder; keyed one side **OR** two sides, **as directed**. Lever operation one side **OR** two sides, **as directed**, retracts head and foot rods, unless deadlocked, for three-point locking.
    b. Latchbolt: 2-inch-high by 3/4-inch- (50-mm-high by 19-mm-) thick steel, with two case-hardened-steel insert pins; 3/4-inch (19-mm) throw.
    c. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.
13. Cremone Bolt Mechanical Deadlocks, Paracentric ML-12: For use on swinging doors or active leaf of pairs of swinging doors where doors may be subject to mass attack. Delete inactive leaf for single door.
    a. Function: Active leaf deadlocks when door is closed (no slam locking); active-leaf deadbolt retracted and extended by five **OR** six, **as directed**,-tumbler paracentric cylinder; keyed one side **OR** two sides, **as directed**. Active-leaf lever operation one side **OR** two sides, **as directed**, retracts active-leaf head and foot bolts unless deadlocked.
        1) Inactive Leaf: Head and foot bolts deadlocked by five **OR** six, **as directed**,-tumbler, inactive-leaf paracentric cylinder. Inactive-leaf lever operation one side **OR** two sides, **as directed**, retracts inactive-leaf head and foot bolts unless deadlocked.
    b. Deadbolt: 2-inch-high by 3/4-inch- (50-mm-high by 19-mm-) thick steel, with two case-hardened-steel insert pins; 3/4-inch (19-mm) throw.
    c. Head and Foot Bolts: 7/8-inch (22-mm) diameter; 3/4-inch (19-mm) throw.
    d. Provide foot bolt receptacle(s).
    e. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.
14. Mechanical Head and Foot Bolts ML-14: For use on the inactive leaf of pairs of swinging doors.
    a. Function: Bolt retracted and extended by spanner-type key **OR** five-tumbler paracentric cylinder, **as directed**; enclosed in iron or steel case with steel cover (not applicable for hollow-metal doors).
    b. Latchbolt: 1-inch- (25-mm-) diameter steel; 3/4-inch (19-mm) throw.
    c. Footbolt Receptacle: Spring-loaded mechanism; brass.
    d. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.

F. Electromechanical Detention Locks And Latches
1. General: Provide electromechanical detention locks and latches with factory-wired plug connector with 6-inch (152-mm) wire pigtail.
    a. Provide security ring for installation of electromechanical detention lock in hollow-metal detention frame, welded to frame or access cover, unless otherwise **OR** where, **as directed**, indicated.
    b. Equip direct-current solenoid-operated detention locks and latches with diode transient voltage protection at each locking device.

2. Solenoid-Operated Deadlatches, Paracentric EL-1: For use on swinging doors, such as entrance, sally port, corridor, and inmate cell doors, that are to be unlocked from remote locations.
   a. Function: Remote switch activates electric solenoid that retracts latchbolt; automatic latching and deadlocking when door is closed (slam locking). Latchbolt can be mechanically retracted by five **OR** six, **as directed**,-tumbler paracentric cylinder; keyed one side **OR** two sides, **as directed**; if latchbolt is retracted by key, it remains retracted until relocked by key.
      1) Latchback: Latchbolt remains retracted until door is opened 2 inches (50 mm), then releases **OR** as long as control switch is activated; latchbolt extends when power is discontinued, **as directed**.
      2) If power fails, latchbolt automatically deadlocks (fail secure).
   b. Latchbolt: 2-inch-high by 3/4-inch- (50-mm-high by 19-mm-) thick hardened steel; 3/4-inch (19-mm) throw.
   c. Provide internal deadlock indicator switch.
   d. Provide roller-type deadlock actuator.
   e. Voltage: 120-V ac.
   f. Listed and labeled for use on fire doors.
   g. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.
3. Motor-Operated Deadlatches, Paracentric EL-2: For use on swinging doors, such as entrance, sally port, corridor, and inmate cell doors, that are to be unlocked from remote locations.
   a. Function: Remote switch activates electric motor that retracts latchbolt; automatic latching and deadlocking when door is closed (slam locking). Latchbolt can be mechanically retracted by five **OR** six, **as directed**,-tumbler paracentric cylinder; keyed one side **OR** two sides, **as directed**; if latchbolt is retracted by key, it remains retracted until relocked by key.
      1) Latchback: Latchbolt remains retracted until door is opened 2 inches (50 mm), then releases **OR** as long as control switch is activated; latchbolt extends when power is discontinued, **as directed**.
      2) If power fails, latchbolt automatically deadlocks (fail-secure).
   b. Latchbolt: 2-inch-high by 3/4-inch- (50-mm-high by 19-mm-) thick hardened steel; 3/4-inch (19-mm) throw.
   c. Provide internal deadlock indicator switch.
   d. Provide roller-type deadlock actuator.
   e. Voltage: 120-V ac **OR** 24-V dc, **as directed**.
   f. Listed and labeled for use on fire doors.
   g. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.
4. Sliding Door Motor-Operated Deadlatches EL-3: For use on sliding doors, such as entrance, sally port, corridor, and inmate cell doors, that are to be unlocked from remote locations.
   a. Function: Remote switch activates electric motor that raises hookbolt; spring-loaded actuator pin pushes door open 1 to 3 inches (25 to 75 mm); automatic latching and deadlocking when door is closed (slam locking). Hookbolt can be mechanically raised by five **OR** six, **as directed**,-tumbler paracentric cylinder; keyed one side **OR** two sides, **as directed**; if hookbolt is raised by key, it remains raised until relocked by key.
      1) Latchback: Hookbolt remains raised until door is opened 2 inches (50 mm), then lowers **OR** as long as control switch is in open position; hookbolt lowers when control switch is moved to locked position, **as directed**.
      2) If power fails, hookbolt automatically deadlocks (fail-secure).
   b. Hookbolt: 1-3/4- by 1/2-inch- (44- by 13-mm-) thick, case-hardened steel; 3/4-inch (19-mm) throw.
   c. Provide internal deadlock indicator switch.
   d. Provide case-hardened-steel deadlock actuator.
   e. Voltage: 120-V ac.
   f. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.
5. Solenoid-Operated Deadlatches, Mogul EL-4: For use on swinging doors, such as entrance, sally port, corridor, and inmate cell doors, that are to be unlocked from remote locations.

a. Function: Remote switch activates electric solenoid that retracts latchbolt; automatic latching and deadlocking when door is closed (slam locking). Latchbolt can be mechanically retracted by mogul cylinder; keyed one side **OR** two sides, **as directed**.
   1) Latchback: Latchbolt remains retracted until door is opened 2 inches (50 mm), then releases **OR** as long as control switch is activated; latchbolt extends when power is discontinued, **as directed**.
   2) Local Electric Key (LEK): Inmate key operates lock electrically when enabled; staff key always operates lock manually and electrically; where indicated.
   3) Key Holdback: If latchbolt is retracted by key, it remains retracted until relocked by key (listing for use on fire doors is not available).
   4) Knob operation retracts latchbolt; always active.
   5) If power fails, latchbolt automatically deadlocks (fail-secure).

b. Latchbolt: 1-1/2-inch-high by 3/4-inch- (38-mm-high by 19-mm-) thick hardened steel; 1-inch (25-mm) throw.

c. Provide internal deadlock indicator switch.

d. Provide roller-type deadlock actuator.

e. Voltage: 120-V ac.

f. Listed and labeled for use on fire doors.

g. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.

6. Motor-Operated Deadlatches, Mogul EL-5: for use on swinging doors, such as entrance, sally port, corridor, and inmate cell doors, that are to be unlocked from remote locations.

a. Function: Remote switch activates electric motor that retracts latchbolt; automatic latching and deadlocking when door is closed (slam locking). Latchbolt can be mechanically retracted by mogul cylinder; keyed one side **OR** two sides, **as directed**.
   1) Latchback: Latchbolt remains retracted until door is opened 2 inches (50 mm), then releases **OR** as long as control switch is in open position; latchbolt extends when control switch is moved to locked position, **as directed**.
   2) Local Electric Key (LEK): Inmate key operates lock electrically when enabled; staff key always operates lock manually and electrically; where indicated.
   3) Key Holdback: If latchbolt is retracted by key, it remains retracted until relocked by key (listing for use on fire doors is not available).
   4) Knob operation retracts latchbolt; always active.
   5) If power fails, latchbolt automatically deadlocks (fail-secure).

b. Latchbolt: 1-1/2-inch-high by 3/4-inch- (38-mm-high by 19-mm-) thick hardened steel; 1-inch (25-mm) throw.

c. Provide internal deadlock indicator switch.

d. Provide roller-type deadlock actuator.

e. Voltage: 120-V ac **OR** 24-V dc, **as directed**.

f. Listed and labeled for use on fire doors.

g. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.

7. Solenoid-Operated Deadlatches, Commercial EL-6: For use on swinging doors, hung in standard 2-inch (50-mm) hollow-metal frames, that are to be unlocked from remote locations.

a. Function: Remote switch activates electric solenoid that retracts latchbolt; automatic latching and deadlocking when door is closed (slam locking). Latchbolt can be mechanically retracted by high-security, **as directed**, commercial cylinder; keyed one side **OR** two sides, **as directed**.
   1) Latchback: Latchbolt remains retracted until door is opened 2 inches (50 mm), then releases **OR** as long as control switch is activated; latchbolt extends when power is discontinued, **as directed**.
   2) Local Electric Key (LEK): Inmate key operates lock electrically when enabled; staff key always operates lock manually and electrically; where indicated.
   3) If power fails, latchbolt automatically deadlocks (fail-secure).

b. Latchbolt: 1-1/2-inch-high by 5/8-inch- (38-mm-high by 16-mm-) thick hardened steel; 3/4-inch (19-mm) throw.

c. Provide internal deadlock indicator switch.

d. Deadlock Actuator: Stainless steel.
e. Strike: Stainless steel.
f. Voltage: 24-V dc.
g. Listed and labeled for use on fire doors.
h. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.

8. Motor-Operated Deadlatches, Commercial EL-7: For use on swinging doors, hung in standard 2-inch (50-mm) hollow-metal frames, that are to be unlocked from remote locations.
   a. Function: Remote switch activates electric motor that retracts latchbolt; automatic latching and deadlocking when door is closed (slam locking). Latchbolt can be mechanically retracted by high-security, **as directed**, commercial cylinder; keyed one side **OR** two sides, **as directed**.
      1) Latchback: Latchbolt remains retracted until door is opened 2 inches (50 mm), then releases **OR** as long as control switch is in open position; latchbolt extends when control switch is moved to locked position, **as directed**.
      2) Local Electric Key (LEK): Inmate key operates lock electrically when enabled; staff key always operates lock manually and electrically; where indicated.
      3) If power fails, latchbolt automatically deadlocks (fail-secure).
   b. Latchbolt: 1-1/2-inch-high by 5/8-inch- (38-mm-high by 16-mm-) thick hardened steel; 3/4-inch (19-mm) throw.
   c. Provide internal deadlock indicator switch.
   d. Deadlock Actuator: Stainless steel.
   e. Strike: Stainless steel.
   f. Voltage: 24-V dc.
   g. Listed and labeled for use on fire doors.
   h. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.
9. Solenoid-Operated Gate Locks, Paracentric EL-8: For use on swinging and sliding gates that are to be unlocked from remote locations.
   a. Function: Remote switch activates electric solenoid that raises an internal bolt; automatic deadlocking when gate is closed. Bolt can be mechanically retracted by five **OR** six, **as directed**,-tumbler paracentric cylinder; keyed one side **OR** two sides, **as directed**.
      1) Latchback: Bolt remains raised until gate is closed.
      2) If power fails, latchbolt automatically deadlocks (fail-secure).
   b. Bolt: 5/8-inch- (16-mm-) diameter stainless steel; 1-inch (25-mm) throw.
   c. Provide internal deadlock indicator switch.
   d. Voltage: 120-V ac.
   e. Finish: Galvanized.
   f. Mounting: Mount lock to gate post; mount locking tongue to gate frame.
   g. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.

G. Pneumatic Detention Locks And Latches
1. General: Provide pneumatic detention locks and latches that operate when supplied with air between 40 psig (275 kPa) minimum and 100 psig (690 kPa) maximum.
2. Factory install quick-connect air fitting and factory-wired plug connector with 6-inch (150-mm) wire pigtail.
   a. Provide security ring for installation of pneumatic detention lock in hollow-metal detention frame, welded to frame or access cover, unless otherwise **OR** where, **as directed**, indicated.
3. Pneumatic Deadlatches, Paracentric PL-1: For use on swinging doors, such as entrance, sally port, corridor, and inmate cell doors, that are to be unlocked from remote locations.
   a. Function: Remote switch activates pneumatic cylinder that retracts latchbolt; latchbolt remains retracted until door is opened 2 inches (50 mm), then releases **OR** as long as control switch is activated, **as directed**; automatic latching and deadlocking when door is closed (slam locking). Latchbolt can be mechanically retracted by five **OR** six, **as directed**,-tumbler paracentric cylinder; keyed one side **OR** two sides, **as directed**.
      1) If power fails or compressed-air system fails, latchbolt automatically deadlocks (fail-secure).

b. Latchbolt: 2-inch-high by 3/4-inch- (50-mm-high by 19-mm-) thick hardened steel; 3/4-inch (19-mm) throw.
c. Provide internal deadlock indicator switch.
d. Provide roller-type deadlock actuator.
e. Voltage: 24-V dc.
f. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.

4. Pneumatic Deadlatches, Mogul PL-2: For use on swinging doors, such as entrance, sally port, corridor, and inmate cell doors, that are to be unlocked from remote locations.
   a. Function: Remote switch activates pneumatic cylinder that retracts latchbolt; latchbolt remains retracted until door is opened 2 inches (50 mm), then releases **OR** as long as control switch is activated, **as directed**; automatic latching and deadlocking when door is closed (slam locking). Latchbolt can be mechanically retracted by mogul cylinder; keyed one side **OR** two sides, **as directed**.
      1) Local Electric Key (LEK): Inmate key operates lock electrically when enabled; staff key always operates lock manually and electrically; where indicated.
      2) Knob on opposite side of cylinder retracts latchbolt.
      3) If power fails or compressed-air system fails, latchbolt automatically deadlocks (fail-secure).
   b. Latchbolt: 1-1/2-inch-high by 3/4-inch- (38-mm-high by 19-mm-) thick hardened steel; 1-inch (25-mm) throw.
   c. Provide internal deadlock indicator switch.
   d. Provide roller-type deadlock actuator.
   e. Voltage: 24-V dc.
   f. Listed and labeled for use on fire doors.
   g. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.
5. Pneumatic Deadlatches, Commercial PL-3: For use on swinging doors, hung in standard 2-inch (50-mm) hollow-metal frames, that are to be unlocked from remote locations.
   a. Function: Remote switch activates pneumatic cylinder that retracts latchbolt; latchbolt remains retracted until door is opened 2 inches (50 mm), then releases **OR** as long as control switch is activated, **as directed**; automatic latching and deadlocking when door is closed (slam locking). Latchbolt can be mechanically retracted by high-security, **as directed**, commercial cylinder; keyed one side **OR** two sides, **as directed**.
      1) Local Electric Key (LEK): Inmate key operates lock electrically when enabled; staff key always operates lock manually and electrically; where indicated.
      2) If power fails or compressed-air system fails, latchbolt automatically deadlocks (fail-secure).
   b. Latchbolt: 1-1/2-inch-high by 5/8-inch- (38-mm-high by 16-mm-) thick hardened steel; 3/4-inch (19-mm) throw.
   c. Faceplate: Stainless steel.
   d. Provide internal deadlock indicator switch.
   e. Provide roller-type deadlock actuator.
   f. Voltage: 24-V dc.
   g. Listed and labeled for use on fire doors.
   h. Security Grade: 1 **OR** 2 **OR** 3 **OR** 4, **as directed**.

H. Cylinders And Keying
1. General: Subject to compliance with requirements, provide cylinders and keying for paracentric and mogul cylinders by the same manufacturer as for detention locks and latches.
2. Commercial (Builders' Hardware) Cylinders: As specified in Division 08 Section "Door Hardware".
3. Paracentric Cylinders: Manufacturer's standard lever-tumbler type, constructed from one-piece spring-tempered brass; with tumblers activated by phosphor bronze springs; five tumblers per lock unless otherwise indicated.

4. Mogul Cylinders: Manufacturer's standard pin-tumbler type, minimum 2-inch (50-mm) diameter; body constructed from brass or bronze, stainless steel, or nickel silver; with stainless-steel tumblers and engaging cylinder balls; complying with the following:
   a. Number of Pins: Five **OR** Six **OR** Seven, **as directed**.
   b. Mortise Type: Threaded cylinders with rings and straight- or clover-type cam.
      1) High-Security Grade: Listed and labeled as complying with pick- and drill-resistant testing requirements in UL 437 (Suffix A); where indicated.
   c. Finish: BHMA 606 **OR** BHMA 626, **as directed**.
5. Keying System: Unless otherwise indicated, provide a factory-registered keying system complying with the following requirements:
   a. Paracentric cylinders operated by change keys only.
   b. No Master Key System: Mogul cylinders operated by change keys only.
      OR
      Master Key System: Mogul cylinders operated by a change key and a master key.
      OR
      Grand Master Key System: Mogul cylinders operated by a change key, a master key, and a grand master key.
      OR
      Great-Grand Master Key System: Mogul cylinders operated by a change key, a master key, a grand master key, and a great-grand master key.
   c. Existing System: Master key or grand master key mogul-cylinder locks to Owner's existing system.
   d. Existing System: Re-key Owner's existing master key system for mogul-cylinder locks into new keying system.
6. Keys: Provide cast silicon-bronze copper alloy keys complying with the following:
   a. Stamping: Permanently inscribe each key with a visual key-control number and include the following notation:
      1) Notation: "DO NOT DUPLICATE" **OR** Information to be furnished by Owner, **as directed**.
   b. Quantity: In addition to one extra blank key for each lock, provide the following:
      1) Cylinder Change Keys: Three.
         OR
         Master Key(s): One.
         OR
         Grand Master Key(s): One.
         OR
         Great-Grand Master Key(s): One.

I. Switches
1. General: Provide switches configured with type of contacts required for functions indicated, including multiple circuiting where required by functional performance of Division 13 Section "Plc Electronic Detention Monitoring And Control Systems".
2. Concealed, Magnetic Door Position Switches: Consisting of actuating magnet mortised into detention door and switch mortised into frame; with stainless-steel faceplates; 24-V dc, factory wired with plug connector. Wire in series with lock monitors. Attach with security fasteners.
3. Concealed, Mechanical Door Position Switches: Consisting of metal track mortised into head of detention door connected by steel actuator arm to steel actuator mortised into frame; switch fully concealed when door is in closed position; with stainless-steel faceplate; 120-V ac; factory wired with plug connector. Action of door mechanically activates switch. Wire in series with lock monitors. Attach with security fasteners.
4. Surface-Mounted Door Position Switches: Switch enclosed in 0.134-inch (3.42-mm) nominal-thickness steel enclosure, factory primed for painting; 120-V ac; factory wired with plug connector. Wire in series with lock monitors. Attach with security fasteners.
   a. Galvanize enclosure for exterior locations and where indicated.

5. Strike Indicator Switches: Designed to be mortised behind strike and to indicate whether door is locked or unlocked; enclosed in metal strike box. Wire in series with door position switches. Attach with security fasteners.
   a. Voltage: 120-V dc **OR** 240-V ac **OR** As indicated, **as directed**.
   b. Locations: At doors with mechanical detention lock **OR** Where indicated, **as directed**.
   c. Manufacturer: Same as detention lock.
6. Inmate Door Control Switches, as directed: Momentary **OR** Maintained-contact, **as directed**, push-button switch with metal faceplate. Attach with security fasteners.
   a. Material and Finish: Brass with BHMA 606 **OR** Brass with BHMA 626 **OR** Stainless steel with BHMA 630, **as directed**, finish.
   b. Operation: When activated from remote location, switch allows inmate operation of electric cell door lock.
7. Push-Button, Inmate Door Control Switches, as directed: Momentary **OR** Maintained-contact, **as directed**, push-button switch for installation without faceplate. Attach with security fasteners.
   a. Material and Finish: Brass with BHMA 606 **OR** Brass with BHMA 626 **OR** Stainless steel with BHMA 630, **as directed**, finish.
   b. Operation: When activated from remote location, switch allows inmate operation of electric cell door lock.

J. Detention Operating Trim
1. Standard: BHMA A156.6, Grade 1.
2. Surface-Mounted Door Pulls (not typically used inside cells): 8-3/4-inch (222-mm) overall length and 2-1/4-inch (57-mm) projection; attach to door with two security fasteners.
   a. Material: Cast bronze with BHMA 606 **OR** BHMA 626, **as directed**, finish.
   b. Material: Cast stainless steel with BHMA 630 finish.
3. Round, Surface-Mounted Door Pulls (not typically used inside cells): 7-inch (178-mm) overall length by 1-inch- (25-mm-) diameter solid bar, with 2-1/4-inch (57-mm) projection; attach to door with two security through fasteners.
   a. Material: Cast or extruded bronze with BHMA 606 **OR** BHMA 626, **as directed**, finish.
   b. Material: Cast stainless steel with BHMA 630 finish.
4. Flush Door Pulls: 5 inches high by 4 inches wide by 1 inch deep (127 mm high by 102 mm wide by 25 mm deep), with 1/8-inch- (3-mm-) thick faceplate; attach to door with four security fasteners.
   a. Material: Formed, wrought, or cast brass/bronze with BHMA 606 **OR** BHMA 626, **as directed**, finish.
   b. Material: Formed or cast stainless steel with BHMA 630 finish.
5. Knob Pulls: 2-inch (50-mm) diameter; fabricated from solid brass with BHMA 606 **OR** BHMA 626, **as directed**, finish. Attach with security fasteners.
6. Lever-Handle Guides: Guide track and escutcheon, **as directed**, that provides selective stopping of lever handle by use of an adjustable stop; fabricated from steel with BHMA 633 **OR** stainless steel with BHMA 630, **as directed**, finish. Attach with security fasteners.

K. Security Door Closers
1. Standard: BHMA A156.4, Grade 1.
   a. Certified Products: Provide security door closers listed in BHMA's "Directory of Certified Products."
2. Surface-Mounted Security Door Closers:
   a. Arms: Minimum 3/8-inch- (9.5-mm-) thick by 1-1/8-inch- (29-mm-) wide, rectangular steel main arm; 5/16-inch- (8-mm-) thick by 1-inch- (25-mm-) wide, rectangular steel secondary arm; full rack-and-pinion type; fabricated with orbital-riveted, pinned, or welded elbow and arm shoe/soffit plate joints designed to prevent disassembly with ordinary hand tools.
   b. Cover: Heavy-duty metal, attached with four security fasteners.
   c. Mounting: Attach security door closer with security fasteners.
3. Concealed Security Door Closers:

a. Construction: Forged-steel arm; security roller; with track concealed in head of detention door, designed to eject foreign objects during opening and closing; fabricated with joints designed to prevent disassembly with ordinary hand tools. Closer arm and track fully concealed when door is closed.
b. Cover Plates: Heavy-duty metal, attached with security fasteners.
c. Provide door position switch integral to closer.

4. Unit Size: Unless otherwise indicated, comply with manufacturer's written recommendations for size of security door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

L. Detention Door Stops
1. Detention Floor Stops: 1-1/2-inch-high by 2-inch- (38-mm-high by 50-mm-) diameter rubber bumper mounted on steel lag bolt; BHMA A156.16; install in floor with nonshrink grout; for detention doors unless wall or other type stops are indicated. Do not mount floor stops where they will impede traffic.
2. Silencers for Detention Door Frames: BHMA A156.16, Grade 1; neoprene or rubber, minimum 1/2-inch (13-mm) diameter; fabricated for drilled-in application to detention door frame. Attach with security fasteners.

M. Sliding Detention Door Device Assemblies
1. Performance Requirements: Provide sliding detention door device assemblies, including locking device, receiver, overhead door hanger, bottom door guide, lock column, and enclosure, as a complete assembly, complying with Grade 1 **OR** Grade 2, **as directed**, according to ASTM F 1643, as determined by testing manufacturers' standard units representing those indicated for Project.
2. Assembly Construction: As follows:
a. Enclosure: Fabricated from 0.179-inch (4.56-mm) nominal-thickness steel plate, with 0.134-inch (3.42-mm) nominal-thickness steel removable **OR** hinged, **as directed**, cover. Baffle openings in enclosure. Provide closures for ends of housings.
1) Provide sloping-top housings. Flat-top housings may be provided for operators mounted to ceiling, **as directed**.
b. Lock Column: Vertical tube enclosure fabricated from 0.134-inch (3.42-mm) nominal-thickness steel, providing mechanical locking control of detention sliding door at door location; operated by paracentric key. Doors shall be capable of being locked at top and bottom, at rear of door, in both open and closed positions, with no components projecting into door opening.
c. Receiver: Fabricated from 0.134-inch (3.42-mm) nominal-thickness steel plate.
d. Hanger Assembly: Extend steel carrier full width of door and door travel required for clear door opening. Provide antifriction ball-bearing steel rollers with hardened members and grease shield.
e. Finish: Factory prime painted.
3. Mechanical-Locking, Manual-Door-Movement, Sliding Door Device Assemblies SDA-1: Doors are manually opened and closed and mechanically locked by means of jamb-mounted mechanical detention lock specified elsewhere in this Section.
4. Electromechanical-Locking, Manual-Door-Movement, Sliding Door Device Assemblies SDA-2: Operated from remote-control panel that activates electric motors to unlock sliding doors. Doors spring open a small distance after unlocking and are manually opened and closed. Locks automatically deadlock when doors are moved to fully open or fully closed position. Provide factory-wired cable harness with plug connectors for each motor unit.
a. Single-Door Function: In an emergency or if power fails, individual doors can be unlocked using a manual-release tool and manually moved; doors relock in either fully open or fully closed position.
b. Multiple-Door Function: Each door can be individually unlocked locally or from a remote panel, or unlocked from a remote panel with other doors as a group. In an emergency or if power fails, door group can be manually operated from mechanical-release cabinet at end

of cell line **OR** pilaster release adjacent to receiving jamb of each door operated by paracentric key, **as directed**; doors shall not relock in any position.

c. Electric Key Switch: Operated by paracentric **OR** mogul, **as directed**, key and providing electric control of detention sliding door operation at door location; where indicated.

5. Electromechanical-Locking, Electromechanical-Door-Movement, Sliding Door Device Assemblies SDA-3: Operated from remote-control panel that activates electric motors to unlock sliding doors and motorized rack-and-pinion drive mechanisms to open and close doors. Doors lock in open position and deadlock when closed. Provide factory-wired cable harness with plug connectors for each motor unit.

   NOTE: Paragraph above describes Southern Folger's "Southern Steel Model 3150LX" and "Southern Steel Model 3165LX." Only the 3150LX system offers multiple door functions, such as for cell doors; the 3165LX system is for individual doors, such as for vestibules, day rooms, and corridors.

   1) Single-Door Function: In an emergency or if power fails, individual doors can be unlocked using a manual-release tool and manually moved; doors relock in either fully open or fully closed position.
   2) Multiple-Door Function: Each door can be individually unlocked locally or from a remote panel, or unlocked from a remote panel with other doors as a group. In an emergency or if power fails, door group can be manually operated from mechanical-release cabinet at end of cell line **OR** pilaster release adjacent to receiving jamb of each door operated by paracentric key, **as directed**; doors shall not relock in any position.

   b. Electric Key Switch: Operated by paracentric **OR** mogul, **as directed**, key and providing electric control of detention sliding door operation at door location; where indicated.

6. Electromechanical-Locking, Pneumatic-Door-Movement, Sliding Door Device Assemblies SDA-4 (for individual doors, such as for vestibules, day rooms, and corridors): Operated from remote-control panel that activates electric motors to unlock sliding doors and pneumatic system to open and close doors. Doors lock in open position and deadlock when closed. Factory install quick-connect air fitting and factory-wired cable harness with plug connectors for each motor unit; 24-V dc.

   a. Single-Door Function: In an emergency or if pneumatic systems or electric power fails, individual doors can be unlocked using a manual-release tool and manually moved; doors relock in either fully open or fully closed position.
      1) Lock Control at Door: Mechanical key release adjacent to receiving jamb of each door, contained in pilaster and operated by paracentric key; where indicated.

7. Pneumatic-Locking, Manual-Door-Movement, Sliding Door Device Assemblies SDA-5: Operated from remote-control panel that activates pneumatic cylinders to unlock doors. Doors spring open a small distance after unlocking and are manually opened and closed. Locks automatically deadlock when doors are moved to fully open or fully closed position. Factory install quick-connect air fitting and factory-wired cable harness with plug connectors for each motor unit.

   a. Single-Door Function: In an emergency or if pneumatic systems or electric power fails, individual doors can be unlocked using a manual-release tool and manually moved; doors relock in either fully open or fully closed position.
      1) Lock Control at Door: Mechanical key release adjacent to receiving jamb of each door, contained in pilaster and operated by paracentric key; where indicated.

   b. Multiple-Door Function: Each door can be individually unlocked locally or from a remote panel, or unlocked from a remote panel with other doors as a group. In an emergency or if pneumatic systems or electric power fails, door group can be operated from remotely located auxiliary pneumatic-release system **OR** pilaster release adjacent to receiving jamb of each door operated by paracentric key, **as directed**; doors shall not relock in any position.

   c. Electric Key Switch: Operated by paracentric **OR** mogul, **as directed**, key and providing electric control of detention sliding door operation at door location; where indicated.

8. Pneumatic-Locking, Pneumatic-Door-Movement, Sliding Door Device Assemblies SDA-6 (Paragraph below describes Southern Folger's "Southern Steel Model 8050L" and "Southern

Steel Model 8065L." Only the 8050L system offers multiple door functions, such as for cell doors; the 8065L system is for individual doors, such as for vestibules, day rooms, and corridors.): Operated from remote-control panel that activates pneumatic cylinder to unlock sliding doors and open and close doors. Doors lock in open position and deadlock when closed. Factory install quick-connect air fitting and factory-wired cable harness with plug connectors for each motor unit; 24-V dc.

a. Single-Door Function: In an emergency or if pneumatic systems or electric power fails, individual doors can be unlocked using a manual-release tool and manually moved; doors relock in either fully open or fully closed position.
b. Multiple-Door Function: Each door can be individually unlocked locally or from a remote panel, or unlocked from a remote panel with other doors as a group. In an emergency or if pneumatic systems or electric power fails, door group can be operated from remotely located auxiliary pneumatic-release system **OR** pilaster release adjacent to receiving jamb of each door operated by paracentric key, **as directed**; doors shall not relock in any position.
c. Electric Key Switch: Operated by paracentric **OR** mogul, **as directed**, key and providing electric control of detention sliding door operation at door location; where indicated.
d. Provide security ring for installation of pneumatic detention lock in hollow-metal detention frame, welded to frame or access cover, unless otherwise **OR** where, **as directed**, indicated.

N. Fabrication

1. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location (omit removable nameplates) except in conjunction with required fire-rated labels and as otherwise approved.
2. Base Metals: Produce detention door hardware units of base metal, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified detention door hardware units and BHMA A156.18 finishes. Do not furnish manufacturer's standard materials or forming methods if different from specified standard.
3. Fasteners: Provide flat-head security fasteners with finished heads to match surface of detention door hardware unless otherwise indicated.
   a. Security Fasteners: Fabricate detention door hardware using security fasteners with head style appropriate for fabrication requirements, strength, and finish of adjacent materials. Provide stainless-steel security fasteners in stainless-steel materials, **as directed**.
   b. Concealed Fasteners: For detention door hardware units that are exposed when detention door is closed except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching detention door hardware. Where through bolts are used on hollow-metal detention door and frame construction, provide sleeves for each through bolt.
   c. Steel Machine Screws (for fire-rated detention door assemblies. NFPA 80 requires locks, latches, and surface-mounted top and bottom bolts to be secured with machine screws or through bolts.): For the following fire-rated applications:
      1) Mortise detention hinges to detention doors.
      2) Strike plates to detention frames.
      3) Security door closers to detention doors and frames.
   d. Steel Through Bolts (for fire-rated detention door assemblies. NFPA 80 requires locks, latches, and surface-mounted top and bottom bolts to be secured with machine screws or through bolts.): For the following fire-rated applications unless door blocking is provided:
      1) Surface detention hinges to detention doors.
      2) Security door closers to detention doors and frames.
   e. Spacers or Sex Bolts: For through bolting of hollow-metal detention doors.
   f. Fasteners for Wood Detention Doors: Comply with DHI WDHS.2.

O. Finishes
1. Standard: Comply with BHMA A156.18.
2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
3. BHMA Designations: Comply with base material and finish requirements indicated by the following:
a. BHMA 600: Primed for painting, over steel base metal.
b. BHMA 606: Satin brass, clear coated, over brass base metal.
c. BHMA 626: Satin chromium plated over nickel, over brass or bronze base metal.
d. BHMA 630: Stainless steel, satin, over stainless-steel base metal.
e. BHMA 652: Satin chromium plated over nickel, over steel base metal.

1.3 EXECUTION

A. Preparation
1. Steel Detention Doors and Frames: Comply with ANSI/DHI A115 Series.
a. Surface-Applied Detention Door Hardware: Drill and tap detention doors and frames according to ANSI/SDI A250.6.
2. Wood Detention Doors: Comply with DHI A115-W Series.

B. Installation
1. Mounting Heights: Mount detention door hardware units at heights indicated in the following applicable publications unless specifically indicated or required to comply with governing regulations:
a. Steel Detention Doors and Frames: DHI's "Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames."
b. Wood Detention Doors: DHI WDHS.3.
2. Install each detention door hardware item to comply with Shop Drawings and manufacturer's written instructions. Where cutting and fitting are required to install detention door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 09. Do not install surface-mounted items until finishes have been completed on substrates involved.
a. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
b. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
3. Install interconnecting wiring and connectors between detention door hardware devices. Terminate device wiring for detention door hardware installed in swinging doors at a plug-type connector located in lock pocket or door frame junction box and for sliding doors at a junction box in door frame.
4. Security Fasteners: Install detention door hardware using security fasteners with head style appropriate for installation requirements, strength, and finish of adjacent materials.

C. Field Quality Control
1. Inspect installed products to verify compliance with requirements. Prepare inspection reports and indicate compliance with and deviations from the Contract Documents.
2. Perform the following field tests and inspections and prepare test reports:
a. After installing electrified and pneumatic, **as directed**, detention door hardware and after electrical circuitry has been energized and compressed-air system is functional, **as directed**, test detention door hardware for compliance with requirements.
1) Test: Operate lock of each door and group of doors in normal remote, normal local, and emergency operating modes. Verify that remote controls operate correct door locks and in correct sequence.

b. Verify that lock bolts engage strikes with required bolt projection.
c. Verify that detention door hardware is installed, connected, and adjusted according to the Contract Documents.
d. Verify that electrical wiring installation complies with manufacturer's submittal and written installation requirements.

3. Remove and replace detention work if inspections indicate that work does not comply with specified requirements. Remove malfunctioning units, replace with new units, and retest as specified above.
4. Perform additional inspections to determine compliance of replaced or additional work. Prepare inspection reports.
5. Prepare field quality-control certification endorsed by Detention Specialist, **as directed**, that states installed products and their installation comply with requirements in the Contract Documents.

D. Adjusting
1. Adjust and check each operating item of detention door hardware and each detention door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust detention door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
a. Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
b. Security Door Closers: Adjust sweep period so that, from an open position of 90 degrees, detention door will take at least five seconds to move to a position of 12 degrees.

E. Cleaning And Protection
1. Clean adjacent surfaces soiled by detention door hardware installation.
2. Clean operating items as necessary to restore proper function and finish.
3. Provide final protection and maintain conditions that ensure that detention door hardware is without damage or deterioration at time of Substantial Completion.

1.4 Detention Door Hardware Sets

Note 1: Hanging devices below include detention hinges and sliding detention door device assemblies. Indicate whether detention hinges are attached to detention doors and frames by security fasteners or by welding.
Note 2: Securing devices (inactive leaf) below include door position switches and strike indicator switches.
Note 3: Securing devices (active leaf) below include detention locksets and latchsets, cylinders, door position switches, strike indicator switches, and inmate door control switches.\
Note 4: Operating trim below includes detention door pulls, flush pulls, knob pulls, and lever-handle guides.
Note 5: Closing devices below include security door closers.
Note 6: Stops below include detention floor stops and door silencers if not specified with steel detention doors and frames.
Note 7: Miscellaneous items that could be inserted at end of detention door hardware sets include key-control cabinets, software if not included in Division 08 Section "Door Hardware", and detention door hardware not otherwise listed.

A. General: Provide detention door hardware for each detention door to comply with requirements in this Section and detention door hardware sets indicated in a door and frame schedule **OR** and detention door hardware sets indicated below, **as directed**.

Detention Door Hardware Set No. [#]
Single Door No. [#]; each to have the following:

*	Hanging Devices	<**Insert description.**>	<**Insert manufacturer.**>	<**Insert finish.**>
[#]	Securing Devices	<**Insert description.**>	<**Insert manufacturer.**>	<**Insert finish.**>

	(inactive leaf)			
<#>	Securing Devices (active leaf)	<**Insert description.**>	<**Insert manufacturer.**>	<**Insert finish.**>
[#]	Operating Trim	<**Insert description.**>	<**Insert manufacturer.**>	<**Insert finish.**>
[#]	Closing Devices	<**Insert description.**>	<**Insert manufacturer.**>	<**Insert finish.**>
[#]	Stops	<**Insert description.**>	<**Insert manufacturer.**>	<**Insert finish.**>
*	Number of Hinges, as specified.			

Note 8: Insert additional requirements and sequence of operation in schedule above for electrified and pneumatic detention door hardware if required.

END OF SECTION 08710a

Task	Specification	Specification Description
08710	01352	No Specification Required
08720	08710	Door Hardware
08730	08710	Door Hardware
08740	08710	Door Hardware

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SECTION 08810 - GLAZING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for glazing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
   a. Windows.
   b. Doors.
   c. Glazed curtain walls.
   d. Storefront framing.
   e. Glazed entrances.
   f. Sloped glazing.
   g. Skylights.
   h. Interior borrowed lites.

C. Definitions
1. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
2. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.
3. Interspace: Space between lites of an insulating-glass unit.

D. Performance Requirements
1. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
2. Delegated Design: Design glass, including comprehensive engineering analysis according to ASTM E 1300 **OR** ICC's 2003 International Building Code, **as directed**, by a qualified professional engineer, using the following design criteria:
   a. Design Wind Pressures: As indicated on Drawings.
      OR
      Design Wind Pressures: Determine design wind pressures applicable to Project according to ASCE/SEI 7, based on heights above grade indicated on Drawings.
      1) Basic Wind Speed: 85 mph (38 m/s) **OR** 90 mph (40 m/s) **OR** 100 mph (44 m/s) **OR** 110 mph (49 m/s), **as directed**.
      2) Importance Factor.
      3) Exposure Category: B **OR** C **OR** D, **as directed**.
   b. Design Snow Loads: As indicated on Drawings, **as directed**.
   c. Vertical Glazing: For glass surfaces sloped 15 degrees or less from vertical, design glass to resist design wind pressure based on glass type factors for short-duration load.
   d. Sloped Glazing: For glass surfaces sloped more than 15 degrees from vertical, design glass to resist each of the following combinations of loads:
      1) Outward design wind pressure minus the weight of the glass. Base design on glass type factors for short-duration load.
      2) Inward design wind pressure plus the weight of the glass plus half of the design snow load. Base design on glass type factors for short-duration load.

3) Half of the inward design wind pressure plus the weight of the glass plus the design snow load. Base design on glass type factors for long-duration load.

e. Glass Type Factors for Wired, Patterned, and Sandblasted Glass:
1) Short-Duration Glass Type Factor for Wired Glass: 0.5.
2) Long-Duration Glass Type Factor for Wired Glass: 0.3.
3) Short-Duration Glass Type Factor for Patterned Glass: 1.0.
4) Long-Duration Glass Type Factor for Patterned Glass: 0.6.
5) Short-Duration Glass Type Factor for Sandblasted Glass: 0.5.

f. Thickness of Patterned Glass: Base design of patterned glass on thickness at thinnest part of the glass.

g. Probability of Breakage for Sloped Glazing: For glass surfaces sloped more than 15 degrees from vertical, design glass for a probability of breakage not greater than 0.001.

h. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch (25 mm), whichever is less.

i. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.

3. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
a. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

E. Preconstruction Testing
1. Preconstruction Adhesion and Compatibility Testing: Test each glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.
a. Testing will not be required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.
b. Use ASTM C 1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
c. Test no fewer than eight Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
d. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
e. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including the use of specially formulated primers.

F. Submittals
1. Product Data: For each glass product and glazing material indicated.
2. LEED Submittals:
a. Product Data for Credit EQ 4.1: For glazing sealants used inside of the weatherproofing system, including printed statement of VOC content.
3. Glass Samples: For each type of glass product other than clear monolithic vision glass **OR** the following products, **as directed**; 12 inches (300 mm) square.
a. Tinted glass.
b. Patterned glass.
c. Coated glass.
d. Wired glass.
e. Fire-resistive glazing products.
f. Laminated glass with colored interlayer.
g. Insulating glass.
4. Glazing Accessory Samples: For gaskets, sealants and colored spacers, in 12-inch (300-mm) lengths. Install sealant Samples between two strips of material representative in color of the adjoining framing system, **as directed**.

5. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.
6. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
7. Qualification Data: For installers, manufacturers of insulating-glass units with sputter-coated, low-e coatings, glass testing agency and sealant testing agency.
8. Product Certificates: For glass and glazing products, from manufacturer.
9. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for tinted glass, coated glass, insulating glass, glazing sealants and glazing gaskets.
    a. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.
10. Preconstruction adhesion and compatibility test report.
11. Warranties: Sample of special warranties.

G. Quality Assurance
1. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved and certified, **as directed**, by coated-glass manufacturer.
2. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
3. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.
4. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
5. Source Limitations for Glass: Obtain ultraclear float glass, tinted float glass, coated float glass, laminated glass and insulating glass from single source from single manufacturer for each glass type.
6. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.
7. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
    a. GANA Publications: GANA's "Laminated Glazing Reference Manual" and GANA's "Glazing Manual."
    b. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR-A7, "Sloped Glazing Guidelines."
    c. IGMA Publication for Sloped Glazing: IGMA TB-3001, "Guidelines for Sloped Glazing."
    d. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
8. Safety Glazing Labeling: Where safety glazing labeling is indicated, permanently mark glazing with certification label of the SGCC **OR** the SGCC or another certification agency acceptable to authorities having jurisdiction **OR** the manufacturer, **as directed**. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
9. Fire-Protection-Rated Glazing Labeling: Permanently mark fire-protection-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, test standard, whether glazing is for use in fire doors or other openings, whether or not glazing passes hose-stream test, whether or not glazing has a temperature rise rating of 450 deg F (250 deg C), and the fire-resistance rating in minutes.
10. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.
11. Preinstallation Conference: Conduct conference at Project site.

H. Delivery, Storage, And Handling

1. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
2. Comply with insulating-glass manufacturer's written recommendations for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

I. Project Conditions
1. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
   a. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or below 40 deg F (4.4 deg C).

J. Warranty
1. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form in which coated-glass manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
   a. Warranty Period: 10 years from date of Substantial Completion.
2. Manufacturer's Special Warranty on Laminated Glass: Manufacturer's standard form in which laminated-glass manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
   a. Warranty Period: Five **OR** 10, **as directed**, years from date of Substantial Completion.
3. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form in which insulating-glass manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
   a. Warranty Period: 10 years from date of Substantial Completion.

1.2 PRODUCTS

A. Glass Products, General
1. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.
   a. Minimum Glass Thickness for Exterior Lites: Not less than 6.0 mm.
   b. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.
2. Strength: Where float glass is indicated, provide annealed float glass, Kind HS heat-treated float glass, or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article, **as directed**. Where heat-strengthened glass is indicated, provide Kind HS heat-treated float glass or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article, **as directed**. Where fully tempered glass is indicated, provide Kind FT heat-treated float glass.
3. Windborne-Debris-Impact Resistance: Provide exterior glazing that passes basic **OR** enhanced, **as directed**,-protection testing requirements in ASTM E 1996 for Wind Zone 1 **OR** Wind Zone 2 **OR** Wind Zone 3 **OR** Wind Zone 4, **as directed**, when tested according to ASTM E 1886. Test

specimens shall be no smaller in width and length than glazing indicated for use on the Project and shall be installed in same manner as glazing indicated for use on the Project.

a. Large-Missile Test: For glazing located within 30 feet (9.1 m) of grade.
b. Small-Missile Test: For glazing located more than 30 feet (9.1 m) above grade.
OR
Large-Missile Test: For all glazing, regardless of height above grade.

4. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
   a. For monolithic-glass lites, properties are based on units with lites 6.0 mm thick **OR** of thickness indicated, **as directed**.
   b. For laminated-glass lites, properties are based on products of construction indicated.
   c. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
   d. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F (W/sq. m x K).
   e. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
   f. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

B. Glass Products
1. Float Glass: ASTM C 1036, Type I, Quality-Q3, Class I (clear) unless otherwise indicated.
2. Ultraclear Float Glass: ASTM C 1036, Type I, Quality-Q3, Class I, complying with other requirements specified and with visible light transmission not less than 91 percent and solar heat gain coefficient not less than 0.87, **as directed**.
3. Heat-Treated Float Glass: ASTM C 1048; Type I; Quality-Q3; Class I (clear) unless otherwise indicated; of kind and condition indicated.
   a. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
   b. For uncoated glass, comply with requirements for Condition A.
   c. For coated vision glass, comply with requirements for Condition C (other coated glass).
4. Pyrolytic-Coated, Self-Cleaning, Low-Maintenance Glass: Clear float glass with a coating on first surface having both photocatalytic and hydrophilic properties that act to loosen dirt and to cause water to sheet evenly over the glass instead of beading.
5. Uncoated Tinted Float Glass: Class 2, complying with other requirements specified.
   a. Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.
   b. Visible Light Transmittance: as directed by the Owner.
6. Polished Wired Glass: ASTM C 1036, Type II, Class 1 (clear), Form 1, Quality-Q6, complying with ANSI Z97.1, Class C.
   a. Mesh: M1 (diamond) **OR** M2 (square), **as directed**.
7. Film-Faced Polished Wired Glass: ASTM C 1036, Type II, Class 1 (clear), Form 1, Quality-Q6 and complying with testing requirements in 16 CFR 1201 for Category II materials.
   a. Mesh: M1 (diamond) **OR** M2 (square), **as directed**.
8. Patterned Glass: ASTM C 1036, Type II, Class 1 (clear), Form 3; Quality-Q6, Finish F1 (patterned one side) **OR** Finish F2 (patterned both sides), **as directed**, Pattern P1 (linear) **OR** Pattern P2 (geometric) **OR** Pattern P3 (random) **OR** Pattern P4 (special), **as directed**.
9. Tempered Patterned Glass: ASTM C 1048, Kind FT (fully tempered), Type II, Class 1 (clear), Form 3; Quality-Q6, Finish F1 (patterned one side) **OR** Finish F2 (patterned both sides), **as directed**, Pattern P1 (linear) **OR** Pattern P2 (geometric) **OR** Pattern P3 (random) **OR** Pattern P4 (special), **as directed**.
10. Patterned Wired Glass: ASTM C 1036, Type II, Class 1 (clear), Form 2, Quality-Q6, Finish F1 (patterned one side) **OR** Finish F2 (patterned both sides), **as directed**, Mesh M1 (diamond), Pattern P1 (linear) **OR** Pattern P2 (geometric) **OR** Pattern P3 (random) **OR** Pattern P4 (special), **as directed**.

11. Ceramic-Coated Vision Glass: Heat-treated float glass, Condition C; with ceramic enamel applied by silk-screened process; complying with Specification No. 95-1-31 in GANA's Tempering Division's "Engineering Standards Manual" and with other requirements specified.
    a. Glass: Clear float **OR** Ultraclear float **OR** Tinted float, **as directed**.
    b. Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.
    c. Ceramic Coating Color and Pattern: As selected from manufacturer's full range.
12. Reflective-Coated Vision Glass: ASTM C 1376, coated by pyrolytic process **OR** vacuum deposition (sputter-coating) process, **as directed**, and complying with other requirements specified.
    a. Kind: Kind CV (coated vision glass), except that Kind CO (coated overhead glass) may be used where the lower edge of the glass is more than 6 feet (1.8 m) above the adjacent floor level or cannot be approached closer than 10 feet (3.0 m).
    b. Coating Color: Gold **OR** Pewter **OR** Silver, **as directed**.
    c. Glass: Clear float **OR** Tinted float, **as directed**.
    d. Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.
    e. Visible Light Transmittance:
    f. Outdoor Visible Reflectance: as directed by the Owner.
    g. Self-Cleaning, Low-Maintenance Coating: Pyrolytic coating on first surface.
13. Ceramic-Coated Spandrel Glass: ASTM C 1048, Condition B, Type I, Quality-Q3, and complying with other requirements specified.
    a. Glass: Clear float **OR** Ultraclear float **OR** Tinted float, **as directed**.
    b. Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.
    c. Ceramic Coating Color: As selected from manufacturer's full range.
14. Silicone-Coated Spandrel Glass: ASTM C 1048, Condition C, Type I, Quality-Q3, and complying with other requirements specified.
    a. Glass: Clear float **OR** Ultraclear float **OR** Tinted float, **as directed**.
    b. Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.
    c. Silicone Coating Color: As selected from manufacturer's full range.
15. Reflective-Coated Spandrel Glass: ASTM C 1376, Kind CS; coated by pyrolytic process **OR** vacuum deposition (sputter-coating) process, **as directed**, and complying with other requirements specified.
    a. Coating Color: Gold **OR** Pewter **OR** Silver, **as directed**.
    b. Glass: Clear float **OR** Ultraclear float **OR** Tinted float, **as directed**.
    c. Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.
    d. Visible Light Transmittance: as directed by the Owner.
    e. Outdoor Visible Reflectance: as directed by the Owner.

C. Laminated Glass
1. Laminated Glass: ASTM C 1172, and complying with testing requirements in 16 CFR 1201 for Category II materials, and with other requirements specified. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
    a. Construction: Laminate glass with polyvinyl butyral interlayer or cast-in-place and cured-transparent-resin interlayer to comply with interlayer manufacturer's written recommendations.
    b. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
    c. Interlayer Color: Clear unless otherwise indicated.
2. Windborne-Debris-Impact-Resistant Laminated Glass: ASTM C 1172, and complying with testing requirements in 16 CFR 1201 for Category II materials, with "Windborne-Debris-Impact Resistance" Paragraph in "Glass Products, General" Article, and with other requirements specified. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
    a. Construction: Laminate glass with one of the following to comply with interlayer manufacturer's written recommendations:

1) Polyvinyl butyral interlayer.
2) Polyvinyl butyral interlayers reinforced with polyethylene terephthalate film.
3) Ionoplast interlayer.
4) Cast-in-place and cured-transparent-resin interlayer.
5) Cast-in-place and cured-transparent-resin interlayer reinforced with polyethylene terephthalate film.

b. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
c. Interlayer Color: Clear unless otherwise indicated.

3. Glass: Comply with applicable requirements in "Glass Products" Article as indicated by designations in "Laminated-Glass Types" Article.

D. Insulating Glass
1. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190, and complying with other requirements specified.
a. Sealing System: Dual seal, with manufacturer's standard **OR** polyisobutylene and polysulfide **OR** polyisobutylene and silicone **OR** polyisobutylene and hot-melt butyl **OR** polyisobutylene and polyurethane, **as directed**, primary and secondary.
b. Spacer: Manufacturer's standard spacer material and construction **OR** Aluminum with mill or clear anodic finish **OR** Aluminum with black, color anodic finish **OR** Aluminum with bronze, color anodic finish **OR** Aluminum with powdered metal paint finish in color selected **OR** Galvanized steel **OR** Stainless steel **OR** Polypropylene covered stainless steel in color selected **OR** Thermally broken aluminum **OR** Nonmetallic laminate **OR** Nonmetallic tube, **as directed**.
c. Desiccant: Molecular sieve or silica gel, or blend of both.
2. Glass: Comply with applicable requirements in "Glass Products" Article and in "Laminated Glass" Article, **as directed**, as indicated by designations in "Insulating-Glass Types" Article and in "Insulating-Laminated-Glass Types" Article, **as directed**.

E. Fire-Protection-Rated Glazing
1. Fire-Protection-Rated Glazing, General: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252 for door assemblies and NFPA 257 for window assemblies.
2. Monolithic Ceramic Glazing: Clear, ceramic flat glass; 3/16-inch (5-mm) nominal thickness.
3. Film-Faced Ceramic Glazing: Clear, ceramic flat glass; 3/16-inch (5-mm) nominal thickness; faced on one surface with a clear glazing film; complying with testing requirements in 16 CFR 1201 for Category II materials.
4. Laminated Ceramic Glazing: Laminated glass made from 2 plies of clear, ceramic flat glass; 5/16-inch (8-mm) total nominal thickness; complying with testing requirements in 16 CFR 1201 for Category II materials.
5. Fire-Protection-Rated Tempered Glass: 1/4-inch- (6.4-mm-) **OR** 3/8-inch- (9.5-mm-) **OR** 1/2-inch- (12.7-mm-), **as directed**, thick, fire-protection-rated tempered glass, complying with testing requirements in 16 CFR 1201 for Category II materials.
6. Fire-Protection-Rated Laminated Glass: 5/16-inch- (8-mm-) thick, fire-protection-rated laminated glass, complying with testing requirements in 16 CFR 1201 for Category II materials.
7. Laminated Glass with Intumescent Interlayers: Laminated glass made from multiple plies of uncoated, clear float glass; with intumescent interlayers; complying with testing requirements in 16 CFR 1201 for Category II materials.
8. Gel-Filled, Double Glazing Units: Double glazing units made from two lites of uncoated, clear, fully tempered float glass; with a perimeter metal spacer separating lites and dual-edge seal enclosing a cavity filled with clear, fully transparent, heat-absorbing gel; complying with testing requirements in 16 CFR 1201 for Category II materials.

F. Glazing Gaskets

1. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from one of the following:
   a. Neoprene complying with ASTM C 864.
   b. EPDM complying with ASTM C 864.
   c. Silicone complying with ASTM C 1115.
   d. Thermoplastic polyolefin rubber complying with ASTM C 1115.
2. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned neoprene, EPDM, silicone or thermoplastic polyolefin rubber gaskets complying with ASTM C 509, Type II, black; of profile and hardness required to maintain watertight seal.
   a. Application: Use where soft compression gaskets will be compressed by inserting dense compression gaskets on opposite side of glazing or pressure applied by means of pressure-glazing stops on opposite side of glazing.
3. Lock-Strip Gaskets: Neoprene extrusions in size and shape indicated, fabricated into frames with molded corner units and zipper lock-strips, complying with ASTM C 542, black.

G. Glazing Sealants
1. General:
   a. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
   b. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
   c. VOC Content: For sealants used inside of the weatherproofing system, not more than 250 g/L when calculated according to 40 CFR 59, Subpart D.
   d. Colors of Exposed Glazing Sealants: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
2. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.
3. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 50, Use NT.
4. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT.
5. Glazing Sealant: Acid-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT.
6. Glazing Sealants for Fire-Rated Glazing Products: Products that are approved by testing agencies that listed and labeled fire-resistant glazing products with which they are used for applications and fire-protection ratings indicated.

H. Glazing Tapes
1. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
   a. AAMA 804.3 tape, where indicated.
   b. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
   c. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
2. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
   a. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
   b. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

I. Miscellaneous Glazing Materials
   1. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
   2. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
   3. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
   4. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
   5. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
   6. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.
   7. Perimeter Insulation for Fire-Resistive Glazing: Product that is approved by testing agency that listed and labeled fire-resistant glazing product with which it is used for application and fire-protection rating indicated.

J. Fabrication Of Glazing Units
   1. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
   2. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.
   3. Grind smooth and polish exposed glass edges and corners.

K. Monolithic-Glass Types
   1. Glass Type: Clear float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
      a. Thickness: 6.0 mm.
      b. Provide safety glazing labeling.
   2. Glass Type: Ultraclear float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
      a. Thickness: 6.0 mm.
      b. Provide safety glazing labeling.
   3. Glass Type: Pyrolytic-coated, self-cleaning, low-maintenance, clear float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
      a. Thickness: 6.0 mm.
      b. Provide safety glazing labeling.
   4. Glass Type: Tinted float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
      a. Thickness: 6.0 mm.
      b. Winter Nighttime U-Factor: as directed by the Owner.
      c. Summer Daytime U-Factor: as directed by the Owner.
      d. Solar Heat Gain Coefficient: as directed by the Owner.
      e. Provide safety glazing labeling.
   5. Glass Type: Polished wired glass.
      a. Thickness: 6.0 mm.
   6. Glass Type: Patterned glass.
      a. Thickness: 4.0 **OR** 5.0 **OR** 6.0, **as directed**, mm.
   7. Glass Type: Tempered patterned glass.
      a. Thickness: 4.0 **OR** 5.0 **OR** 6.0, **as directed**, mm.
      b. Provide safety glazing labeling.
   8. Glass Type: Patterned wired glass.
      a. Thickness: 6.0 mm.

9. Glass Type: Ceramic-coated vision glass, heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
   a. Thickness: 6.0 mm.
   b. Coating Location: Second surface.
   c. Winter Nighttime U-Factor: as directed by the Owner.
   d. Summer Daytime U-Factor: as directed by the Owner.
   e. Solar Heat Gain Coefficient: as directed by the Owner.
   f. Provide safety glazing labeling.
10. Glass Type: Reflective-coated vision glass, float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
   a. Thickness: 6.0 mm.
   b. Coating Location: First **OR** Second, **as directed**, surface.
   c. Winter Nighttime U-Factor: as directed by the Owner.
   d. Summer Daytime U-Factor: as directed by the Owner.
   e. Solar Heat Gain Coefficient: as directed by the Owner.
   f. Provide safety glazing labeling.
11. Glass Type: Ceramic-coated spandrel glass, heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
   a. Thickness: 6.0 mm.
   b. Coating Location: Second surface.
   c. Winter Nighttime U-Factor: as directed by the Owner.
   d. Summer Daytime U-Factor: as directed by the Owner.
   e. Fallout Resistance: Passes fallout-resistance test in ASTM C 1048 for an assembly of glass and adhered reinforcing material.
12. Glass Type: Silicone-coated spandrel glass, heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
   a. Thickness: 6.0 mm.
   b. Coating Location: Second surface.
   c. Winter Nighttime U-Factor: as directed by the Owner.
   d. Summer Daytime U-Factor: as directed by the Owner.
   e. Fallout Resistance: Passes fallout-resistance test in ASTM C 1048 for an assembly of glass and adhered reinforcing material.
13. Glass Type: Reflective-coated spandrel glass, heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
   a. Thickness: 6.0 mm.
   b. Coating Location: First **OR** Second, **as directed**, surface.
   c. Winter Nighttime U-Factor: as directed by the Owner.
   d. Summer Daytime U-Factor: as directed by the Owner.
   e. Fallout Resistance: Passes fallout-resistance test in ASTM C 1048 for an assembly of glass and adhered reinforcing material.
   f. Factory apply manufacturer's standard opacifier of the following material to coated second surface of lites, with resulting products complying with Specification No. 89-1-6 in GANA's Tempering Division's "Engineering Standards Manual":
      1) Manufacturer's standard opacifier material.
         OR
         Polyester film laminated to glass with solvent-based adhesive.

L. Laminated-Glass Types
1. Glass Type: Clear laminated glass with two plies of float glass **OR** heat-strengthened float glass **OR** fully tempered float glass **OR** ultraclear float glass **OR** ultraclear heat-strengthened float glass **OR** ultraclear fully tempered float glass, **as directed**.
   a. Thickness of Each Glass Ply: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
   b. Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.29 mm), **as directed**.

c. Provide safety glazing labeling.

2. Glass Type: Antireflective-coated clear laminated glass with two plies of float glass **OR** heat-strengthened float glass **OR** fully tempered float glass **OR** ultraclear float glass **OR** ultraclear heat-strengthened float glass **OR** ultraclear fully tempered float glass, **as directed**.
   a. Thickness of Each Glass Ply: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm, **as directed**.
   b. Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.29 mm), **as directed**.
   c. Visible Reflectance: Less than 2 percent.
   d. Winter Nighttime U-Factor: as directed by the Owner.
   e. Summer Daytime U-Factor: as directed by the Owner.
   f.
   g. Solar Heat Gain Coefficient: as directed by the Owner.
   h.
   i. Provide safety glazing labeling.
3. Glass Type: Tinted laminated glass with two plies of float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**, with outer ply Class 2 (tinted) and inner ply Class 1 (clear).
   a. Thickness of Each Glass Ply: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
   b. Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.29 mm), **as directed**.
   c. Winter Nighttime U-Factor: as directed by the Owner.
   d.
   e. Summer Daytime U-Factor: as directed by the Owner.
   f.
   g. Solar Heat Gain Coefficient: as directed by the Owner.
   h.
   i. Provide safety glazing labeling.
4. Glass Type: Tinted laminated glass with two plies of clear float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**, and tinted interlayer.
   a. Thickness of Each Glass Ply: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
   b. Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.29 mm), **as directed**.
   c. Interlayer Color: Blue-green **OR** Bronze light **OR** Gray, **as directed**.
   d. Winter Nighttime U-Factor: as directed by the Owner.
   e.
   f. Summer Daytime U-Factor: as directed by the Owner.
   g.
   h. Solar Heat Gain Coefficient: as directed by the Owner.
   i. Provide safety glazing labeling.
5. Glass Type: Ceramic-coated, laminated vision glass with two plies of heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
   a. Thickness of Each Glass Ply: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
   b. Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.29 mm), **as directed**.
   c. Coating Location: Second **OR** Third **OR** Fourth, **as directed**, surface.
   d. Winter Nighttime U-Factor: as directed by the Owner.
   e.
   f. Summer Daytime U-Factor: as directed by the Owner.
   g.
   h. Solar Heat Gain Coefficient: as directed by the Owner.
   i.
   j. Provide safety glazing labeling.

6. Glass Type: Reflective-coated, laminated vision glass with two plies of heat-strengthened float glass **OR** fully tempered float glass, **as directed**, with inner ply Class 1 (clear).
   a. Thickness of Each Glass Ply: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
   b. Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.29 mm), **as directed**.
   c. Coating Location: First **OR** Second **OR** Third, **as directed**, surface.
   d. Winter Nighttime U-Factor: as directed by the Owner.
   e.
   f. Summer Daytime U-Factor: as directed by the Owner.
   g.
   h. Solar Heat Gain Coefficient: as directed by the Owner.
   i. Provide safety glazing labeling.
7. Glass Type: Low-e-coated, laminated vision glass with two plies of clear float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
   a. Thickness of Each Glass Ply: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
   b. Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.29 mm), **as directedf**.
   c. Low-E Coating: Pyrolytic on second **OR** Pyrolytic on third **OR** Sputtered on second **OR** Sputtered on third **OR** Pyrolytic or sputtered on second or third, **as directed**, surface.
   d. Visible Light Transmittance: as directed by the Owner.
   e.
   f. Winter Nighttime U-Factor: as directed by the Owner.
   g.
   h. Summer Daytime U-Factor: as directed by the Owner.
   i.
   j. Solar Heat Gain Coefficient: as directed by the Owner.
   k.
   l. Provide safety glazing labeling.
8. Glass Type: Reflective-coated, laminated spandrel glass with two plies of heat-strengthened float glass **OR** fully tempered float glass, **as directed**, with inner ply Class 1 (clear).
   a. Thickness of Each Glass Ply: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
   b. Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.29 mm), **as directed**.
   c. Coating Location: First **OR** Second **OR** Third, **as directed**, surface.
   d. Winter Nighttime U-Factor: as directed by the Owner.
   e.
   f. Summer Daytime U-Factor: as directed by the Owner.
   g.

M. Insulating-Glass Types
1. Glass Type: Clear insulating glass.
   a. Overall Unit Thickness: 1 inch (25 mm) **OR** 5/8 inch (16 mm), **as directed**.
   b. Thickness of Each Glass Lite: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm, **as directed**.
   c. Outdoor Lite: Float glass **OR** Heat-strengthened float glass **OR** Fully tempered float glass, **as directed**.
   d. Interspace Content: Air **OR** Argon, **as directed**.
   e. Indoor Lite: Float glass **OR** Heat-strengthened float glass **OR** Fully tempered float glass, **as directed**.
   f. Winter Nighttime U-Factor: as directed by the Owner.
   g.
   h. Summer Daytime U-Factor: as directed by the Owner.
   i. Provide safety glazing labeling.

2. Glass Type: Ultraclear insulating glass.
   a. Overall Unit Thickness: 1 inch (25 mm) **OR** 5/8 inch (16 mm), **as directed**.
   b. Thickness of Each Glass Lite: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm, **as directed**.
   c. Outdoor Lite: Ultraclear float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
   d. Interspace Content: Air **OR** Argon, **as directed**.
   e. Indoor Lite: Ultraclear float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
   f. Winter Nighttime U-Factor: as directed by the Owner.
   g.
   h. Summer Daytime U-Factor: as directed by the Owner.
   i.
   j. Provide safety glazing labeling.
3. Glass Type: Pyrolytic-coated, self-cleaning, low-maintenance, clear insulating glass.
   a. Overall Unit Thickness: 1 inch (25 mm) **OR** 5/8 inch (16 mm), **as directed**.
   b. Thickness of Each Glass Lite: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm, **as directed**.
   c. Outdoor Lite: Pyrolytic-coated, self-cleaning, low-maintenance, clear float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
   d. Interspace Content: Air **OR** Argon, **as directed**.
   e. Indoor Lite: Float glass **OR** Heat-strengthened float glass **OR** Fully tempered float glass, **as directed**.
   f. Winter Nighttime U-Factor: as directed by the Owner.
   g. Summer Daytime U-Factor: as directed by the Owner.
   h. Provide safety glazing labeling.
4. Glass Type: Low-e-coated, clear insulating glass.
   a. Overall Unit Thickness: 1 inch (25 mm) **OR** 5/8 inch (16 mm), **as directed**.
   b. Thickness of Each Glass Lite: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm, **as directed**.
   c. Outdoor Lite: Float glass **OR** Heat-strengthened float glass **OR** Fully tempered float glass **OR** Ultraclear float glass **OR** Ultraclear heat-strengthened float glass **OR** Ultraclear fully tempered float glass, **as directed**.
   d. Interspace Content: Air **OR** Argon, **as directed**.
   e. Indoor Lite: Float glass **OR** Heat-strengthened float glass **OR** Fully tempered float glass **OR** Ultraclear float glass **OR** Ultraclear heat-strengthened float glass **OR** Ultraclear fully tempered float glass, **as directed**.
   f. Low-E Coating: Pyrolytic on second **OR** Pyrolytic on third **OR** Sputtered on second **OR** Sputtered on third **OR** Pyrolytic or sputtered on second or third, **as directed**, surface.
   g. Visible Light Transmittance: as directed by the Owner.
   h. Winter Nighttime U-Factor: as directed by the Owner.
   i. Summer Daytime U-Factor: as directed by the Owner.
   j. Solar Heat Gain Coefficient: as directed by the Owner.
   k. Provide safety glazing labeling.
5. Glass Type: Tinted insulating glass.
   a. Overall Unit Thickness: 1 inch (25 mm) **OR** 5/8 inch (16 mm), **as directed**.
   b. Thickness of Each Glass Lite: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm, **as directed**.
   c. Outdoor Lite: Tinted float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
   d. Interspace Content: Air **OR** Argon, **as directed**.
   e. Indoor Lite: Clear float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
   f. Winter Nighttime U-Factor: as directed by the Owner.
   g. Summer Daytime U-Factor: as directed by the Owner.
   h. Solar Heat Gain Coefficient: as directed by the Owner.
   i. Provide safety glazing labeling.
6. Glass Type: Low-e-coated, tinted insulating glass.
   a. Overall Unit Thickness: 1 inch (25 mm) **OR** 5/8 inch (16 mm), **as directed**.
   b. Thickness of Each Glass Lite: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm, **as directed**.

c. Outdoor Lite: Tinted float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
d. Interspace Content: Air **OR** Argon, **as directed**.
e. Indoor Lite: Clear float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
f. Low-E Coating: Pyrolytic on second **OR** Pyrolytic on third **OR** Sputtered on second **OR** Sputtered on third **OR** Pyrolytic or sputtered on second or third, **as directed**, surface.
g. Visible Light Transmittance: as directed by the Owner.
h. Winter Nighttime U-Factor: as directed by the Owner.
i. Summer Daytime U-Factor: as directed by the Owner.
j. Solar Heat Gain Coefficient: as directed by the Owner.
k. Provide safety glazing labeling.

7. Glass Type: Ceramic-coated, insulating vision glass.
a. Overall Unit Thickness: 1 inch (25 mm) **OR** 5/8 inch (16 mm), **as directed**.
b. Thickness of Each Glass Lite: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm, **as directed**.
c. Outdoor Lite: Heat-strengthened float glass **OR** Fully tempered float glass **OR** Ultraclear heat-strengthened float glass **OR** Ultraclear fully tempered float glass, **as directed**.
d. Interspace Content: Air **OR** Argon, **as directed**.
e. Indoor Lite: Float glass **OR** Heat-strengthened float glass **OR** Fully tempered float glass **OR** Ultraclear float glass **OR** Ultraclear heat-strengthened float glass **OR** Ultraclear fully tempered float glass, **as directed**.
f. Coating Location: Second **OR** Third **OR** Fourth, **as directed**, surface.
g. Winter Nighttime U-Factor: as directed by the Owner.
h. Summer Daytime U-Factor: as directed by the Owner.
i. Solar Heat Gain Coefficient: as directed by the Owner.
j. Provide safety glazing labeling.

8. Glass Type: Reflective-coated, clear insulating glass.
a. Overall Unit Thickness: 1 inch (25 mm) **OR** 5/8 inch (16 mm), **as directed**.
b. Thickness of Each Glass Lite: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm, **as directed**.
c. Outdoor Lite: Clear float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
d. Interspace Content: Air **OR** Argon, **as directed**.
e. Indoor Lite: Clear float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
f. Coating Location: First **OR** Second **OR** Third, **as directed**, surface.
g. Winter Nighttime U-Factor: as directed by the Owner.
h. Summer Daytime U-Factor: as directed by the Owner.
i. Solar Heat Gain Coefficient: as directed by the Owner.
j. Provide safety glazing labeling.

9. Glass Type: Reflective-coated, tinted insulating glass.
a. Overall Unit Thickness: 1 inch (25 mm) **OR** 5/8 inch (16 mm), **as directed**.
b. Thickness of Each Glass Lite: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm, **as directed**.
c. Outdoor Lite: Tinted float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
d. Interspace Content: Air **OR** Argon, **as directed**.
e. Indoor Lite: Clear float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
f. Coating Location: First **OR** Second **OR** Third, **as directed**, surface.
g. Winter Nighttime U-Factor: as directed by the Owner.
h. Summer Daytime U-Factor: as directed by the Owner.
i. Solar Heat Gain Coefficient: as directed by the Owner.
j. Provide safety glazing labeling.

10. Glass Type: Ceramic-coated **OR** Silicone-coated, **as directed**, insulating spandrel glass.
a. Overall Unit Thickness: 1 inch (25 mm).
b. Thickness of Each Glass Lite: 5.0 mm **OR** 6.0 mm, **as directed**.

c. Outdoor Lite: Float glass **OR** Heat-strengthened float glass **OR** Fully tempered float glass **OR** Ultraclear float glass **OR** Ultraclear heat-strengthened float glass **OR** Ultraclear fully tempered float glass, **as directed**.
d. Interspace Content: Air **OR** Argon, **as directed**.
e. Indoor Lite: Float glass **OR** Heat-strengthened float glass **OR** Fully tempered float glass **OR** Ultraclear float glass **OR** Ultraclear heat-strengthened float glass **OR** Ultraclear fully tempered float glass, **as directed**.
f. Coating Location: Fourth surface.
g. Winter Nighttime U-Factor: as directed by the Owner.
h. Summer Daytime U-Factor: as directed by the Owner.

11. Glass Type: Ceramic-coated **OR** Silicone-coated, **as directed**, low-e, insulating spandrel glass.
a. Overall Unit Thickness: 1 inch (25 mm).
b. Thickness of Each Glass Lite: 5.0 mm **OR** 6.0 mm, **as directed**.
c. Outdoor Lite: Float glass **OR** Heat-strengthened float glass **OR** Fully tempered float glass **OR** Ultraclear float glass **OR** Ultraclear heat-strengthened float glass **OR** Ultraclear fully tempered float glass, **as directed**.
d. Interspace Content: Air **OR** Argon, **as directed**.
e. Indoor Lite: Float glass **OR** Heat-strengthened float glass **OR** Fully tempered float glass **OR** Ultraclear float glass **OR** Ultraclear heat-strengthened float glass **OR** Ultraclear fully tempered float glass, **as directed**.
f. Low-E Coating: Pyrolytic on second **OR** Pyrolytic on third **OR** Sputtered on second **OR** Sputtered on third **OR** Pyrolytic or sputtered on second or third, **as directed**, surface.
g. Opaque Coating Location: Fourth surface.
h. Winter Nighttime U-Factor: as directed by the Owner.
i. Summer Daytime U-Factor: as directed by the Owner.

12. Glass Type: Ceramic-coated **OR** Silicone-coated, **as directed**, tinted, insulating spandrel glass.
a. Overall Unit Thickness: 1 inch (25 mm).
b. Thickness of Each Glass Lite: 5.0 mm **OR** 6.0 mm.
c. Outdoor Lite: Tinted float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
d. Interspace Content: Air **OR** Argon, **as directed**.
e. Indoor Lite: Clear float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
f. Coating Location: Fourth surface.
g. Winter Nighttime U-Factor: as directed by the Owner.
h. Summer Daytime U-Factor: as directed by the Owner.

N. Insulating-Laminated-Glass Types
1. Glass Type: Clear insulating laminated glass.
a. Overall Unit Thickness: 1-3/16 inch (30 mm) **OR** 1 inch (25 mm) **OR** 3/4 inch (19 mm), **as directed**.
b. Thickness of Outdoor Lite: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm, **as directed**.
c. Outdoor Lite: Heat-strengthened float glass **OR** Fully tempered float glass, **as directed**.
d. Interspace Content: Air **OR** Argon, **as directed**.
e. Indoor Lite: Clear laminated glass with two plies of float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
1) Thickness of Each Glass Ply: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
2) Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.29 mm), **as directed**.
f. Winter Nighttime U-Factor: as directed by the Owner.
g. Summer Daytime U-Factor: as directed by the Owner.
h. Solar Heat Gain Coefficient: as directed by the Owner.
i. Provide safety glazing labeling.

2. Glass Type: Low-e-coated, clear insulating laminated glass.

a. Overall Unit Thickness: 1-3/16 inch (30 mm) **OR** 1 inch (25 mm) **OR** 3/4 inch (19 mm), **as directed**.
b. Thickness of Outdoor Lite: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm, **as directed**.
c. Outdoor Lite: Heat-strengthened float glass **OR** Fully tempered float glass, **as directed**.
d. Interspace Content: Air **OR** Argon, **as directed**.
e. Indoor Lite: Clear laminated glass with two plies of float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
   1) Thickness of Each Glass Ply: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
   2) Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.29 mm), **as directed**.
f. Low-E Coating: Pyrolytic on second **OR** Pyrolytic on third **OR** Sputtered on second **OR** Sputtered on third **OR** Pyrolytic or sputtered on second or third, **as directed**, surface.
g. Visible Light Transmittance: as directed by the Owner.
h. Winter Nighttime U-Factor: as directed by the Owner.
i. Summer Daytime U-Factor: as directed by the Owner.
j. Solar Heat Gain Coefficient: as directed by the Owner.
k. Provide safety glazing labeling.

3. Glass Type: Tinted, insulating laminated glass.
   a. Overall Unit Thickness: 1-3/16 inch (30 mm) **OR** 1 inch (25 mm) **OR** 3/4 inch (19 mm), **as directed**.
   b. Thickness of Outdoor Lite: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm, **as directed**.
   c. Outdoor Lite: Tinted heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
   d. Interspace Content: Air **OR** Argon, **as directed**.
   e. Indoor Lite: Clear laminated glass with two plies of float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
      1) Thickness of Each Glass Ply: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
      2) Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.29 mm), **as directed**.
   f. Winter Nighttime U-Factor: as directed by the Owner.
   g. Summer Daytime U-Factor: as directed by the Owner.
   h. Solar Heat Gain Coefficient: as directed by the Owner.
   i. Provide safety glazing labeling.

4. Glass Type: Low-e-coated, tinted, insulating laminated glass.
   a. Overall Unit Thickness: 1-3/16 inch (30 mm) **OR** 1 inch (25 mm) **OR** 3/4 inch (19 mm), **as directed**.
   b. Thickness of Outdoor Lite: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm, **as directed**.
   c. Outdoor Lite: Tinted heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
   d. Interspace Content: Air **OR** Argon, **as directed**.
   e. Indoor Lite: Clear laminated glass with two plies of float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
      1) Thickness of Each Glass Ply: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
      2) Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.29 mm), **as directed**.
   f. Low-E Coating: Pyrolytic on second **OR** Pyrolytic on third **OR** Sputtered on second **OR** Sputtered on third **OR** Pyrolytic or sputtered on second or third, **as directed**, surface.
   g. Visible Light Transmittance: as directed by the Owner.
   h. Winter Nighttime U-Factor: as directed by the Owner.
   i. Summer Daytime U-Factor: as directed by the Owner.
   j. Solar Heat Gain Coefficient: as directed by the Owner.
   k. Provide safety glazing labeling.

5. Glass Type: Reflective-coated, clear, insulating laminated glass.
   a. Overall Unit Thickness: 1-3/16 inch (30 mm) **OR** 1 inch (25 mm), **as directed**.
   b. Thickness of Outdoor Lite: 6.0 mm.
   c. Outdoor Lite: Clear heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
   d. Interspace Content: Air **OR** Argon, **as directed**.
   e. Indoor Lite: Clear laminated glass with two plies of float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
      1) Thickness of Each Glass Ply: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
      2) Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.29 mm), **as directed**.
   f. Coating Location: First **OR** Second **OR** Third, **as directed**, surface.
   g. Winter Nighttime U-Factor: as directed by the Owner.
   h. Summer Daytime U-Factor: as directed by the Owner.
   i. Solar Heat Gain Coefficient: as directed by the Owner.
   j. Provide safety glazing labeling.
6. Glass Type: Reflective-coated, tinted, insulating laminated glass.
   a. Overall Unit Thickness: 1-3/16 inch (30 mm) **OR** 1 inch (25 mm), **as directed**.
   b. Thickness of Outdoor Lite: 6.0 mm.
   c. Outdoor Lite: Tinted heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
   d. Interspace Content: Air **OR** Argon, **as directed**.
   e. Indoor Lite: Clear laminated glass with two plies of float glass **OR** heat-strengthened float glass **OR** fully tempered float glass, **as directed**.
      1) Thickness of Each Glass Ply: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
      2) Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.29 mm), **asdrected**.
   f. Coating Location: First **OR** Second **OR** Third, **as directed**, surface.
   g. Winter Nighttime U-Factor: as directed by the Owner.
   h. Summer Daytime U-Factor: as directed by the Owner.
   i. Solar Heat Gain Coefficient: as directed by the Owner.
   j. Provide safety glazing labeling.

O. Fire-Protection-Rated Glazing Types
1. Glass Type: 20-minute fire-rated glazing without hose-stream test; monolithic ceramic glazing **OR** film-faced ceramic glazing **OR** laminated ceramic glazing **OR** fire-protection-rated tempered glass **OR** fire-protection-rated laminated glass **OR** gel-filled, double glazing units, **as directed**.
   a. Provide safety glazing labeling.
2. Glass Type: 20-minute fire-rated glazing with hose-stream test; monolithic ceramic glazing **OR** film-faced ceramic glazing **OR** laminated ceramic glazing **OR** gel-filled, double glazing units, **as directd**.
   a. Provide safety glazing labeling.
3. Glass Type: 45-minute **OR** 60-minute **OR** 90-minute **OR** 120-minute, **as directed**, fire-rated glazing; monolithic ceramic glazing **OR** film-faced ceramic glazing **OR** laminated ceramic glazing **OR** laminated glass with intumescent interlayers **OR** gel-filled, double glazing units, **as directed**.
   a. Provide safety glazing labeling.
4. Glass Type: 45-minute **OR** 60-minute **OR** 90-minute **OR** 120-minute, **as directed**, fire-rated glazing with 450 deg F (250 deg C) temperature rise limitation; laminated glass with intumescent interlayers **OR** gel-filled, double glazing units, **as directed**.
   a. Provide safety glazing labeling.

1.3 EXECUTION

A. Examination
1. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
   a. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
   b. Presence and functioning of weep systems.
   c. Minimum required face and edge clearances.
   d. Effective sealing between joints of glass-framing members.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
2. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that will leave visible marks in the completed work.

C. Glazing, General
1. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
2. Adjust glazing channel dimensions as required by Project conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.
3. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.
4. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
5. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
6. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
7. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm).
   a. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
   b. Provide 1/8-inch (3-mm) minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
8. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
9. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
10. Set glass lites with proper orientation so that coatings face exterior or interior as specified.
11. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
12. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

D. Tape Glazing
   1. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
   2. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
   3. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.
   4. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
   5. Do not remove release paper from tape until right before each glazing unit is installed.
   6. Apply heel bead of elastomeric sealant.
   7. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
   8. Apply cap bead of elastomeric sealant over exposed edge of tape.

E. Gasket Glazing (Dry)
   1. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
   2. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
   3. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
   4. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
   5. Install gaskets so they protrude past face of glazing stops.

F. Sealant Glazing (Wet)
   1. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
   2. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
   3. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

G. Lock-Strip Gasket Glazing
   1. Comply with ASTM C 716 and gasket manufacturer's written instructions. Provide supplementary wet seal and weep system unless otherwise indicated.

H. Cleaning And Protection
   1. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels and clean surfaces.
   2. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.

3. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.
4. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.
5. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

END OF SECTION 08810

Task	Specification	Specification Description
08820	08810	Glazing

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SECTION 08830 - MIRRORS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for mirrors. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes the following types of silvered flat glass mirrors:
   a. Annealed monolithic glass mirrors.
   b. Film-backed, Laminated and Tempered glass mirrors qualifying as safety glazing.

C. Submittals
1. Product Data: For each type of product indicated.
   a. Mirrors. Include description of materials and process used to produce each type of silvered flat glass mirror specified that indicates sources of glass, glass coating components, edge sealer, and quality-control provisions.
2. Shop Drawings: Include mirror elevations, edge details, mirror hardware, and attachments to other work.
3. Samples: For each type of the following products:
   a. Mirrors: 12 inches (300 mm) square, including edge treatment on two adjoining edges.
   b. Mirror Clips: Full size.
   c. Mirror Trim: 12 inches (300 mm) long.
4. Qualification Data: For qualified Installer.
5. Product Certificates: For each type of mirror and mirror mastic, from manufacturer.
6. Preconstruction Test Reports: From mirror manufacturer indicating that mirror mastic was tested for compatibility and adhesion with mirror backing paint **OR** film, **as directed**, and substrates on which mirrors are installed.
7. Maintenance Data: For mirrors to include in maintenance manuals.
8. Warranty: Sample of special warranty.

D. Quality Assurance
1. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
2. Source Limitations for Mirrors: Obtain mirrors from single source from single manufacturer.
3. Source Limitations for Mirror Accessories: Obtain mirror glazing accessories from single source.
4. Glazing Publications: Comply with the following published recommendations:
   a. GANA's "Glazing Manual" unless more stringent requirements are indicated. Refer to this publication for definitions of glass and glazing terms not otherwise defined in this Section or in referenced standards.
   b. GANA Mirror Division's "Mirrors, Handle with Extreme Care: Tips for the Professional on the Care and Handling of Mirrors."
5. Safety Glazing Products: For film-backed, laminated and tempered mirrors, provide products complying with testing requirements in 16 CFR 1201 for Category II materials.
6. Preconstruction Mirror Mastic Compatibility Test: Submit mirror mastic products to mirror manufacturer for testing to determine compatibility of mastic with mirror backing paint **OR** film, **as directed**, and substrates on which mirrors are installed.

E. Delivery, Storage, And Handling

1. Protect mirrors according to mirror manufacturer's written instructions and as needed to prevent damage to mirrors from moisture, condensation, temperature changes, direct exposure to sun, or other causes.
2. Comply with mirror manufacturer's written instructions for shipping, storing, and handling mirrors as needed to prevent deterioration of silvering, damage to edges, and abrasion of glass surfaces and applied coatings. Store indoors.

F. Project Conditions
1. Environmental Limitations: Do not install mirrors until ambient temperature and humidity conditions are maintained at levels indicated for final occupancy.

G. Warranty
1. Special Warranty: Manufacturer's standard form in which mirror manufacturer agrees to replace mirrors that deteriorate within specified warranty period. Deterioration of mirrors is defined as defects developed from normal use that are not attributed to mirror breakage or to maintaining and cleaning mirrors contrary to manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.
   a. Warranty Period: Five years from date of Substantial Completion.

1.2 PRODUCTS

A. Silvered Flat Glass Mirrors
1. Glass Mirrors, General: ASTM C 1503; manufactured using copper-free, low-lead mirror coating process, **as directed**.
2. Clear Glass: Mirror Select **OR** Glazing, **as directed**, Quality; ultraclear (low-iron) float glass with a minimum 91 percent visible light transmission, **as directed**.
   a. Nominal Thickness: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
3. Tinted Glass: Mirror Glazing Quality.
   a. Nominal Thickness: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
   b. Tint Color: Blue **OR** Black **OR** Bronze **OR** Gold **OR** Gray **OR** Green **OR** Peach **OR** Pink, **as directed**.
4. Tempered Clear **OR** Tinted, **as directed**, Glass: Mirror Glazing Quality, for blemish requirements; and comply with ASTM C 1048 for Kind FT, Condition A, tempered float glass before silver coating is applied.
   a. Nominal Thickness: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
   b. Tint Color: Blue **OR** Black **OR** Bronze **OR** Gold **OR** Gray **OR** Green **OR** Peach **OR** Pink, **as directed**.
5. Laminated Mirrors: ASTM C 1172, Kind LM.
   a. Clear Glass for Outer Lite: Mirror Select **OR** Glazing, **as directed**, Quality; ultraclear (low-iron) float glass with a minimum 91 percent visible light transmission, **as directed**.
   b. Tinted Glass for Outer Lite: Mirror Glazing Quality.
      1) Tint Color: Blue **OR** Black **OR** Bronze **OR** Gold **OR** Gray **OR** Green **OR** Peach **OR** Pink, **as directed**.
   c. Nominal Thickness for Outer Lite: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.
   d. Glass for Inner Lite: Annealed float glass; ASTM C 1036, Type I (transparent flat glass), Quality-Q3; Class 1 (clear).
      OR
      Glass for Inner Lite: Heat-treated float glass; ASTM C 1048 Type I; Quality-Q3; Class I (clear) Kind HS, Condition A.
      OR

Glass for Inner Lite: Tempered float glass; ASTM C 1048 Type I; Quality-Q3; Class I (clear), Kind FT, Condition A.

e. Nominal Thickness for Inner Lite: 3.0 mm **OR** 4.0 mm **OR** 5.0 mm **OR** 6.0 mm **OR** As indicated, **as directed**.

f. Interlayer: Mirror manufacturer's standard 0.030-inch- (0.76-mm-) thick, clear polyvinyl-butyral interlayer with a proven record of showing no tendency to delaminate from, or cause damage to, silver coating.

B. Miscellaneous Materials

1. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
2. Edge Sealer: Coating compatible with glass coating and approved by mirror manufacturer for use in protecting against silver deterioration at mirrored glass edges.
3. Mirror Mastic: An adhesive setting compound, asbestos-free, produced specifically for setting mirrors and certified by both mirror manufacturer and mastic manufacturer as compatible with glass coating and substrates on which mirrors will be installed.
4. Film Backing for Safety Mirrors: Film backing and pressure-sensitive adhesive; both compatible with mirror backing paint as certified by mirror manufacturer.

C. Mirror Hardware

1. Top and Bottom Aluminum J-Channels: Aluminum extrusions with a return deep enough to produce a glazing channel to accommodate mirrors of thickness indicated and in lengths required to cover bottom and top edges of each mirror in a single piece.
   a. Bottom Trim: J-channels formed with front leg and back leg not less than 3/8 and 7/8 inch (9.5 and 22 mm) in height, respectively, and a thickness of not less than 0.04 inch (1.0 mm) **OR** 0.05 inch (1.3 mm), **as directed**.
   b. Top Trim: J-channels formed with front leg and back leg not less than 5/8 and 1 inch (16 and 25 mm) in height, respectively, and a thickness of not less than 0.04 inch (1.0 mm) **OR** 0.062 inch (1.57 mm), **as directed**.
   c. Finish: Clear **OR** Gold, **as directed**, bright anodized.
2. Top Channel/Cleat and Bottom Aluminum J-Channels: Aluminum extrusions with a return deep enough to produce a glazing channel to accommodate mirrors of thickness indicated and in lengths required to cover bottom and top edges of each mirror in a single piece.
   a. Bottom Trim: J-channels formed with front leg and back leg not less than 5/16 and 3/4 inch (7.9 and 19 mm) in height, respectively.
   b. Top Trim: Formed with front leg with a height of 5/16 inch (7.9 mm) and back leg designed to fit into the pocket created by wall-mounted aluminum cleat.
   c. Finish: Clear **OR** Gold, **as directed**, bright anodized.
3. Mirror Bottom Clips: As indicated.
4. Mirror Top Clips: As indicated.
5. Plated Steel Hardware: Formed-steel shapes with plated finish indicated.
   a. Profile: As indicated.
   b. Finish: Selected from manufacturer’s standards.
6. Fasteners: Fabricated of same basic metal and alloy as fastened metal and matching it in finished color and texture where fasteners are exposed.
7. Anchors and Inserts: Provide devices as required for mirror hardware installation. Provide toothed or lead-shield expansion-bolt devices for drilled-in-place anchors. Provide galvanized anchors and inserts for applications on inside face of exterior walls and where indicated.

D. Fabrication

1. Mirror Sizes: To suit Project conditions, and before tempering, **as directed**, cut mirrors to final sizes and shapes.
2. Cutouts: Fabricate cutouts before tempering, **as directed**, for notches and holes in mirrors without marring visible surfaces. Locate and size cutouts so they fit closely around penetrations in mirrors.

3. Mirror Edge Treatment: Flat polished **OR** Rounded polished **OR** Flat high-polished **OR** Rounded high-polished **OR** Beveled polished edge of width shown, **as directed**.
   a. Seal edges of mirrors with edge sealer after edge treatment to prevent chemical or atmospheric penetration of glass coating.
   b. Require mirror manufacturer to perform edge treatment and sealing in factory immediately after cutting to final sizes.
4. Film-Backed Safety Mirrors: Apply film backing with adhesive coating over mirror backing paint as recommended in writing by film-backing manufacturer to produce a surface free of bubbles, blisters, and other imperfections.

1.3 EXECUTION

A. Examination
   1. Examine substrates, over which mirrors are to be mounted, with Installer present, for compliance with installation tolerances, substrate preparation, and other conditions affecting performance of the Work.
   2. Verify compatibility with and suitability of substrates, including compatibility of mirror mastic with existing finishes or primers.
   3. Proceed with installation only after unsatisfactory conditions have been corrected and surfaces are dry.

B. Preparation
   1. Comply with mastic manufacturer's written installation instructions for preparation of substrates, including coating substrates with mastic manufacturer's special bond coating where applicable.

C. Installation
   1. General: Install mirrors to comply with mirror manufacturer's written instructions and with referenced GANA publications. Mount mirrors accurately in place in a manner that avoids distorting reflected images.
   2. Provide a minimum air space of 1/8 inch (3 mm) between back of mirrors and mounting surface for air circulation between back of mirrors and face of mounting surface.
   3. Wall-Mounted Mirrors: Install mirrors with mirror hardware **OR** mastic and mirror hardware, **as directed**. Attach mirror hardware securely to mounting surfaces with mechanical fasteners installed with anchors or inserts as applicable. Install fasteners so heads do not impose point loads on backs of mirrors.
      a. Top and Bottom Aluminum J-Channels: Provide setting blocks 1/8 inch (3 mm) thick by 4 inches (100 mm) long at quarter points. To prevent trapping water, provide, between setting blocks, two slotted weeps not less than 1/4 inch (6.4 mm) wide by 3/8 inch (9.5 mm) long at bottom channel.
      b. Top Channel/Cleat and Bottom Aluminum J-Channels: Fasten J-channel directly to wall and attach top trim to continuous cleat fastened directly to wall.
      c. Mirror Clips: Place a felt or plastic pad between mirror and each clip to prevent spalling of mirror edges. Locate clips where indicated **OR** so they are symmetrically placed and evenly spaced, **as directed**.
      d. Install mastic as follows:
         1) Apply barrier coat to mirror backing where approved in writing by manufacturers of mirrors and backing material.
         2) Apply mastic to comply with mastic manufacturer's written instructions for coverage and to allow air circulation between back of mirrors and face of mounting surface.
         3) After mastic is applied, align mirrors and press into place while maintaining a minimum air space of 1/8 inch (3 mm) between back of mirrors and mounting surface.

D. Cleaning And Protection

1. Protect mirrors from breakage and contaminating substances resulting from construction operations.
2. Do not permit edges of mirrors to be exposed to standing water.
3. Maintain environmental conditions that will prevent mirrors from being exposed to moisture from condensation or other sources for continuous periods of time.
4. Wash exposed surface of mirrors not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash mirrors as recommended in writing by mirror manufacturer.

END OF SECTION 08830

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Task	Specification	Specification Description
08830	08810	Glazing

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SECTION 08840 - PLASTIC GLAZING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for plastic glazing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Monolithic acrylic glazing.
b. Monolithic polycarbonate glazing.
c. Multiwalled structured polycarbonate glazing.

C. Performance Requirements
1. Provide plastic glazing sheets and glazing materials capable of withstanding normal temperature changes, wind, and impact loads without failure, including loss or breakage of plastic sheets attributable to the following: failure of sealants or gaskets to remain watertight and airtight, deterioration of plastic sheet and glazing materials, or other defects in materials and installation.
2. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on plastic glazing and glazing framing members.
a. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

D. Preconstruction Testing
1. Preconstruction Adhesion and Compatibility Testing: Test each plastic glazing type, tape sealant, gasket, glazing accessory, and glazing-framing member for adhesion to and compatibility with elastomeric glazing sealants.
a. Testing will not be required if data are submitted based on previous testing of current sealant products and plastic glazing matching those submitted.
b. Use ASTM C 1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glazing, tape sealants, gaskets, and glazing channel substrates.
c. Test no fewer than eight Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
d. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
e. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including the use of specially formulated primers.

E. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:
a. Product Data for Credit EQ 4.1: For glazing sealants used inside the weatherproofing system, including printed statement of VOC content.
3. Plastic Glazing Samples: For each color and finish of plastic glazing indicated, 12 inches (300 mm) square and of same thickness indicated for final Work.
4. Glazing Accessory Samples: For gaskets and sealants, in 12-inch (300-mm) lengths. Install sealant Samples between two strips of material representative in color of the adjoining framing system, **as directed**.
5. Plastic Glazing Schedule: List plastic glazing types and thicknesses for each size opening and location. Use same designations indicated on Drawings. Indicate coordinated dimensions of

plastic glazing and construction that receives plastic glazing, including clearances and glazing channel dimensions.

6. Qualification Data: For installers, plastic glazing testing agency and sealant testing agency.
7. Product Certificates: For plastic glazing and glazing products, from manufacturer.
8. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for plastic glazing, glazing sealants and glazing gaskets.
   a. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.
9. Preconstruction adhesion and compatibility test report.
10. Research/Evaluation Reports: For plastic glazing.
11. Maintenance Data: For plastic glazing to include in maintenance manuals.
12. Warranty: Sample of special warranty.

F. Quality Assurance
   1. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
   2. Source Limitations: Obtain plastic glazing from single source from single manufacturer. Obtain sealants and gaskets from single source from single manufacturer for each product and installation method.
   3. Glazing Publication: Comply with published recommendations of plastic glazing manufacturers and with GANA's "Glazing Manual" unless more stringent requirements are indicated. Refer to this publication for definitions of glazing terms not otherwise defined in this Section or in other referenced standards.
   4. Plastic Glazing Labeling: Identify plastic sheets with appropriate markings of applicable testing and inspecting agency, indicating compliance with required fire-test-response characteristics.
   5. Safety Glazing Labeling: Where safety glazing labeling is indicated, permanently mark glazing with certification label of a certification agency acceptable to authorities having jurisdiction or manufacturer. Label shall indicate manufacturer's name, type of plastic glazing, thickness, and safety glazing standard with which glass complies.

G. Delivery, Storage, And Handling
   1. Protect plastic glazing materials according to manufacturer's written instructions. Prevent damage to plastic glazing and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
   2. Maintain protective coverings on plastic glazing to avoid exposures to abrasive substances, excessive heat, and other sources of possible deterioration.

H. Project Conditions
   1. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
      a. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or below 40 deg F (4.4 deg C).

I. Coordination
   1. Coordinate dimensions of plastic glazing with dimensions of construction that receives plastic glazing to ensure that glazing channels provide adequate face and edge clearance, bite, and allowance for expansion.

J. Warranty
   1. Manufacturer's Special Warranty for Abrasion- and UV-Resistant, Monolithic **OR** Multiwalled Structured, **as directed**, Polycarbonate: Manufacturer's standard form, made out to Owner and signed by polycarbonate manufacturer, in which manufacturer agrees to replace polycarbonate products that break or develop defects from normal use that are attributable to manufacturing process and not to practices for maintaining and cleaning plastic glazing contrary to

manufacturer's written instructions. Defects include coating delamination, haze, excessive yellowing, and loss of light transmission beyond the limits stated in plastic glazing manufacturer's standard form.

a. Warranty Period: Five years from date of Substantial Completion.

1.2 PRODUCTS

A. Plastic Glazing, General

1. Sizes: Fabricate plastic glazing to sizes required for openings indicated. Allow for thermal expansion and contraction of plastic glazing without restraint and without withdrawal of edges from frames, with edge clearances and tolerances complying with plastic glazing manufacturer's written instructions.
2. Fire-Test-Response Characteristics of Plastic Glazing: As determined by testing plastic glazing by a qualified testing agency acceptable to authorities having jurisdiction.
   a. Self-ignition temperature of 650 deg F (343 deg C) or higher when tested according to ASTM D 1929 on plastic sheets in thicknesses indicated for the Work.
   b. Smoke-developed index of 450 or less when tested according to ASTM E 84, or smoke density of 75 or less when tested according to ASTM D 2843 on plastic sheets in thicknesses indicated for the Work.
   c. Burning extent of 1 inch (25 mm) or less when tested according to ASTM D 635 at a nominal thickness of 0.060 inch (1.52 mm) or thickness indicated for the Work, where Class CC1 is indicated.
   d. Burning rate of 2.5 in./min. (1.06 mm/s) or less when tested according to ASTM D 635 at a nominal thickness of 0.060 inch (1.52 mm) or thickness indicated for the Work, where Class CC2 is indicated.
   e. Flame-spread index not less than that indicated when tested according to ASTM E 84.
3. Windborne-Debris-Impact Resistance: Provide exterior plastic glazing that passes basic **OR** enhanced, **as directed**,-protection testing requirements in ASTM E 1996 for Wind Zone 1 **OR** Wind Zone 2 **OR** Wind Zone 3 **OR** Wind Zone 4, **as directed**, when tested according to ASTM E 1886. Test specimens shall be no smaller in width and length than plastic glazing indicated for use on Project and shall be installed in same manner as indicated for use on Project.
   a. Large-Missile Test: For plastic glazing located within 30 feet (9.1 m) of grade.
   b. Small-Missile Test: For plastic glazing located more than 30 feet (9.1 m) above grade.
      OR
      Large-Missile Test: For all plastic glazing, regardless of height above grade.

B. Monolithic Acrylic Glazing

1. Plastic Glazing: Transparent acrylic sheet; ASTM D 4802, Category A-1 (cell cast) **OR** Category A-2 (continuously cast) **OR** Category B-1 (continuously manufactured), **as directed**, Finish 1 (smooth or polished), Type UVF (UV filtering).
   a. Nominal Thickness: 0.093 inch (2.5 mm) **OR** 0.118 inch (3 mm) **OR** 0.177 inch (4.5 mm) **OR** 0.236 inch (6 mm), **as directed**.
   b. Color: Colorless **OR** As selected from manufacturer's full range, **as directed**.
   c. Combustibility Class: CC2.
   d. Provide safety glazing labeling.
2. Plastic Glazing: Coated, transparent acrylic sheet; ASTM D 4802, Category A-1 (cell cast) **OR** Category B-1 (continuously manufactured), **as directed**, Finish 3 (abrasion-resistant coating) with coating on one side **OR** both sides, **as directed**, Type UVF (UV filtering).
   a. Nominal Thickness: 0.093 inch (2.5 mm) **OR** 0.118 inch (3 mm) **OR** 0.177 inch (4.5 mm) **OR** 0.236 inch (6 mm), **as directed**.
   b. Color: Colorless **OR** As selected from manufacturer's full range, **as directed**.
   c. Combustibility Class: CC2.
   d. Provide safety glazing labeling.

3. Plastic Glazing: Translucent acrylic sheet; ASTM D 4802, Category A-1 (cell cast) **OR** Category B-1 (continuously manufactured), **as directed**, Finish 1 (smooth or polished), Type UVF (UV filtering).
   a. Nominal Thickness: 0.093 inch (2.5 mm) **OR** 0.118 inch (3 mm) **OR** 0.177 inch (4.5 mm) **OR** 0.236 inch (6 mm), **as directed**.
   b. Color: White, with visible light transmittance of not more than 50 percent for 0.117-inch-(2.9-mm-) thick sheet, measured according to ASTM D 1003 **OR** As selected from manufacturer's full range, **as directed**.
   c. Combustibility Class: CC2.
   d. Provide safety glazing labeling.
4. Plastic Glazing: Patterned acrylic sheet; ASTM D 4802, Category A-1 (cell cast), Finish 2 (patterned), Type UVF (UV filtering).
   a. Nominal Thickness: 0.093 inch (2.5 mm) **OR** 0.118 inch (3 mm) **OR** 0.177 inch (4.5 mm) **OR** 0.236 inch (6 mm), **as directed**.
   b. Pattern: Matte finish **OR** As selected from manufacturer's full range, **as directed**.
   c. Color: Transparent colorless **OR** Translucent white **OR** As selected from manufacturer's full range, **as directed**.
   d. Combustibility Class: CC2.
   e. Provide safety glazing labeling.

C. Monolithic Polycarbonate Glazing
1. Plastic Glazing: Polycarbonate sheet; ASTM C 1349, Appendix X1, Type I (standard, UV stabilized), with a polished finish.
   a. Nominal Thickness: 0.093 inch (2.5 mm) **OR** 0.118 inch (3 mm) **OR** 0.177 inch (4.5 mm) **OR** 0.236 inch (6 mm), **as directed**.
   b. Color: Transparent colorless **OR** As selected from manufacturer's full range, **as directed**.
   c. Combustibility Class: CC1.
   d. Flame-Spread Index: 25 **OR** 75 **OR** 200, **as directed**, or less.
   e. Provide safety glazing labeling.
2. Plastic Glazing: Coated polycarbonate sheet; ASTM C 1349, Appendix X1, Type II (coated mar-resistant, UV stabilized), with coating on both sides.
   a. Nominal Thickness: 0.093 inch (2.5 mm) **OR** 0.118 inch (3 mm) **OR** 0.177 inch (4.5 mm) **OR** 0.236 inch (6 mm), **as directed**.
   b. Color: Transparent colorless **OR** As selected from manufacturer's full range, **as directed**.
   c. Combustibility Class: CC1.
   d. Flame-Spread Index: 25 **OR** 75 **OR** 200, **as directed**, or less.
   e. Provide safety glazing labeling.

D. Multiwalled Structured Polycarbonate Glazing
1. Multiwalled Structured Polycarbonate Sheet: Manufacturer's standard polycarbonate extruded shape with smooth, flat exterior surfaces and internal ribbing.
   a. Nominal Thickness: 5/16 inch (8 mm) **OR** 3/8 inch (10 mm) **OR** 5/8 inch (16 mm) **OR** 3/4 inch (20 mm) **OR** 1 inch (25 mm), **as directed**.
   b. Color: Transparent colorless **OR** As selected from manufacturer's full range, **as directed**.
   c. Combustibility Class: CC1 **OR** CC2, **as directed**.
   d. Flame-Spread Index: 25 **OR** 75 **OR** 200, **as directed**, or less.

E. Glazing Gaskets
1. Dense Compression Gaskets: Molded or extruded gaskets, EPDM, ASTM C 864 or silicone, ASTM C 1115; and of profile and hardness required to maintain watertight seal.
2. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned EPDM or silicone gaskets complying with ASTM C 509, Type II, black; and of profile and hardness required to maintain watertight seal.

F. Glazing Sealants

1. General:
   a. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they will contact, including plastic glazing products and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
   b. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
   c. VOC Content: For sealants used inside the weatherproofing system, not more than 250 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   d. Colors of Exposed Glazing Sealants: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
2. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.
   OR
   Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 50, Use NT.
   OR
   Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT.
   OR
   Glazing Sealant: Acid-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT.

G. Glazing Tapes
1. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
   a. AAMA 804.3 tape, where indicated.
   b. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
   c. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
2. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
   a. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
   b. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

H. Miscellaneous Glazing Materials
1. Compatibility: Provide products of material, size, and shape complying with requirements of manufacturers of plastic glazing and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
2. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
3. Setting Blocks: EPDM or silicone as required for compatibility with glazing sealant and plastic glazing, and of hardness recommended by plastic glazing manufacturer for application indicated.
4. Compressible Filler Rods: Closed cell of waterproof-jacketed rod stock of synthetic rubber or plastic foam, flexible and resilient, with 5- to 10-psi (35- to 70-kPa) compression strength for 25 percent deflection.

1.3 EXECUTION

A. Examination
1. Examine plastic glazing framing, with glazing Installer present, for compliance with the following:

a. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
b. Minimum required face or edge clearances.
c. Effective sealing between joints of plastic glazing framing members.

2. Proceed with glazing only after unsatisfactory conditions have been corrected.

B. Preparation

1. Clean glazing channels and other framing members immediately before glazing. Remove coatings not firmly bonded to substrates. Remove lacquer from metal surfaces where elastomeric sealants are indicated for use.

C. Glazing, General

1. Comply with combined written instructions of manufacturers of plastic glazing materials, sealants, gaskets, and other glazing materials unless more stringent requirements are indicated, including those in referenced glazing publication.
2. Glazing channel dimensions indicated on Drawings are designed to provide the necessary bite on plastic glazing, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust plastic glazing lites during installation to ensure that bite is equal on all sides.
3. Sand or scrape cut edges of plastic glazing to provide smooth edges, free of chips and hairline cracks.
4. Remove burrs and other projections from glazing channel surfaces.
5. Protect plastic glazing surfaces from abrasion and other damage during handling and installation, according to the following requirements:
   a. Retain plastic glazing manufacturer's protective covering or protect by other methods according to plastic glazing manufacturer's written instructions.
   b. Remove covering at border of each piece before glazing; remove remainder of covering immediately after installation where plastic glazing will be exposed to sunlight or where other conditions make later removal difficult.
   c. Remove damaged plastic glazing sheets from Project site and legally dispose of off-site. Damaged plastic glazing sheets are those containing imperfections that, when installed, result in weakened glazing and impaired performance and appearance.
6. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.
7. Install elastomeric setting blocks in sill channels, sized and located to comply with referenced glazing publication, unless otherwise instructed by plastic glazing manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
8. Provide edge blocking to comply with referenced glazing publication unless otherwise instructed by plastic glazing manufacturer.
9. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
10. Square cut wedge-shaped gaskets at corners and install gaskets as recommended in writing by gasket manufacturer to prevent corners from pulling away; seal corner and butt joints with sealant recommended by gasket manufacturer.

D. Tape Glazing

1. Install tapes continuously, but not in one continuous length. Do not stretch tapes to make them fit opening.
2. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.
3. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant recommended by tape manufacturer.
4. Do not remove release paper from tape until immediately before each lite is installed.
5. Apply heel bead of glazing sealant.

6. Center plastic glazing lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
7. Apply cap bead of glazing sealant over exposed edge of tape.

E. Gasket Glazing (Dry)
1. Fabricate compression gaskets in lengths recommended in writing by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
2. Insert soft compression gasket between plastic glazing and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
3. Center plastic glazing lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in plastic glazing. Seal gasket joints with sealant recommended by gasket manufacturer.
4. Install gaskets so they protrude past face of glazing stops.

F. Sealant Glazing (Wet)
1. Install continuous spacers between plastic glazing lites and glazing stops to maintain plastic glazing face clearances and to prevent sealant from extruding into glazing channel weep systems until sealants cure. Secure spacers in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
2. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to plastic glazing and channel surfaces.
3. Tool exposed surfaces of sealants to provide a substantial wash away from plastic glazing.

G. Protecting And Cleaning
1. Protect plastic glazing from contact with contaminating substances from construction operations. If, despite such protection, contaminating substances do come into contact with plastic glazing, remove immediately and wash plastic glazing according to plastic glazing manufacturer's written instructions.
2. Remove and replace plastic glazing that is broken, chipped, cracked, abraded, or damaged in other ways during construction period, including natural causes, accidents, and vandalism.
3. Wash plastic glazing on both faces before date scheduled for inspections intended to establish date of Substantial Completion in each area of Project. Wash plastic glazing according to plastic glazing manufacturer's written instructions.

END OF SECTION 08840

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Task	Specification	Specification Description
08850	08810	Glazing

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SECTION 08860 - SECURITY GLAZING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for security glazing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes glazing for the following products and applications and of the following types:
   a. Products and applications specified in other Sections where glazing requirements are specified by reference to this Section:
      1) Steel detention and Steel doors.
      2) Glazed entrances.
      3) Storefront framing.
      4) Interior borrowed lites.
      5) Glazed curtain walls.
      6) Sloped glazing.
      7) Security, Detention, Aluminum and Steel windows.
   b. Security Glazing Types:
      1) Monolithic polycarbonate.
      2) Laminated glass.
      3) Laminated polycarbonate.
      4) Glass-clad polycarbonate.
      5) Laminated glass and polycarbonate.
      6) Insulating security glazing.
      7) Air-gap security glazing.

C. Definitions
1. Glazing Manufacturers: Firms that produce primary glass, monolithic plastic glazing, or fabricated security glazing, as defined in referenced glazing publications.
2. Interspace: Space between lites of air-gap security glazing or insulating security glazing.

D. Performance Requirements
1. General:
   a. Installed security glazing shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing; or other defects in construction.
   b. Installed security glazing shall withstand security-related loads and forces without damage to the glazing beyond that allowed by referenced standards.
2. Delegated Design: Design security glazing, including comprehensive engineering analysis by a qualified professional engineer.
   a. Design Procedure for Glass: Design according to ASTM E 1300 **OR** ICC's 2003 International Building Code, **as directed**.
   b. Design Wind Pressures: As indicated on Drawings.
      OR
      Design Wind Pressures: Determine design wind pressures applicable to Project according to ASCE/SEI 7, based on heights above grade indicated on Drawings.
      1) Basic Wind Speed: 85 mph (38 m/s) **OR** 90 mph (40 m/s) **OR** 100 mph (44 m/s) **OR** 110 mph (49 m/s), **as directed**.
      2) Importance Factor.

3) Exposure Category: B **OR** C **OR** D, **as directed**.

c. Design Snow Loads: As indicated on Drawings **OR as directed**.

d. Vertical Glazing: For glass surfaces sloped 15 degrees or less from vertical, design glass to resist design wind pressure based on glass type factors for short-duration load.

e. Sloped Glazing: For glass surfaces sloped more than 15 degrees from vertical, design glass to resist each of the following combinations of loads:

1) Outward design wind pressure minus the weight of the glass. Base design on glass type factors for short-duration load.

2) Inward design wind pressure plus the weight of the glass plus half of the design snow load. Base design on glass type factors for short-duration load.

3) Half of the inward design wind pressure plus the weight of the glass plus the design snow load. Base design on glass type factors for long-duration load.

f. Probability of Breakage for Sloped Glazing: For glass surfaces sloped more than 15 degrees from vertical, design glass for a probability of breakage not greater than 0.001.

g. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch (25 mm), whichever is less.

3. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on glazing framing members and glazing components.

a. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

E. Preconstruction Testing

1. Preconstruction Adhesion and Compatibility Testing: Test each security glazing type, tape sealant, gasket, glazing accessory, and glazing-framing member for adhesion to and compatibility with elastomeric glazing sealants.

a. Testing will not be required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.

b. Use ASTM C 1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to security glazing, tape sealants, gaskets, and glazing channel substrates.

c. Test no fewer than eight Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.

d. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.

e. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including the use of specially formulated primers.

F. Submittals

1. Product Data: For each type of product indicated.

2. LEED Submittal:

a. Product Data for Credit EQ 4.1: For glazing sealants used inside of the weatherproofing system, including printed statement of VOC content.

3. Security Glazing Samples: For each type of security glazing; 12 inches (300 mm) square.

4. Glazing Accessory Samples: For gaskets, sealants and colored spacers, in 12-inch (300-mm) lengths. Install sealant Samples between two strips of material representative in color of the adjoining framing system, **as directed**.

5. Security Glazing Schedule: List security glazing types and thicknesses for each size opening and location. Use same designations indicated on Drawings. Indicate coordinated dimensions of security glazing and construction that receives security glazing, including clearances and glazing channel dimensions.

6. Delegated-Design Submittal: For security glazing indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

7. Qualification Data: For installers, manufacturers of insulating security glazing with sputter-coated, low-e coatings, glazing testing agency and sealant testing agency.

8. Product Certificates: For each type of product indicated, from manufacturer.
9. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of security glazing, glazing sealant and glazing gasket.
    a. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.
10. Preconstruction adhesion and compatibility test reports.
11. Warranties: Sample of special warranties.

G. Quality Assurance
1. Manufacturer Qualifications for Insulating Security Glazing Units with Sputter-Coated, Low-E Coatings: A qualified insulating glazing manufacturer who is approved and certified, **as directed**, by coated-glass manufacturer.
2. Installer Qualifications: A qualified installer who employs glazing installers for this Project who are certified under the National Glass Association Glazier Certification Program.
3. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
4. Source Limitations for Security Glazing: Obtain security glazing from single source from single manufacturer using the same type of lites, plies, interlayers, and spacers for each security glazing type indicated.
    a. Source Limitations for Tinted Glass: Obtain tinted glass from single source from single primary glass manufacturer for each tint color indicated.
5. Source Limitations for Glazing Sealants and Gaskets: Obtain from single source from single manufacturer for each product and installation method.
6. Glazing Publications: Comply with published recommendations of security glazing and glazing material manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
    a. GANA Publications: GANA's "Laminated Glazing Reference Manual" and GANA's "Glazing Manual."
    b. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR-A7, "Sloped Glazing Guidelines."
    c. IGMA Publication for Sloped Glazing: IGMA TB-3001, "Guidelines for Sloped Glazing."
    d. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
7. Plastic Glazing Labeling: Identify plastic sheets with appropriate markings of applicable testing and inspecting agency, indicating compliance with required fire-test-response characteristics.
8. Safety Glazing Labeling: Where safety glazing labeling is indicated, permanently mark glazing with certification label of the SGCC **OR** another certification agency acceptable to authorities having jurisdiction **OR** manufacturer, **as directed**. Label shall indicate manufacturer's name, type of glazing, thickness, and safety glazing standard with which glazing complies.
9. Insulating Glazing Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.
10. Preinstallation Conference: Conduct conference at Project site.

H. Delivery, Storage, And Handling
1. Protect security glazing and glazing materials according to manufacturer's written instructions. Prevent damage from condensation, temperature changes, direct exposure to sun, or other causes.
2. Comply with insulating security glazing and with air-gap security glazing manufacturers' written recommendations for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

I. Project Conditions
1. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

a. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or below 40 deg F (4.4 deg C).

J. Coordination
1. Coordinate dimensions, including thickness, of security glazing with dimensions of construction that receives security glazing.

K. Warranty
1. Manufacturer's Special Warranty for Coated Glass: Manufacturer's standard form in which coated-glass manufacturer agrees to replace coated glass that deteriorates within specified warranty period. Deterioration is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
   a. Warranty Period: 10 years from date of Substantial Completion.
2. Manufacturer's Special Warranty on Laminated Glass: Manufacturer's standard form in which laminated-glass manufacturer agrees to replace laminated glass that deteriorates within specified warranty period. Deterioration is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
   a. Warranty Period: Five **OR** 10, **as directed**, years from date of Substantial Completion.
3. Manufacturer's Special Warranty for Polycarbonate Sheet: Manufacturer's standard form in which glazing manufacturer agrees to replace polycarbonate sheet that deteriorates within specified warranty period. Deterioration is defined as defects developed from normal use that are not attributed to maintaining and cleaning polycarbonate sheet contrary to manufacturer's written instructions. Defects include yellowing and loss of light transmission.
   a. Warranty Period: 10 years from date of Substantial Completion.
4. Manufacturer's Special Warranty for Laminated Polycarbonate: Manufacturer's standard form in which laminated polycarbonate manufacturer agrees to replace laminated polycarbonate that deteriorates within specified warranty period. Deterioration is defined as defects developed from normal use that are not attributed to maintaining and cleaning laminated polycarbonate contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glazing, blemishes exceeding those allowed by referenced standard, yellowing, and loss of light transmission.
   a. Warranty Period: Five **OR** 10, **as directed**, years from date of Substantial Completion.
5. Manufacturer's Special Warranty for Glass-Clad Polycarbonate: Manufacturer's standard form in which glass-clad polycarbonate manufacturer agrees to replace glass-clad polycarbonate that deteriorates within specified warranty period. Deterioration is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning glass-clad polycarbonate contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glazing, blemishes exceeding those allowed by referenced glass-clad polycarbonate standard, yellowing, and loss of light transmission.
   a. Warranty Period: Five **OR** 10, **as directed**, years from date of Substantial Completion.
6. Manufacturer's Special Warranty for Laminated Glass and Polycarbonate: Manufacturer's standard form in which laminated-glass-and-polycarbonate manufacturer agrees to replace laminated glass and polycarbonate that deteriorates within specified warranty period. Deterioration is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass and polycarbonate contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glazing, blemishes exceeding those allowed by referenced glass-clad polycarbonate standard, yellowing, and loss of light transmission.
   a. Warranty Period: Five **OR** 10, **as directed**, years from date of Substantial Completion.

7. Manufacturer's Special Warranty on Insulating Security Glazing: Manufacturer's standard form in which insulating security glazing manufacturer agrees to replace insulating security glazing that deteriorates within specified warranty period. Deterioration is defined as defects in individual lites developed from normal use or failure of hermetic seal under normal use. Deterioration does not include defects in individual lites or failure of hermetic seal that is attributed to glass breakage or to maintaining and cleaning insulating security glazing contrary to manufacturer's written instructions.
   a. Defects in coated glass lites include peeling, cracking, and other indications of deterioration in coating.
   b. Defects in laminated-glass lites include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
   c. Defects in glass-clad polycarbonate lites include edge separation, delamination materially obstructing vision through glazing, blemishes exceeding those allowed by referenced glass-clad polycarbonate standard, yellowing, and loss of light transmission.
   d. Evidence of hermetic seal failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glazing.
   e. Warranty Period: Five **OR** 10, **as directed**, years from date of Substantial Completion.

1.2 PRODUCTS

A. Security Glazing, General
   1. Thickness: Where thickness is indicated, it is a minimum. Provide security glazing in thicknesses as needed to comply with requirements indicated.
   2. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.
   3. Fire-Test-Response Characteristics of Plastic Sheets: As determined by testing plastic sheets identical to those used in security glazing products by a qualified testing agency acceptable to authorities having jurisdiction.
      a. Self-ignition temperature of 650 deg F (343 deg C) or more when tested per ASTM D 1929 on plastic sheets in thicknesses indicated for the Work.
      b. Smoke-developed index of 450 or less when tested according to ASTM E 84, or smoke density of 75 or less when tested per ASTM D 2843 on plastic sheets in thicknesses indicated for the Work.
      c. Burning extent of 1 inch (25 mm) **OR** rate of 2.5 in./min. (1.06 mm/s), **as directed**, or less when tested per ASTM D 635 at a nominal thickness of 0.060 inch (1.52 mm) or thickness indicated for the Work.
   4. Windborne-Debris-Impact Resistance: Provide exterior security glazing that passes basic **OR** enhanced, **as directed**,-protection testing requirements in ASTM E 1996 for Wind Zone 1 **OR** Wind Zone 2 **OR** Wind Zone 3 **OR** Wind Zone 4, **as directed**, when tested according to ASTM E 1886. Test specimens shall be no smaller in width and length than security glazing indicated for use on the Project and shall be installed in same manner as indicated for use on the Project.
      a. Large-Missile Test: For security glazing located within 30 feet (9.1 m) of grade.
      b. Small-Missile Test: For security glazing located more than 30 feet (9.1 m) above grade.
         OR
         Large-Missile Test: For all security glazing, regardless of height above grade.
   5. Thermal and Optical Performance Properties: Provide security glazing with performance properties specified, as indicated in manufacturer's published test data, based on products of construction indicated and on procedures indicated below:
      a. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F (W/sq. m x K).
      b. Solar-Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
      c. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

B. Glass Products
1. Float Glass: ASTM C 1036, Type I, Quality-Q3, Class I (clear) unless otherwise indicated.
2. Heat-Treated Float Glass: ASTM C 1048; Type I; Quality-Q3; Class I (clear) unless otherwise indicated; of kind and condition indicated.
   a. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
   b. For heat-strengthened float glass, comply with requirements for Kind HS.
   c. For fully tempered float glass, comply with requirements for Kind FT.
   d. For uncoated glass, comply with requirements for Condition A.
   e. For coated vision glass, comply with requirements for Condition C (other coated glass).
3. Chemically Strengthened Glass: Annealed float glass chemically strengthened to comply with ASTM C 1422, Surface Compression Level 1 **OR** Level 2 **OR** Level 3 **OR** Level 4 **OR** Level 5, **as directed**, and Case Depth Level A **OR** Level B **OR** Level C **OR** Level D **OR** Level E **OR** Level F, **as directed**.
4. Reflective-Coated Vision Glass: ASTM C 1376, Kind CV (coated vision glass), coated by pyrolytic process **OR** vacuum deposition (sputter-coating) process, **as directed**, and complying with other requirements specified.

C. Laminated Glass
1. Laminated Glass: ASTM C 1172, and complying with testing requirements in 16 CFR 1201 for Category II materials, and with other requirements specified. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
   a. Construction: Laminate glass with polyvinyl butyral interlayer or cast-in-place and cured-transparent-resin interlayer to comply with interlayer manufacturer's written recommendations.
   b. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
   c. Interlayer Color: Clear unless otherwise indicated.
2. Windborne-Debris-Impact-Resistant Laminated Glass: ASTM C 1172, and complying with testing requirements in 16 CFR 1201 for Category II materials, with "Windborne-Debris-Impact Resistance" Paragraph, and with other requirements specified.
   a. Construction: Laminate glass with one of the following to comply with interlayer manufacturer's written recommendations:
      1) Polyvinyl butyral interlayer.
      2) Polyvinyl butyral interlayers reinforced with polyethylene terephthalate film.
      3) Ionoplast interlayer.
      4) Cast-in-place and cured-transparent-resin interlayer.
      5) Cast-in-place and cured-transparent-resin interlayer reinforced with polyethylene terephthalate film.
   b. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
   c. Interlayer Color: Clear unless otherwise indicated.

D. Polycarbonate Security Glazing
1. Polycarbonate Sheet: ASTM C 1349, Appendix X1, Type II, coated, mar-resistant, UV-stabilized polycarbonate with coating on exposed surfaces and Type I, standard, UV-stabilized polycarbonate where no surfaces are exposed.
2. Laminated Polycarbonate: Polycarbonate sheets laminated with clear urethane interlayer that complies with ASTM C 1349, Appendix X2, and has a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation. Provide laminated units that comply with requirements of ASTM C 1349 for maximum allowable laminating process blemishes and haze.
3. Glass-Clad Polycarbonate: ASTM C 1349, and other requirements specified.

a. Provide glass-clad polycarbonate that complies with testing requirements in 16 CFR 1201 for Category II materials, and with other requirements specified.

4. Laminated Glass and Polycarbonate: ASTM C 1349, and other requirements specified.
   a. Provide laminated glass and polycarbonate that complies with testing requirements in 16 CFR 1201 for Category II materials, and with other requirements specified.

E. Spall-Resistant Film
1. Spall-Resistant Film: Composite of clear polyvinyl butyral film and clear abrasion-resistant polyester film.
2. Laminating Process: Laminate spall-resistant film to glazing assemblies in factory to produce laminated lites free of foreign substances, air, and glass pockets.

F. Insulating Security Glazing
1. Insulating Security Glazing: Factory-assembled units consisting of sealed lites separated by a dehydrated interspace, qualified according to ASTM E 2190, and complying with other requirements specified.
   a. Sealing System: Dual seal, with manufacturer's standard **OR** polyisobutylene and polysulfide **OR** polyisobutylene and silicone **OR** polyisobutylene and hot-melt butyl **OR** polyisobutylene and polyurethane, **as directed**, primary and secondary.
   b. Spacer: Manufacturer's standard spacer material and construction **OR** Aluminum with mill or clear anodic finish **OR** Aluminum with black, color anodic finish **OR** Aluminum with bronze, color anodic finish **OR** Aluminum with powdered metal paint finish in color selected **OR** Galvanized steel **OR** Stainless steel **OR** Polypropylene-covered stainless steel in color selected **OR** Thermally broken aluminum **OR** Nonmetallic laminate **OR** Nonmetallic tube, **as directed**.
   c. Desiccant: Molecular sieve or silica gel, or blend of both.

G. Air-Gap Security Glazing
1. Air-Gap Security Glazing: Factory-assembled units consisting of sealed lites separated by a dehydrated interspace and complying with other requirements specified.
   a. Sealing System: Dual seal, with manufacturer's standard primary and secondary sealants.
   b. Spacer Specifications: Manufacturer's standard rigid, **as directed**, spacer material and construction.

H. Glazing Gaskets
1. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from one of the following:
   a. Neoprene complying with ASTM C 864.
   b. EPDM complying with ASTM C 864.
   c. Silicone complying with ASTM C 1115.
   d. Thermoplastic polyolefin rubber complying with ASTM C 1115.
2. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned neoprene, EPDM, silicone or thermoplastic polyolefin rubber gaskets complying with ASTM C 509, Type II, black; of profile and hardness required to maintain watertight seal.
   a. Application: Use where soft compression gaskets will be compressed by inserting dense compression gaskets on opposite side of glazing or pressure applied by means of pressure-glazing stops on opposite side of glazing.

I. Glazing Sealants
1. General:
   a. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they will contact, including security glazing, seals of insulating security glazing and air-gap security glazing, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.

b. Suitability: Comply with sealant and security glazing manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
c. VOC Content: For sealants used inside of the weatherproofing system, not more than 250 g/L when calculated according to 40 CFR 59, Subpart D.
d. Colors of Exposed Glazing Sealants: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

2. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.
3. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 50, Use NT.
4. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT.
5. Glazing Sealant: Acid-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT.

J. Glazing Tapes
1. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and security glazing manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
a. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
b. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
2. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
a. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
b. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

K. Miscellaneous Glazing Materials
1. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of security glazing and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
2. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
3. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
4. Spacers: Elastomeric blocks or continuous extrusions of hardness required by security glazing manufacturer to maintain security glazing lites in place for installation indicated.
5. Edge Blocks: Elastomeric material of hardness needed to limit security glazing lateral movement (side walking).
6. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

L. Fabrication Of Security Glazing
1. Fabricate security glazing in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

M. Laminated-Glass Security Glazing Types
1. Security Glazing: Clear laminated glass **OR** Tinted laminated glass **OR** Clear reflective-coated laminated glass **OR** Tinted reflective-coated laminated glass, **as directed**.

a. Forced-Entry Resistance: Class I **OR** Class II **OR** Class III **OR** Class IV **OR** Class V, **as directed**, per ASTM F 1233.
OR
Forced-Entry Resistance: Level I **OR** Level II **OR** Level III **OR** Level IV **OR** Level V, **as directed**, per HPW-TP-0500.03.

b. Ballistic Resistance: Class/Level HG1 **OR** Class/Level HG2 **OR** Class/Level HG3 **OR** Class/Level HG4 **OR** Class/Level SMG **OR** Class/Level R1 **OR** Class/Level R2 **OR** Class/Level R3 **OR** Class/Level R4-AP **OR** Class/Level SH1 **OR** Class/Level SH2, **as directed**, per ASTM F 1233.
OR
Ballistic Resistance: Level 1 **OR** Level 2 **OR** Level 3 **OR** Level 4 **OR** Level 5 **OR** Level 6 **OR** Level 7 **OR** Level 8 **OR** Level 1-SG **OR** Level 2-SG **OR** Level 3-SG **OR** Level 4-SG **OR** Level 5-SG **OR** Level 6-SG **OR** Level 7-SG **OR** Level 8-SG, **as directed**, per UL 752.

c. Blast Resistance:
   1) Hazard Rating: No hazard **OR** Minimal hazard **OR** Very low hazard **OR** Low hazard **OR** High hazard, **as directed**, per ASTM F 1642.
   OR
   Performance Condition: 1 **OR** 2 **OR** 3a **OR** 3b **OR** 4 **OR** 5, **as directed**, per GSA-TS01.
   2) Peak Pressure: as directed by the Owner.
   3) Positive Phase Impulse: as directed by the Owner.

d. Number of Plies: Two **OR** Three, **as directed**.

e. Overall Unit Thickness: as directed by the Owner.

f. Outer Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, float glass **OR** heat-strengthened float glass **OR** fully tempered float glass **OR** chemically strengthened float glass, **as directed**.

g. Core Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, float glass **OR** heat-strengthened float glass **OR** fully tempered float glass **OR** chemically strengthened float glass, **as directed**.

h. Inner Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, float glass **OR** heat-strengthened float glass **OR** fully tempered float glass **OR** chemically strengthened float glass, **as directed**.

i. Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.3 mm)\, **as directed**.

j. Glass Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray **as directed**.

k. Tinted Glass Location: Outer ply.

l. Coating Color: Gold **OR** Pewter **OR** Silver, **as directed**.

m. Coating Location: Second **OR** Third **OR** Fifth, **as directed**, surface.

n. Overall Visible Light Transmittance: as directed by the Owner.

o. Outdoor Visible Reflectance: as directed by the Owner. Winter Nighttime U-Factor: as directed by the Owner.

p. Summer Daytime U-Factor: as directed by the Owner.

q. Solar Heat-Gain Coefficient: as directed by the Owner.

r. Provide safety glazing labeling.

2. Security Glazing: Tinted reflective-coated, **as directed**, laminated glass with clear glass and tinted interlayer.

   a. Forced-Entry Resistance: Class I **OR** Class II **OR** Class III **OR** Class IV **OR** Class V, **as directed**, per ASTM F 1233.
   OR
   Forced-Entry Resistance: Level I **OR** Level II **OR** Level III **OR** Level IV **OR** Level V, **as directed**, per HPW-TP-0500.03.

   b. Ballistic Resistance: Class/Level HG1 **OR** Class/Level HG2 **OR** Class/Level HG3 **OR** Class/Level HG4 **OR** Class/Level SMG **OR** Class/Level R1 **OR** Class/Level R2 **OR** Class/Level R3 **OR** Class/Level R4-AP **OR** Class/Level SH1 **OR** Class/Level SH2, **as directed**, per ASTM F 1233.
   OR
   Ballistic Resistance: Level 1 **OR** Level 2 **OR** Level 3 **OR** Level 4 **OR** Level 5 **OR** Level 6 **OR** Level 7 **OR** Level 8 **OR** Level 1-SG **OR** Level 2-SG **OR** Level 3-SG **OR** Level 4-SG **OR** Level 5-SG **OR** Level 6-SG **OR** Level 7-SG **OR** Level 8-SG, **as directed**, per UL 752.

c. Blast Resistance:
   1) Hazard Rating: No hazard **OR** Minimal hazard **OR** Very low hazard **OR** Low hazard **OR** High hazard, **as directed**, per ASTM F 1642.
      OR
      Performance Condition: 1 **OR** 2 **OR** 3a **OR** 3b **OR** 4 **OR** 5, **as directed**, per GSA-TS01.
   2) Peak Pressure: as directed by the Owner.
   3) Positive Phase Impulse: as directed by the Owner.

d. Number of Plies: Two **OR** Three, **as directed**.

e. Overall Unit Thickness: as directed by the Owner.

f. Outer Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, float glass **OR** heat-strengthened float glass **OR** fully tempered float glass **OR** chemically strengthened float glass, **as directed**.

g. Core Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, float glass **OR** heat-strengthened float glass **OR** fully tempered float glass **OR** chemically strengthened float glass, **as directed**.

h. Inner Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, float glass **OR** heat-strengthened float glass **OR** fully tempered float glass **OR** chemically strengthened float glass, **as directed**.

i. Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.3 mm), **as directed**.

j. Interlayer Color: Clear **OR** Blue-green **OR** Bronze light **OR** Gray, **as directed**.

k. Coating Color: Gold **OR** Pewter **OR** Silver, **as directed**.

l. Coating Location: Second **OR** Third **OR** Fifth, **as directed**, surface.

m. Overall Visible Light Transmittance: as directed by the Owner.

n. Outdoor Visible Reflectance: as directed by the Owner. Winter Nighttime U-Factor: as directed by the Owner.

o. Summer Daytime U-Factor: as directed by the Owner.

p. Solar Heat-Gain Coefficient: as directed by the Owner. Provide safety glazing labeling.

N. Monolithic Polycarbonate Security Glazing Types
   1. Security Glazing: Monolithic polycarbonate with mar-resistant coating on both surfaces.
      a. Detention Security Grade: Grade 4 per ASTM F 1915 cold-temperature impact test **OR** warm-temperature impact test **OR** torch and small blunt impactor test, **as directed**.
         OR
         Thickness: 3/8 inch (9.25 mm) **OR** 1/2 inch (12.7 mm), **as directed**.

O. Laminated-Polycarbonate Security Glazing Types
   1. Security Glazing: Laminated polycarbonate.
      a. Detention Security Grade: Grade 1 **OR** Grade 2 **OR** Grade 3 **OR** Grade 4, **as directed**, per ASTM F 1915 cold-temperature impact test **OR** warm-temperature impact test **OR** torch and small blunt impactor test, **as directed**.
      b. Forced-Entry Resistance: Class I **OR** Class II **OR** Class III **OR** Class IV **OR** Class V, **as directed**, per ASTM F 1233.
         OR
         Forced-Entry Resistance: Level I **OR** Level II **OR** Level III **OR** Level IV **OR** Level V, **as directed**, per HPW-TP-0500.03.
      c. Blast Resistance:
         1) Hazard Rating: No hazard **OR** Minimal hazard **OR** Very low hazard **OR** Low hazard **OR** High hazard, **as directed**, per ASTM F 1642.
            OR
            Performance Condition: 1 **OR** 2 **OR** 3a **OR** 3b **OR** 4 **OR** 5, **as directed**, per GSA-TS01.
         2) Peak Pressure: as directed by the Owner.
         3) Positive Phase Impulse: as directed by the Owner.
      d. Number of Plies: Two **OR** Three **OR** Four, **as directed**.
      e. Overall Unit Thickness: as directed by the Owner.

f. Outer and Inner Plies: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
g. Core Ply **OR** Core Plies, **as directed**: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
h. Interlayer Thicknesses: 0.025 inch (0.635 mm).

P. Glass-Clad Polycarbonate Security Glazing Types
1. Security Glazing: Clear symmetrical glass-clad polycarbonate **OR** Tinted symmetrical glass-clad polycarbonate **OR** Clear reflective-coated symmetrical glass-clad polycarbonate **OR** Tinted reflective-coated symmetrical glass-clad polycarbonate, **as directed**.
a. Detention Security Grade: Grade 1 **OR** Grade 2 **OR** Grade 3 **OR** Grade 4, **as directed**, per ASTM F 1915 cold-temperature impact test **OR** warm-temperature impact test **OR** torch and small blunt impactor test, **as directed**.
b. Forced-Entry Resistance: Class I **OR** Class II **OR** Class III **OR** Class IV **OR** Class V, **as directed**, per ASTM F 1233.
OR
Forced-Entry Resistance: Level I **OR** Level II **OR** Level III **OR** Level IV **OR** Level V, **as directed**, per HPW-TP-0500.03.
c. Ballistic Resistance: Class/Level HG1 **OR** Class/Level HG2 **OR** Class/Level HG3 **OR** Class/Level HG4 **OR** Class/Level SMG **OR** Class/Level R1 **OR** Class/Level R2 **OR** Class/Level R3 **OR** Class/Level R4-AP **OR** Class/Level SH1 **OR** Class/Level SH2, **as directed**, per ASTM F 1233.
OR
Ballistic Resistance: Level 1 **OR** Level 2 **OR** Level 3 **OR** Level 4 **OR** Level 5 **OR** Level 6 **OR** Level 7 **OR** Level 8 **OR** Level 1-SG **OR** Level 2-SG **OR** Level 3-SG **OR** Level 4-SG **OR** Level 5-SG **OR** Level 6-SG **OR** Level 7-SG **OR** Level 8-SG, **as directed**, per UL 752.
d. Blast Resistance:
1) Hazard Rating: No hazard **OR** Minimal hazard **OR** Very low hazard **OR** Low hazard **OR** High hazard, **as directed**, per ASTM F 1642.
OR
Performance Condition: 1 **OR** 2 **OR** 3a **OR** 3b **OR** 4 **OR** 5, **as directed**, per GSA-TS01.
2) Peak Pressure: as directed by the Owner.
3) Positive Phase Impulse: as directed by the Owner.
e. Overall Unit Thickness: as directed by the Owner. Outer Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, heat-strengthened **OR** chemically strengthened, **as directed**, float glass.
f. Single Core: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
OR
Multiple Core:
1) Outer Core Ply: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
2) Single Inner Core Ply **OR** Double Inner Core Plies, **as directed**: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
g. Inner Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, heat-strengthened **OR** chemically strengthened, **as directed**, float glass.
h. Interlayer Thickness: 0.025 inch (0.635 mm) **OR** 0.050 inch (0.127 mm), **as directed**.
i. Glass Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.
j. Tinted Glass Location: Outer ply.
k. Coating Color: Gold **OR** Pewter **OR** Silver, **as directed**.
l. Coating Location: Second **OR** Third **OR** Fifth, **as directed**, surface.
m. Overall Visible Light Transmittance: as directed by the Owner.
n. Outdoor Visible Reflectance: as directed by the Owner.
o. Winter Nighttime U-Factor: as directed by the Owner.
p. Summer Daytime U-Factor: as directed by the Owner.

q. Solar Heat-Gain Coefficient: as directed by the Owner.
r. Provide safety glazing labeling.

Q. Laminated-Glass-And-Polycarbonate Security Glazing Types
1. Security Glazing: Nonsymmetrical clear **OR** tinted **OR** reflective-coated, **as directed**, laminated glass and polycarbonate with glass plies on the attack or threat side and polycarbonate plies on the witness side.
a. Detention Security Grade: Grade 1 **OR** Grade 2 **OR** Grade 3 **OR** Grade 4, **as directed**, per ASTM F 1915 cold-temperature impact test **OR** warm-temperature impact test **OR** torch and small blunt impactor test, **as directed**.
b. Forced-Entry Resistance: Class I **OR** Class II **OR** Class III **OR** Class IV **OR** Class V, **as directed**, per ASTM F 1233.
OR
Forced-Entry Resistance: Level I **OR** Level II **OR** Level III **OR** Level IV **OR** Level V, **as directed**, per HPW-TP-0500.03.
c. Ballistic Resistance: Class/Level HG1 **OR** Class/Level HG2 **OR** Class/Level HG3 **OR** Class/Level HG4 **OR** Class/Level SMG **OR** Class/Level R1 **OR** Class/Level R2 **OR** Class/Level R3 **OR** Class/Level R4-AP **OR** Class/Level SH1 **OR** Class/Level SH2, **as directed**, per ASTM F 1233.
OR
Ballistic Resistance: Level 1 **OR** Level 2 **OR** Level 3 **OR** Level 4 **OR** Level 5 **OR** Level 6 **OR** Level 7 **OR** Level 8 **OR** Level 1-SG **OR** Level 2-SG **OR** Level 3-SG **OR** Level 4-SG **OR** Level 5-SG **OR** Level 6-SG **OR** Level 7-SG **OR** Level 8-SG, **a directed**, per UL 752.
d. Blast Resistance:
1) Hazard Rating: No hazard **OR** Minimal hazard **OR** Very low hazard **OR** Low hazard **OR** High hazard, **as directed**, per ASTM F 1642.
OR
Performance Condition: 1 **OR** 2 **OR** 3a **OR** 3b **OR** 4 **OR** 5, **as directed**, per GSA-TS01.
2) Peak Pressure: as directed by the Owner.
3) Positive Phase Impulse: as directed by the Owner.
e. Overall Unit Thickness: as directed by the Owner.
f. Makeup:
1) Outer Glass Ply: 3-mm heat-strengthened float glass.
2) Interlayer Thickness: 0.025 inch (0.635 mm) **OR** 0.050 inch (0.127 mm), **as directed**.
3) First Inner Glass Ply: 12-mm, **as directed**, float glass.
4) Interlayer Thickness: 0.025 inch (0.635 mm) **OR** 0.050 inch (0.127 mm), **as directed**.
5) Second Inner Glass Ply: 10-mm, **as directed**, float glass.
6) Interlayer Thickness: 0.025 inch (0.635 mm) **OR** 0.050 inch (0.127 mm), **as directed**.
7) Inner Polycarbonate Ply: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, Type I (standard, UV-stabilized) polycarbonate.
8) Interlayer Thickness: 0.025 inch (0.635 mm) **OR** 0.050 inch (0.127 mm), **as directed**.
9) Outer Polycarbonate Ply: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, Type II (coated, mar-resistant, UV-stabilized) polycarbonate.
g. Glass Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.
h. Tinted Glass Location: Outer glass ply.
i. Coating Color: Gold **OR** Pewter **OR** Silver, **as directed**.
j. Coating Location: Second **OR** Third **OR** Fifth, **as directed**, surface.
k. Overall Visible Light Transmittance: as directed by the Owner.
l. Outdoor Visible Reflectance: as directed by the Owner.

m. Winter Nighttime U-Factor: as directed by the Owner.
n. Summer Daytime U-Factor: as directed by the Owner.
o. Solar Heat-Gain Coefficient: as directed by the Owner.
p. Provide safety glazing labeling.

R. Insulating Security Glazing Types
1. Security Glazing: Clear insulating security glazing **OR** Tinted insulating security glazing **OR** Reflective-coated, clear insulating security glazing **OR** Reflective-coated, tinted insulating security glazing, **as directed**. Outdoor lite is monolithic glass and indoor lite is glass-clad polycarbonate.
a. Detention Security Grade: Grade 1 **OR** Grade 2 **OR** Grade 3 **OR** Grade 4, **as directed**, per ASTM F 1915 cold-temperature impact test **OR** warm-temperature impact test **OR** torch and small blunt impactor test, **as directed**.
b. Overall Unit Thickness: as directed by the Owner.
c. Outdoor Lite: Float glass **OR** Heat-strengthened float glass **OR** Fully tempered float glass, **as directed**.
d. Indoor Lite: Glass-clad polycarbonate.
1) Outer Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, heat-strengthened **OR** chemically strengthened **OR** fully tempered, **as directed**, float glass.
2) Single Core: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
OR
Multiple Core:
a) Outer Core Ply: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
b) Single Inner Core Ply **OR** Double Inner Core Plies, **as directed**: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
3) Inner Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, heat-strengthened **OR** chemically strengthened **OR** fully tempered, **as directed**, float glass.
e. Interspace Content: Air **OR** Argon, **as directed**.
f. Interspace Dimension: as directed by the Owner.
g. Glass Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.
h. Tinted Glass Location: Outdoor lite.
i. Coating Color: Gold **OR** Pewter **OR** Silver, **as directed**.
j. Coating Location: Second **OR** Third **OR** Fifth, **as directed**, surface.
k. Overall Visible Light Transmittance: as directed by the Owner.
l. Outdoor Visible Reflectance: as directed by the Owner.
m. Winter Nighttime U-Factor: as directed by the Owner.
n. Summer Daytime U-Factor: as directed by the Owner.
o. Solar Heat-Gain Coefficient: as directed by the Owner.
p. Provide safety glazing labeling.
2. Security Glazing: Low-e-coated, clear insulating security glazing **OR** Low-e-coated, tinted insulating security glazing, **as directed**. Outdoor lite is monolithic glass and indoor lite is glass-clad polycarbonate.
a. Detention Security Grade: Grade 1 **OR** Grade 2 **OR** Grade 3 **OR** Grade 4, **as directed**, per ASTM F 1915 cold-temperature impact test **OR** warm-temperature impact test **OR** torch and small blunt impactor test, **as directed**.
b. Overall Unit Thickness: as directed by the Owner.
c. Outdoor Lite: Float glass **OR** Heat-strengthened float glass **OR** Fully tempered float glass, **as directed**.
d. Indoor Lite: Glass-clad polycarbonate.
1) Outer Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, heat-strengthened **OR** chemically strengthened **OR** fully tempered, **as directed**, float glass.
2) Single Core: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
OR

Multiple Core:

a) Outer Core Ply: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.

b) Single Inner Core Ply **OR** Double Inner Core Plies, **as directed**: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.

3) Inner Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, heat-strengthened **OR** chemically strengthened **OR** fully tempered, **as directed**, float glass.

e. Interspace Content: Air **OR** Argon, **as directed**.

f. Interspace Dimension: as directed by the Owner.

g. Glass Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.

h. Tinted Glass Location: Outer lite.

i. Low-E Coating: Pyrolytic on second surface **OR** Pyrolytic on third surface **OR** Sputtered on second surface **OR** Sputtered on third surface, **as directed**.

j. Overall Visible Light Transmittance: as directed by the Owner.

k. Winter Nighttime U-Factor: as directed by the Owner.

l. Summer Daytime U-Factor: as directed by the Owner.

m. Solar Heat-Gain Coefficient: as directed by the Owner..

n. Provide safety glazing labeling.

3. Security Glazing: Clear insulating security glazing **OR** Tinted insulating security glazing **OR** Reflective-coated, clear insulating security glazing **OR** Reflective-coated, tinted insulating security glazing, **as directed**. Outdoor lite is laminated glass and indoor lite is glass-clad polycarbonate with spall-resistant film on inside face.

a. Detention Security Grade: Grade 1 **OR** Grade 2 **OR** Grade 3 **OR** Grade 4, **as directed**, per ASTM F 1915 cold-temperature impact test **OR** warm-temperature impact test **OR** torch and small blunt impactor test, **as directed**.

b. Forced-Entry Resistance: Class I **OR** Class II **OR** Class III **OR** Class IV **OR** Class V, **as directed**, per ASTM F 1233.

OR

Forced-Entry Resistance: Level I **OR** Level II **OR** Level III **OR** Level IV **OR** Level V, **as directed**, per HPW-TP-0500.03.

c. Ballistic Resistance: Class/Level HG1 **OR** Class/Level HG2 **OR** Class/Level HG3 **OR** Class/Level HG4 **OR** Class/Level SMG **OR** Class/Level R1 **OR** Class/Level R2 **OR** Class/Level R3 **OR** Class/Level R4-AP **OR** Class/Level SH1 **OR** Class/Level SH2, **as directed**, per ASTM F 1233.

OR

Ballistic Resistance: Level 1 **OR** Level 2 **OR** Level 3 **OR** Level 4 **OR** Level 5 **OR** Level 6 **OR** Level 7 **OR** Level 8 **OR** Level 1-SG **OR** Level 2-SG **OR** Level 3-SG **OR** Level 4-SG **OR** Level 5-SG **OR** Level 6-SG **OR** Level 7-SG **OR** Level 8-SG, **as directed**, per UL 752.

d. Blast Resistance:

1) Hazard Rating: No hazard **OR** Minimal hazard **OR** Very low hazard **OR** Low hazard **OR** High hazard, **as directed**, per ASTM F 1642.

OR

Performance Condition: 1 **OR** 2 **OR** 3a **OR** 3b **OR** 4 **OR** 5, **as directed**, per GSA-TS01.

2) Peak Pressure: as directed by the Owner.

3) Positive Phase Impulse: as directed by the Owner.

e. Overall Unit Thickness: as directed by the Owner.

f. Outdoor Lite: Laminated glass with two plies of heat-strengthened float glass **OR** three plies of heat-strengthened float glass **OR** two outer plies of heat-strengthened float glass and two inner plies of annealed float glass, **as directed**.

1) Outer Ply Thickness: 3 mm **OR** 5 mm **OR** 6 mm, **as directed**.

2) Core Ply Thickness: 3 mm **OR** 5 mm **OR** 6 mm, **as directed**.

3) Inner Ply Thickness: 3 mm **OR** 5 mm **OR** 6 mm, **as directed**.

4) Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.3 mm), **as directed**.

g. Indoor Lite: Glass-clad polycarbonate faced with a 0.037-inch- (0.94-mm-) thick, spall-resistant polyester film laminated to indoor face.
   1) Outer Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, heat-strengthened **OR** chemically strengthened, **as directed**, float glass.
   2) Single Core: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
      OR
      Multiple Core:
      a) Outer Core Ply: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
      b) Single Inner Core Ply **OR** Double Inner Core Plies, **as directed**: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
   3) Inner Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, heat-strengthened **OR** chemically strengthened, **as directed**, float glass.

h. Interspace Content: Air **OR** Argon, **as directed**.

i. Interspace Dimension: as directed by the Owner.

j. Glass Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.

k. Tinted Glass Location: Outer **OR** Inner, **as directed**, ply of outdoor lite.

l. Coating Color: Gold **OR** Pewter **OR** Silver, **as directed**.

m. Coating Location: Second **OR** Third **OR** Fifth, **as directed**, surface.

n. Overall Visible Light Transmittance: as directed by the Owner.

o. Outdoor Visible Reflectance: as directed by the Owner.

p. Winter Nighttime U-Factor: as directed by the Owner.

q. Summer Daytime U-Factor: as directed by the Owner.

r. Solar Heat-Gain Coefficient: as directed by the Owner.

s. Provide safety glazing labeling.

4. Security Glazing: Low-e-coated, clear insulating security glazing **OR** Low-e-coated, tinted insulating security glazing, **as directed**. Outdoor lite is laminated glass and indoor lite is glass-clad polycarbonate with spall-resistant film on inside face.

   a. Detention Security Grade: Grade 1 **OR** Grade 2 **OR** Grade 3 **OR** Grade 4, **as directed**, per ASTM F 1915 cold-temperature impact test **OR** warm-temperature impact test **OR** torch and small blunt impactor test, **as directed**.

   b. Forced-Entry Resistance: Class I **OR** Class II **OR** Class III **OR** Class IV **OR** Class V, **as directed**, per ASTM F 1233.
      OR
      Forced-Entry Resistance: Level I **OR** Level II **OR** Level III **OR** Level IV **OR** Level V, **as directed**, per HPW-TP-0500.03.

   c. Ballistic Resistance: Class/Level HG1 **OR** Class/Level HG2 **OR** Class/Level HG3 **OR** Class/Level HG4 **OR** Class/Level SMG **OR** Class/Level R1 **OR** Class/Level R2 **OR** Class/Level R3 **OR** Class/Level R4-AP **OR** Class/Level SH1 **OR** Class/Level SH2, **as directed**, per ASTM F 1233.
      OR
      Ballistic Resistance: Level 1 **OR** Level 2 **OR** Level 3 **OR** Level 4 **OR** Level 5 **OR** Level 6 **OR** Level 7 **OR** Level 8 **OR** Level 1-SG **OR** Level 2-SG **OR** Level 3-SG **OR** Level 4-SG **OR** Level 5-SG **OR** Level 6-SG **OR** Level 7-SG **OR** Level 8-SG, **as directed**, per UL 752.

   d. Blast Resistance:
      1) Hazard Rating: No hazard **OR** Minimal hazard **OR** Very low hazard **OR** Low hazard **OR** High hazard, **as directed**, per ASTM F 1642.
         OR
         Performance Condition: 1 **OR** 2 **OR** 3a **OR** 3b **OR** 4 **OR** 5, **as directed**, per GSA-TS01.
      2) Peak Pressure: as directed by the Owner.
      3) Positive Phase Impulse: as directed by the Owner.

e. Overall Unit Thickness: as directed by the Owner.
f. Outdoor Lite: Laminated glass with two plies of heat-strengthened float glass **OR** three plies of heat-strengthened float glass **OR** two outer plies of heat-strengthened float glass and two inner plies of annealed float glass, **as directed**.
   1) Outer Ply Thickness: 3 mm **OR** 5 mm **OR** 6 mm, **as directed**.
   2) Core Ply Thickness: 3 mm **OR** 5 mm **OR** 6 mm, **as directed**.
   3) Inner Ply Thickness: 3 mm **OR** 5 mm **OR** 6 mm, **as directed**.
   4) Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.3 mm), **as directed**.
g. Indoor Lite: Glass-clad polycarbonate faced with a 0.037-inch- (0.94-mm-) thick, spall-resistant polyester film laminated to indoor face.
   1) Outer Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, heat-strengthened **OR** chemically strengthened, **as directed**, float glass.
   2) Inner Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, heat-strengthened **OR** chemically strengthened, **as directed**, float glass.
   3) Single Core: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
      OR
      Multiple Core:
      a) Outer Core Ply: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
      b) Single Inner Core Ply **OR** Double Inner Core Plies, **as directed**: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
   4) Inner Ply: 3-mm **OR** 5-mm **OR** 6-mm, **as directed**, heat-strengthened **OR** chemically strengthened, **as directed**, float glass.
h. Interspace Content: Air **OR** Argon, **as directed**.
i. Interspace Dimension: as directed by the Owner.
j. Glass Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.
k. Tinted Glass Location: Outer lite.
l. Low-E Coating: Pyrolytic on second surface **OR** Pyrolytic on third surface **OR** Sputtered on second surface **OR** Sputtered on third surface, **as directed**.
m. Overall Visible Light Transmittance: as directed by the Owner.
n. Winter Nighttime U-Factor: as directed by the Owner.
o. Summer Daytime U-Factor: as directed by the Owner.
p. Solar Heat-Gain Coefficient: as directed by the Owner. Provide safety glazing labeling.

S. Air-Gap Security Glazing Types
   1. Security Glazing: Clear air-gap security glazing **OR** Tinted air-gap security glazing **OR** Clear reflective-coated air-gap security glazing **OR** Tinted reflective-coated air-gap security glazing, **as directed**. Outdoor lite is laminated glass and indoor lite is laminated polycarbonate.
      a. Forced-Entry Resistance: Class I **OR** Class II **OR** Class III **OR** Class IV **OR** Class V, **as directed**, per ASTM F 1233.
         OR
         Forced-Entry Resistance: Level I **OR** Level II **OR** Level III **OR** Level IV **OR** Level V, **as directed**, per HPW-TP-0500.03.
      b. Ballistic Resistance: Class/Level HG1 **OR** Class/Level HG2 **OR** Class/Level HG3 **OR** Class/Level HG4 **OR** Class/Level SMG **OR** Class/Level R1 **OR** Class/Level R2 **OR** Class/Level R3 **OR** Class/Level R4-AP **OR** Class/Level SH1 **OR** Class/Level SH2, **as directed**, per ASTM F 1233.
         OR
         Ballistic Resistance: Level 1 **OR** Level 2 **OR** Level 3 **OR** Level 4 **OR** Level 5 **OR** Level 6 **OR** Level 7 **OR** Level 8 **OR** Level 1-SG **OR** Level 2-SG **OR** Level 3-SG **OR** Level 4-SG **OR** Level 5-SG **OR** Level 6-SG **OR** Level 7-SG **OR** Level 8-SG, **as directed**, per UL 752.
      c. Blast Resistance:

1) Hazard Rating: No hazard **OR** Minimal hazard **OR** Very low hazard **OR** Low hazard **OR** High hazard, **as directed**, per ASTM F 1642.
OR
Performance Condition: 1 **OR** 2 **OR** 3a **OR** 3b **OR** 4 **OR** 5, **as directed**, per GSA-TS01.
2) Peak Pressure: as directed by the Owner.
3) Positive Phase Impulse: as directed by the Owner.

d. Overall Unit Thickness: as directed by the Owner.
e. Outdoor Lite: Laminated glass with two **OR** three, **as directed**, plies of float glass **OR** heat-strengthened float glass **OR** fully tempered float glass **OR** chemically strengthened float glass, **as directed**.
1) Outer Ply Thickness: 3 mm **OR** 5 mm **OR** 6 mm, **as directed**.
2) Core Ply Thickness: 3 mm **OR** 5 mm **OR** 6 mm, **as directed**.
3) Inner Ply Thickness: 3 mm **OR** 5 mm **OR** 6 mm, **as directed**.
4) Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.3 mm), **as directed**.
f. Indoor Lite: Laminated polycarbonate with two **OR** three **OR** four, **as directed**, polycarbonate plies.
1) Overall Unit Thickness: as directed by the Owner.
2) Outer and Inner Plies: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
3) Core Ply **OR** Core Plies, **as directed**: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
4) Interlayer Thicknesses: 0.025 inch (0.635 mm).
g. Air-Gap Dimension: as directed by the Owner.
h. Glass Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.
i. Tinted Glass Location: Outer **OR** Inner, **as directed**, ply of outdoor lite.
j. Coating Color: Gold **OR** Pewter **OR** Silver, **as directed**.
k. Coating Location: Second **OR** Third **OR** Fifth, **as directed**, surface.
l. Overall Visible Light Transmittance: as directed by the Owner..
m. Outdoor Visible Reflectance: as directed by the Owner.
n. Winter Nighttime U-Factor: as directed by the Owner.
o. Summer Daytime U-Factor: as directed by the Owner.
p. Solar Heat-Gain Coefficient: as directed by the Owner.
q. Provide safety glazing labeling.

2. Security Glazing: Low-e-coated, clear air-gap security glazing **OR** Low-e-coated, tinted air-gap security glazing, **as directed**. Outdoor lite is laminated glass and indoor lite is laminated polycarbonate.
a. Forced-Entry Resistance: Class I **OR** Class II **OR** Class III **OR** Class IV **OR** Class V, **as directed**, per ASTM F 1233.
OR
Forced-Entry Resistance: Level I **OR** Level II **OR** Level III **OR** Level IV **OR** Level V, **as directed**, per HPW-TP-0500.03.
b. Ballistic Resistance: Class/Level HG1 **OR** Class/Level HG2 **OR** Class/Level HG3 **OR** Class/Level HG4 **OR** Class/Level SMG **OR** Class/Level R1 **OR** Class/Level R2 **OR** Class/Level R3 **OR** Class/Level R4-AP **OR** Class/Level SH1 **OR** Class/Level SH2, **as directed**, per ASTM F 1233.
OR
Ballistic Resistance: Level 1 **OR** Level 2 **OR** Level 3 **OR** Level 4 **OR** Level 5 **OR** Level 6 **OR** Level 7 **OR** Level 8 **OR** Level 1-SG **OR** Level 2-SG **OR** Level 3-SG **OR** Level 4-SG **OR** Level 5-SG **OR** Level 6-SG **OR** Level 7-SG **OR** Level 8-SG, **as directed**, per UL 752.
c. Blast Resistance:
1) Hazard Rating: No hazard **OR** Minimal hazard **OR** Very low hazard **OR** Low hazard **OR** High hazard, **as directed**, per ASTM F 1642.
OR

Performance Condition: 1 **OR** 2 **OR** 3a **OR** 3b **OR** 4 **OR** 5, **as directed**, per GSA-TS01.
2) Peak Pressure: as directed by the Owner.
3) Positive Phase Impulse: as directed by the Owner.

d. Overall Unit Thickness: as directed by the Owner.
e. Outdoor Lite: Laminated glass with two **OR** three, **as directed**, plies of float glass **OR** heat-strengthened float glass **OR** fully tempered float glass **OR** chemically strengthened float glass, **as directed**.
1) Outer Ply Thickness: 3 mm **OR** 5 mm **OR** 6 mm, **as directed**.
2) Core Ply Thickness: 3 mm **OR** 5 mm **OR** 6 mm, **as directed**.
3) Inner Ply Thickness: 3 mm **OR** 5 mm **OR** 6 mm, **as directed**.
4) Interlayer Thickness: 0.030 inch (0.76 mm) **OR** 0.060 inch (1.52 mm) **OR** 0.090 inch (2.3 mm), **as directed**.
f. Indoor Lite: Laminated polycarbonate with two **OR** three **OR** four, **as directed**, polycarbonate plies.
1) Overall Unit Thickness: as directed by the Owner.
2) Outer and Inner Plies: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
3) Core Ply **OR** Core Plies, **as directed**: 0.118-inch (4.57-mm) **OR** 0.177-inch (2.97-mm) **OR** 0.236-inch (5.99-mm), **as directed**, polycarbonate.
4) Interlayer Thicknesses: 0.025 inch (0.635 mm).
g. Air-Gap Dimension: as directed by the Owner.
h. Glass Tint Color: Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.
i. Tinted Glass Location: Outer **OR** Inner, **as directed**, ply of outdoor lite.
j. Low-E Coating: Pyrolytic on second surface **OR** Pyrolytic on third surface **OR** Sputtered on second surface **OR** Sputtered on third surface, **as directed**.
k. Overall Visible Light Transmittance: as directed by the Owner.
l. Winter Nighttime U-Factor: as directed by the Owner.
m. Summer Daytime U-Factor: as directed by the Owner.
n. Solar Heat-Gain Coefficient: as directed by the Owner.
o. Provide safety glazing labeling.

1.3 EXECUTION

A. Examination
1. Examine framing for security glazing, with Installer present, for compliance with the following:
a. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
b. Presence and functioning of weep system.
c. Minimum required face or edge clearances.
d. Effective sealing between joints of framing members.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Clean glazing channels and other framing members receiving security glazing immediately before glazing. Remove coatings not firmly bonded to substrates.

C. Glazing, General
1. Comply with combined written instructions of manufacturers of security glazing, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
2. Protect edges of security glazing from damage during handling and installation. Remove damaged security glazing from Project site and legally dispose of off Project site. Damaged

security glazing includes units with edge or face damage or other imperfections that, when installed, could weaken security glazing, impair performance, or impair appearance.

3. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
4. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications unless otherwise required by glazing unit manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
5. Do not exceed edge pressures stipulated by security glazing manufacturers for installing lites.
6. Provide spacers for security glazing lites where the length plus width is larger than 50 inches (1270 mm).
   a. Locate spacers directly opposite each other on both inside and outside faces of security glazing. Install correct size and spacing to preserve required face clearances unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with performance requirements.
   b. Provide 1/8-inch (3-mm) minimum bite of spacers on glazing lites and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
7. Provide edge blocking where indicated or needed to prevent security glazing from moving sideways in glazing channel, as recommended in writing by security glazing manufacturer and according to requirements in referenced glazing publications.
8. Set security glazing in each series with uniform pattern, draw, bow, and similar characteristics.
9. Set coated security glazing with proper orientation so that coatings face exterior or interior as specified.
10. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
11. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

D. Tape Glazing
   1. Position tapes on fixed stops so that, when compressed by security glazing, their exposed edges are flush with or protrude slightly above sightline of stops.
   2. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
   3. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.
   4. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
   5. Do not remove release paper from tape until just before each glazing unit is installed.
   6. Apply heel bead of elastomeric sealant.
   7. Center security glazing in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
   8. Apply cap bead of elastomeric sealant over exposed edge of tape.

E. Gasket Glazing (Dry)
   1. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
   2. Insert soft compression gasket securely in place between glazing unit and frame or fixed stop, with joints miter cut and bonded together at corners.
   3. Installation with Drive-in Wedge Gaskets: Center security glazing in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal

without developing bending stresses in security glazing. Seal gasket joints with sealant recommended by gasket manufacturer.

4. Installation with Pressure-Glazing Stops: Center security glazing in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in security glazing. Seal gasket joints with sealant recommended by gasket manufacturer.
5. Install gaskets so they protrude past face of glazing stops.

F. Sealant Glazing (Wet)

1. Install continuous spacers, or spacers combined with cylindrical sealant backing, between security glazing and glazing stops to maintain face clearances and to prevent sealant from extruding into glazing channel and blocking weep systems. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
2. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to security glazing and channel surfaces.
3. Tool exposed surfaces of sealants to provide a substantial wash away from security glazing.

G. Protection And Cleaning

1. Protect exterior security glazing from damage immediately after installation by attaching crossed streamers to framing held away from glazing unit. Do not apply markers to security glazing surfaces. Remove nonpermanent labels, and clean surfaces.
2. Protect security glazing from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with security glazing, remove substances immediately as recommended in writing by security glazing manufacturer.
3. Examine security glazing surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by security glazing manufacturer.
4. Remove and replace security glazing that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, or vandalism during construction period.
5. Wash security glazing on exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash security glazing as recommended in writing by security glazing manufacturer.

END OF SECTION 08860

Task	Specification	Specification Description
08860	08810	Glazing

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SECTION 08861 - FRAGMENT RETENTION FILM FOR GLASS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of fragment retention film for glass. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.
2. Samples: For each type of product indicated.
3. Test Reports: Certified test reports including analysis and interpretation of test results. Each report shall identify the manufacturer, the specific product name, the film thickness, the adhesive type and thickness, and the glass type and thickness. Test reports shall clearly identify the methods used and shall include the results recorded.
4. Certificates: On applications where the film will contact the glazing beads or gaskets, a certificate from the Contractor stating that the glazing compounds and gaskets are compatible with the fragment retention film and adhesive.

C. Delivery, Storage, And Handling
1. Deliver, store, and handle in accordance with the manufacturer's recommendations. Glass, including glass in windows or doors, that has the film factory applied shall be stored in a dry location free of dust, water, and other contaminants. Glass with factory applied film shall be delivered, stored, and handled so that the film is not damaged, scratched, or abraded and shall be stored in a manner which permits easy access for inspection and handling. Each roll of film shall have a tamperproof label containing full details of the roll and the batch number.

D. Warranty
1. Provide a 5 year warranty for fragment retention film material. The warranty shall provide for replacement of film if cracking, crazing, peeling, or inadequate adhesion occurs.

1.2 PRODUCTS

A. Standard Products: Fragment retention film shall be the standard product of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

B. Fragment Retention Film: Fragment retention film shall be polyester, polyethylene terephthalate, or a composite. Fragment retention film shall be optically clear and free of waves, distortions, impurities, and adhesive lines. The film may be a single layer or laminated. Lamination of the film shall only occur at the factory of the fragment retention film manufacturer. The film shall include an abrasion resistant coating on the surface that does not receive the film adhesive. Fragment retention film shall be a minimum thickness of 0.004 inch (0.10 mm), as required to meet Project requirements, and shall be clear **OR** tinted, **OR** reflective, **as directed**. The film shall be supplied with an optically clear weatherable pressure sensitive adhesive. The adhesive shall contain ultraviolet inhibitors to protect the film for its required life and shall limit ultraviolet transmission to not more than 8 percent of the radiation between 300 and 380 nanometers. The adhesive shall not be water activated.
1. Impact Performance: Test fragment retention film for impact in accordance with ANSI Z97.1 or 16 CFR 1201.

2. Tensile Strength: The fragment retention film samples tested shall exhibit a minimum tensile strength at break of 25,000 psi (172.4 MPa) when tested in accordance with ASTM D882, Method A.
3. Peel Strength: The fragment retention film shall exhibit a minimum peel strength of 5.3 pounds/inch (930 N/m) for 0.004 inch (0.10 mm) thick film when tested in accordance with ASTM D3330, Method A.
4. Surface Abrasion: The fragment retention film shall exhibit a change in haze not to exceed 3.2 percent following 100 turns, using 500-gram weights on a CS 10F abrasive wheel when tested in accordance with ASTM D1044.
5. Flame Spread and Smoke Density: The fragment retention film shall exhibit a flame spread index not exceeding 25 and a smoke density index not exceeding 100 when tested in accordance with ASTM E84.

1.3 EXECUTION

A. Surface Preparation: The glass surface to which the fragment retention film is to be applied shall be cleaned of paint, foreign compounds, smears, and spatters. After the initial cleaning, the surface to receive the film shall be further cleaned in accordance with the film manufacturer's instructions.

B. Application: Provide fragment retention film on window and door glass where indicated. After surface preparation, apply the fragment retention film in accordance with the manufacturer's recommendations and instructions. Apply film to the interior (room) side of the glass for both single and double glazed sheets, unless otherwise indicated. Multiple applications of film to achieve specified thicknesses will not be allowed. The film shall not be applied if there are visible dust particles in the air, if there is frost on the glazing, or if any room condition such as temperature and humidity do not meet the manufacturer's instructions. After film application, maintain room conditions as required by the manufacturer's instructions to allow for proper curing of the adhesive.
1. Application to New Glass Before Glazing: Apply fragment retention film so that it extends edge to edge of the glass sheet. Set the film reinforced glass into the frame with glazing compounds or gaskets as specified in Division 08 Section "Glazing". When contact between the glazing compounds and/or gaskets and the film occurs, the Contractor shall ensure compatibility. The Contractor shall be responsible for delivery of the fragment retention film to the appropriate location for application. Coordinate fragment retention film application and curing with the glass supplier and window or door manufacturer prior to glazing installation.
2. Application to Existing Glass Involving Dismantlement: Remove the existing glazing compound, gaskets, and/or stops as required to expose the existing glass pane. If necessary, remove the glass so that the film can be applied. Apply the film so that it extends edge to edge of the glass sheet. Install existing gaskets and/or stops and replace any removed glazing compounds with new glazing compounds. Scrap removed glazing compounds. Glazing compounds shall be in accordance with GANA Sealant Manual. Glazing methods shall be in accordance with GANA Glazing Manual. When contact between the glazing compounds and/or gaskets and the film occurs, the Contractor shall ensure compatibility. Replace and reinstall any damaged or broken glazing and gaskets in kind.
3. Application to Existing Glass Without Dismantlement: Apply fragment retention film so that it extends to within 1/16-inch (1.6 mm), with a maximum of 1/8 inch (3 mm), of the edge of the visible glass area.
4. Application to Existing Glass and Frame Without Dismantlement: Apply fragment retention film past the edge of the visible glass and extend onto the frame. Amount of film overlap, edge connection to the frame, and adhesive for adhering film to frame shall be as recommended by the film manufacturer. When contact between the glazing compounds and/or gaskets and the film occurs, the Contractor shall ensure compatibility.
5. Splicing: Splices or seams in fragment retention film shall be permitted only when a sheet of glass has a dimension exceeding 58 inches (1.475 m) in both directions. All seams shall be

applied with a minimum overlap of 1/4 inch (6 mm) unless submitted test reports indicate impact performance is not diminished when seam is applied with a different overlap or a gap.

C. Cleaning: Clean the fragment retention film in accordance with the manufacturer's instructions.

END OF SECTION 08861

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Task	Specification	Specification Description
08875	08810	Glazing
08890	08810	Glazing

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SECTION 08912 - GLAZED ALUMINUM CURTAIN WALLS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for glazed aluminum curtain walls. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes conventionally glazed aluminum curtain walls installed as stick, unitized, and unit-and-mullion assemblies.

C. Performance Requirements
1. General Performance: Comply with performance requirements specified, as determined by testing of manufacturer's standard glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
   a. Glazed aluminum curtain walls shall withstand movements of supporting structure indicated on Drawings **OR as directed,** including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
   b. Failure also includes the following:
      1) Thermal stresses transferring to building structure.
      2) Glass breakage.
      3) Noise or vibration created by wind and thermal and structural movements.
      4) Loosening or weakening of fasteners, attachments, and other components.
      5) Failure of operating units.
2. Delegated Design: Design glazed aluminum curtain walls, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
3. Structural Loads:
   a. Wind Loads: As indicated on Drawings **OR as directed**.
      1) Basic Wind Speed: 85 mph (38 m/s) **OR** 90 mph (40 m/s) **OR** 100 mph (44 m/s) **OR** 110 mph (49 m/s), **as directed**.
      2) Exposure Category: A **OR** B **OR** C **OR** D, **as directed**.
   b. Blast Loads: As indicated on Drawings **OR as directed**.
   c. Periodic Maintenance-Equipment Loads: As indicated on Drawings **OR as directed**.
4. Structural-Test Performance: Test according to ASTM E 330 as follows:
   a. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
   b. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
   c. Test Durations: As required by design wind velocity, but not less than 10 seconds.
5. Deflection of Framing Members: At design wind pressure, as follows:
   a. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding L/175 of the glass edge length for each individual glazing lite **OR** 1/175 of clear span for spans up to 13 feet 6 inches (4.1 m) and to 1/240 of clear span plus 1/4 inch (6.35 mm) for spans greater than 13 feet 6 inches (4.1 m), **as directed**, or an amount that restricts edge deflection of individual glazing lites to 3/4 inch (19 mm), whichever is less.

b. Deflection Parallel to Glazing Plane: Limited to L/360 of clear span or 1/8 inch (3.2 mm), whichever is smaller **OR** amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch (3.2 mm), **as directed**.
   1) Operable Units: Provide a minimum 1/16-inch (1.6-mm) clearance between framing members and operable units.

c. Cantilever Deflection: Where framing members overhang an anchor point, limit deflection to two times the length of cantilevered member, divided by 175.

6. Windborne-Debris-Impact-Resistance Performance: Pass missile-impact and cyclic-pressure tests when tested according to ASTM E 1886 and testing information in ASTM E 1996 for Wind Zone 1 **OR** Zone 2 **OR** Zone 3 **OR** Zone 4, **as directed**.
   a. Large-Missile Test: For glazed openings located within 30 feet (9.1 m) of grade.
   b. Small-Missile Test: For glazed openings located more than 30 feet (9.1 m) above grade.
7. Seismic Performance: Glazed aluminum curtain walls shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
   a. Component Importance Factor is 1.5 **OR** 1.0, **as directed**.
8. Story Drift: Accommodate design displacement of adjacent stories indicated.
   a. Design Displacement: As indicated on Drawings **OR as directed**.
   b. Test Performance: Meeting criteria for passing based on building occupancy type when tested according to AAMA 501.4 at design displacement and 1.5 times the design displacement, **as directed**.
9. Water Penetration under Static Pressure: No evidence of water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa) **OR** 10 lbf/sq. ft. (480 Pa) **OR** 15 lbf/sq. ft. (720 Pa), **as directed**.
10. Water Penetration under Dynamic Pressure: No evidence of water penetration through fixed glazing and framing areas when tested according to AAMA 501.1 at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa) **OR** 10 lbf/sq. ft. (480 Pa) **OR** 15 lbf/sq. ft. (720 Pa), **as directed**.
    a. Maximum Water Leakage: According to AAMA 501.1 **OR** No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation, **as directed**. Water leakage does not include water controlled by flashing and gutters that is drained to exterior.
11. Thermal Movements: Allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures:
    a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
    b. Test Interior Ambient-Air Temperature: 75 deg F (24 deg C).
    c. Test Performance: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.
12. Energy Performance: Glazed aluminum curtain walls shall have certified and labeled energy performance ratings in accordance with NFRC.
    a. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 0.45 Btu/sq. ft. x h x deg F (2.55 W/sq. m x K) **OR** 0.57 Btu/sq. ft. x h x deg F (3.23 W/sq. m x K) **OR** 0.69 Btu/sq. ft. x h x deg F (3.92 W/sq. m x K), **as directed**, as determined according to NFRC 100.
    b. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.35 **OR** 0.40 **OR** 0.45, **as directed**, as determined according to NFRC 200.
    c. Air Infiltration: Maximum air leakage through fixed glazing and framing areas of 0.30 cfm/sq. ft. (1.50 L/s per sq. m) of fixed wall area as determined according to ASTM E 283 at a minimum static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa) **OR** 6.24 lbf/sq. ft. (300 Pa), **as directed**.

d. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC- certified condensation resistance rating of no less than 15 **OR** 25 **OR** 35 **OR** 45, **as directed**, as determined according to NFRC 500.

13. Sound Transmission: Provide glazed aluminum curtain walls with fixed glazing and framing areas having the following sound-transmission characteristics:
    a. Outdoor-Indoor Transmission Class: Minimum 26 **OR** 30 **OR** 34, **as directed**, when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 1332.

D. Submittals
1. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. LEED Submittal:
    a. Product Data for Credit EQ 4.1: For glazing sealants used inside of the weatherproofing system, including printed statement of VOC content.
3. Shop Drawings: For glazed aluminum curtain walls. Include plans, elevations, sections, full-size details, and attachments to other work.
    a. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
    b. Include full-size isometric details of each vertical-to-horizontal intersection of glazed aluminum curtain walls, showing the following:
        1) Joinery, including concealed welds.
        2) Anchorage.
        3) Expansion provisions.
        4) Glazing.
        5) Flashing and drainage.
4. Samples: For each type of exposed finish required.
5. Delegated-Design Submittal: For glazed aluminum curtain walls indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
6. Qualification Data: For qualified Installer and testing agency, **as directed**.
7. Seismic Qualification Certificates: For glazed aluminum curtain walls, accessories, and components, from manufacturer.
    a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
8. Welding certificates.
9. Energy Performance Certificates: For glazed aluminum curtain walls, accessories, and components, from manufacturer.
    a. Basis for Certification: NFRC-certified energy performance values for each glazed aluminum curtain wall.
10. Product test reports.
11. Field quality-control reports.
12. Maintenance data.
13. Warranties: Sample of special warranties.

E. Quality Assurance
1. Manufacturer Qualifications: A manufacturer capable of fabricating glazed aluminum curtain walls that meet or exceed energy performance requirements indicated and of documenting this performance by certification, labeling, and inclusion in lists.
2. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
3. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.
4. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

5. Welding Qualifications: Qualify procedures and personnel according to the following:
   a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   b. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
6. Energy Performance Standards: Comply with NFRC for minimum standards of energy performance, materials, components, accessories, and fabrication. Comply with more stringent requirements if indicated.
   a. Provide NFRC-certified glazed aluminum curtain walls with an attached label.
7. Preinstallation Conference: Conduct conference at Project site.

F. Warranty
1. Special Assembly Warranty: Standard form in which manufacturer **OR** Installer, **as directed**, agrees to repair or replace components of glazed aluminum curtain walls that do not comply with requirements or that fail in materials or workmanship within Two **OR** Five **OR** 10, **as directed**, years from date of Substantial Completion.
2. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within Five **OR** 10 **OR** 20, **as directed**, years from date of Substantial Completion.

1.2 PRODUCTS

A. Materials
1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
   a. Sheet and Plate: ASTM B 209 (ASTM B 209M).
   b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
   c. Extruded Structural Pipe and Tubes: ASTM B 429.
   d. Structural Profiles: ASTM B 308/B 308M.
   e. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.
2. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
   a. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
   b. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
   c. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

B. Framing
1. Framing Members: Manufacturer's standard extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
   a. Construction: Nonthermal **OR** Thermally improved **OR** Thermally broken, **as directed**.
   b. Glazing System: Retained mechanically with gaskets on four sides.
   c. Glazing Plane: Front.
2. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
3. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
   a. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
   b. Reinforce members as required to receive fastener threads.
   c. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system **OR** fabricated from 300 series stainless steel, **as directed**.
4. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch (25.4 mm) that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.

a. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.

5. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials **OR** Dead-soft, 0.018-inch- (0.457-mm-) thick stainless steel, ASTM A 240/A 240M of type recommended by manufacturer, **as directed**.
6. Framing Sealants: Manufacturer's standard sealants.

C. Glazing
1. Glazing: Comply with Division 08 Section "Glazing".
2. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers **OR** Comply with Division 08 Section "Glazing", **as directed**.
3. Glazing Sealants: As recommended by manufacturer **OR** Comply with Division 08 Section "Glazing", **as directed**.
   a. Provide sealants for use inside of the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Insulated Spandrel Panels
1. Insulated Spandrel Panels: Laminated, metal-faced flat panels with no deviations in plane exceeding 0.8 percent of panel dimension in width or length.
   a. Overall Panel Thickness: As indicated **OR** 1 inch (25.4 mm), **as directed**.
   b. Exterior Skin: Aluminum.
      1) Thickness: Manufacturer's standard for finish and texture indicated.
      2) Finish: Matching framing system.
      3) Texture: Smooth **OR** Embossed, **as directed**.
      4) Backing Sheet: 1/8-inch- (3.2-mm-) thick, tempered hardboard **OR** 0.157-inch- (4-mm-) thick, cement board **OR** 0.125-inch- (3.2-mm-) thick, corrugated, high-density polyethylene, **as directed**.
   c. Interior Skin: Aluminum **OR** Manufacturer's standard galvanized-steel sheet, **as directed**.
      1) Thickness: Manufacturer's standard for finish and texture indicated.
      2) Finish: Matching curtain-wall framing **OR** Low-gloss, white baked enamel **OR** Mill finish, **as directed**.
      3) Texture: Smooth **OR** Embossed, **as directed**.
      4) Backing Sheet: 1/8-inch- (3.2-mm-) thick, tempered hardboard **OR** 0.157-inch- (4-mm-) thick, cement board **OR** 1/2-inch- (12.7-mm-) thick, gypsum board with proprietary fire-resistance-rated core **OR** 0.125-inch- (3.2-mm-) thick, corrugated, high-density polyethylene, **as directed**.
   d. Thermal Insulation Core: Manufacturer's standard rigid, closed-cell, polyisocyanurate board **OR** extruded-polystyrene board **OR** expanded-perlite, mineral-insulation board, **as directed**.
   e. Surface-Burning Characteristics: For exposed interior surfaces of panels, when tested according to ASTM E 84 as follows:
      1) Flame-Spread Index: 25 or less.
      2) Smoke-Developed Index: 450 or less.

E. Operable Units
1. Venting Windows: Comply with Division 08 Section "Aluminum Windows".
2. Doors: Comply with Division 08 Section "Aluminum-framed Entrances And Storefronts".

F. Accessory Materials
1. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.

G. Fabrication
1. Form or extrude aluminum shapes before finishing.

2. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
3. Fabricate components that, when assembled, have the following characteristics:
   a. Profiles that are sharp, straight, and free of defects or deformations.
   b. Accurately fitted joints with ends coped or mitered.
   c. Physical and thermal isolation of glazing from framing members.
   d. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
   e. Provisions for field replacement of glazing from exterior **OR** interior **OR** interior for vision glass and exterior for spandrel glazing or metal panels, **as directed**.
   f. Provisions for safety railings mounted on interior face of mullions **OR** between mullions at interior, **as directed**.
   g. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
   h. Components curved to indicated radii.
4. Fabricate components that, when assembled, have the following characteristics:
   a. Internal guttering system or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.
   b. Pressure-equalized system or double barrier design with primary air and vapor barrier at interior side of glazed aluminum curtain wall and secondary seal weeped and vented to exterior.
5. Curtain-Wall Framing: Fabricate components for assembly using shear-block system **OR** screw-spline system **OR** head-and-sill-receptor system with shear blocks at intermediate horizontal members, **as directed**.
6. Factory-Assembled Frame Units:
   a. Rigidly secure nonmovement joints.
   b. Seal joints watertight unless otherwise indicated.
   c. Install glazing to comply with requirements in Division 08 Section "Glazing".
7. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

H. Aluminum Finishes
1. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
2. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, a**s directed**, or thicker.
   a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Champagne **OR** Black **OR** Match sample **OR** As selected from full range of industry colors and color densities, **as directed**.
3. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
4. High-Performance Organic Finish:
   a. Two-coat fluoropolymer finish complying with AAMA 2604 **OR** AAMA 2605, **as directed**, and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      OR
      Three-coat **OR** Four-coat, **as directed**, fluoropolymer finish complying with AAMA 2605 and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

OR

Two-coat fluoropolymer finish complying with AAMA 2604 and containing 100 percent FEVE resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

b. Color and Gloss: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.

1.3 EXECUTION

A. Installation
1. General:
   a. Comply with manufacturer's written instructions.
   b. Do not install damaged components.
   c. Fit joints to produce hairline joints free of burrs and distortion.
   d. Rigidly secure nonmovement joints.
   e. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
   f. Weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
   g. Seal joints watertight unless otherwise indicated.
2. Metal Protection:
   a. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape or installing nonconductive spacers as recommended by manufacturer for this purpose.
   b. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
3. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.
4. Install components plumb and true in alignment with established lines and grades.
5. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.
6. Install glazing as specified in Division 08 Section "Glazing".

B. Erection Tolerances
1. Erection Tolerances: Install glazed aluminum curtain walls to comply with the following maximum tolerances:
   a. Plumb: 1/8 inch in 10 feet (3.2 mm in 3 m); 1/4 inch in 40 feet (6 mm in 12 m).
   b. Level: 1/8 inch in 20 feet (3.2 mm in 6 m); 1/4 inch in 40 feet (6 mm in 12 m).
   c. Alignment:
      1) Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch (12.7 mm) wide, limit offset from true alignment to 1/16 inch (1.6 mm).
      2) Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch (12.7 to 25.4 mm) wide, limit offset from true alignment to 1/8 inch (3.2 mm).
      3) Where surfaces are separated by reveal or protruding element of 1 inch (25.4 mm) wide or more, limit offset from true alignment to 1/4 inch (6 mm).
   d. Location: Limit variation from plane to 1/8 inch in 12 feet (3.2 mm in 3.7 m); 1/2 inch (12.7 mm) over total length.

C. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Testing Services: Testing and inspecting of representative areas of glazed aluminum curtain walls shall take place as installation proceeds to determine compliance of installed assemblies with specified requirements.
   a. Air Infiltration: Areas shall be tested for air leakage of 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article, but not more than 0.50 cfm/sq. ft.

(2.25 L/s per sq. m), of fixed wall area when tested according to ASTM E 783 at a minimum static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa) **OR** 6.24 lbf/sq. ft. (300 Pa), **as directed**.

1) Test Area: One bay wide, but not less than 30 feet (9.1 m), by one story of glazed aluminum curtain wall.
2) Perform a minimum of two **OR** three, **as directed**, tests in areas as directed by the Owner.

   OR

   Perform tests in each test area as directed by the Owner. Perform at least three tests, prior to 10, 35, and 70 percent completion.

b. Water Penetration: Areas shall be tested according to ASTM E 1105 at a minimum uniform and cyclic static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft. (300 Pa), and shall not evidence water penetration.

1) Test Area: One bay wide, but not less than 30 feet (9.1 m), by one story of glazed aluminum curtain wall.
2) Perform a minimum of two **OR** three, **as directed**, tests in areas as directed by the Owner.

   OR

   Perform tests in each test area as directed by the Owner. Perform at least three tests, prior to 10, 35, and 70 percent completion.

c. Water Spray Test: Before installation of interior finishes has begun, areas designated by the Owner shall be tested according to AAMA 501.2 and shall not evidence water penetration.

1) Test Area: A minimum area of 75 feet (23 m) by one story of glazed aluminum curtain wall.

3. Glazed aluminum curtain walls will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.

END OF SECTION 08912

SECTION 08912a - STRUCTURAL-SEALANT-GLAZED CURTAIN WALLS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for structural-sealant-glazed curtain walls. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Factory-glazed **OR** Field-glazed, **as directed**, two-sided structural-sealant-glazed curtain-wall assemblies.
b. Factory-glazed, four-sided structural-sealant-glazed curtain-wall assemblies.

C. Performance Requirements
1. General Performance: Comply with performance requirements specified, as determined by testing manufacturer's standard of structural-sealant-glazed curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
a. Structural-sealant-glazed curtain walls shall withstand movements of supporting structure indicated on Drawings, **OR as directed**, including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
b. Failure also includes the following:
1) Thermal stresses transferring to building structure.
2) Glass breakage.
3) Noise or vibration created by wind and thermal and structural movements.
4) Loosening or weakening of fasteners, attachments, and other components.
5) Failure of operating units.
2. Delegated Design: Design structural-sealant-glazed curtain walls, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
3. Structural Loads:
a. Wind Loads: As indicated on Drawings **OR as directed**.
1) Basic Wind Speed: 85 mph (38 m/s) **OR** 90 mph (40 m/s) **OR** 100 mph (44 m/s) **OR** 110 mph (49 m/s), **as directed**.
2) Exposure Category: A **OR** B **OR** C **OR** D, **as directed**.
b. Blast Loads: As indicated on Drawings **OR as directed**.
c. Periodic Maintenance-Equipment Loads: As indicated on Drawings **OR as directed**.
4. Structural-Test Performance: Provide structural-sealant-glazed curtain walls tested according to ASTM E 330 as follows:
a. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
b. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
c. Test Durations: As required by design wind velocity, but not less than 10 seconds.
5. Deflection of Framing Members: At design wind pressure, as follows:
a. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding L/175 of the glass edge length for each individual glazing lite **OR** 1/175 of clear span for spans up to 13 feet 6 inches (4.1 m) and to 1/240 of clear span plus 1/4 inch (6.35 mm) for spans greater than 13 feet 6 inches (4.1 m), **as directed**, or an

amount that restricts edge deflection of individual glazing lites to 3/4 inch (19 mm), whichever is less.

b. Deflection Parallel to Glazing Plane: Limited to L/360 of clear span or 1/8 inch (3.2 mm), whichever is smaller **OR** amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch (3.2 mm), **as directed**.

1) Operable Units: Provide a minimum 1/16-inch (1.6-mm) clearance between framing members and operable units.

c. Cantilever Deflection: Where framing members overhang an anchor point, limit deflection to 2 times the length of cantilevered member divided by 175.

6. Windborne-Debris-Impact-Resistance Performance: Pass missile-impact and cyclic-pressure tests when tested according to ASTM E 1886 and testing information in ASTM E 1996 for Wind Zone 1 **OR** Zone 2 **OR** Zone 3 **OR** Zone 4, **as directed**.
   a. Large-Missile Test: For glazed openings located within 30 feet (9.1 m) of grade.
   b. Small-Missile Test: For glazed openings located more than 30 feet (9.1 m) above grade.
7. Seismic Performance: Structural-sealant-glazed curtain walls shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
   a. Component Importance Factor is 1.5 **OR** 1.0, **as directed**.
8. Story Drift: Accommodate design displacement of adjacent stories indicated.
   a. Design Displacement: As indicated on Drawings **OR as directed**.
   b. Test Performance: Meets criteria for passing based on building occupancy type when tested according to AAMA 501.4 at design displacement and 1.5 times the design displacement, **as directed**.
9. Water Penetration under Static Pressure: No evidence of water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa) **OR** 10 lbf/sq. ft. (480 Pa) **OR** 15 lbf/sq. ft. (720 Pa), **as directed**.
10. Water Penetration under Dynamic Pressure: No evidence of water penetration through fixed glazing and framing areas when tested according to AAMA 501.1 at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa) **OR** 10 lbf/sq. ft. (480 Pa) **OR** 15 lbf/sq. ft. (720 Pa), **as directed**.
    a. Maximum Water Leakage: According to AAMA 501.1 **OR** No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation, **as directed**. Water leakage does not include water controlled by flashing and gutters that is drained to exterior.
11. Thermal Movements: Allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures:
    a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
    b. Test Interior Ambient-Air Temperature: 75 deg F (24 deg C).
    c. Test Performance: No buckling, stress on glass, sealant failure, or excess stress on framing, anchors, and fasteners and no reduction of performance when tested according to AAMA 501.5.
12. Energy Performance: Structural-sealant-glazed curtain walls shall have certified and labeled energy performance ratings according to NFRC.
    a. Thermal Transmittance (U-Factor): Fixed glazing and framing areas shall have U-factor of not more than 0.45 Btu/sq. ft. x h x deg F (2.55 W/sq. m x K) **OR** 0.57 Btu/sq. ft. x h x deg F (3.23 W/sq. m x K) **OR** 0.69 Btu/sq. ft. x h x deg F (3.92 W/sq. m x K), **as directed**, as determined according to NFRC 100.
    b. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a SHGC of no greater than 0.35 **OR** 0.40 **OR** 0.45, **as directed**, as determined according to NFRC 200.
    c. Air Infiltration: Maximum air leakage through fixed glazing and framing areas of 0.30 cfm/sq. ft. (1.50 L/s per sq. m) of fixed wall area as determined according to ASTM E 283

at a minimum static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa) **OR** 6.24 lbf/sq. ft. (300 Pa), **as directed**.

d. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC-certified CR rating of no less than 15 **OR** 25 **OR** 35 **OR** 45, **as directed**, as determined according to NFRC 500

13. Sound Transmission: Fixed glazing and framing areas shall have the following sound-transmission characteristics:
    a. Outdoor-Indoor Transmission Class: Minimum 26 **OR** 30 **OR** 34, **as directed**, when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 1332.
14. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed curtain walls without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.
    a. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
    b. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant's internal strength.
15. Structural-Sealant Joints:
    a. Designed to carry gravity loads of glazing.
    b. Designed to produce tensile or shear stress of less than 20 psi (138 kPa).
    c. Design reviewed and approved by structural-sealant manufacturer.

D. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:
    a. Product Data for Credit EQ 4.1: For glazing sealants used inside of the weatherproofing system, including printed statement of VOC content.
3. Shop Drawings: For structural-sealant-glazed curtain walls. Include plans, elevations, sections, full-size details, and attachments to other work.
    a. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
    b. Include full-size isometric details of each vertical-to-horizontal intersection of structural-sealant-glazed curtain walls, showing the following:
        1) Joinery, including concealed welds.
        2) Anchorage.
        3) Expansion provisions.
        4) Glazing.
        5) Flashing and drainage.
4. Samples: For each type of exposed finish required.
5. Delegated-Design Submittal: For structural-sealant-glazed curtain walls indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
6. Qualification Data: For qualified Installer and testing agency.
7. Seismic Qualification Certificates: For structural-sealant-glazed curtain walls, accessories, and components, from manufacturer.
    a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
8. Welding certificates.
9. Energy-Performance Certificates: For structural-sealant-glazed curtain walls, accessories, and components, from manufacturer.
    a. Basis for Certification: NFRC-certified energy-performance values for each structural-sealant-glazed curtain wall.
10. Product test reports.
11. Preconstruction sealant test reports.

12. Quality-Control Program: Developed specifically for Project, including fabrication and installation, according to recommendations in ASTM C 1401. Include periodic quality-control reports.
13. Source quality-control reports.
14. Field quality-control reports.
15. Maintenance Data: For structural-sealant-glazed curtain walls to include in maintenance manuals. Include ASTM C 1401 recommendations for postinstallation-phase quality-control program.
16. Warranties: Sample of special warranties.

E. Quality Assurance
1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
2. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.
3. Product Options: Information on Drawings and in Specifications establishes requirements for assemblies' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
4. Structural-Sealant Glazing: Comply with ASTM C 1401 for design and installation of structural-sealant-glazed curtain walls.
5. Welding Qualifications: Qualify procedures and personnel according to the following:
   a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   b. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
6. Energy-Performance Standards: Comply with NFRC for minimum standards of energy performance, materials, components, accessories, and fabrication. Comply with more stringent requirements if indicated.
   a. Provide NFRC-certified, structural-sealant-glazed curtain walls with an attached label.
7. Preinstallation Conference: Conduct conference at Project site.

F. Warranty
1. Special Assembly Warranty: Standard form in which manufacturer **OR** Installer, ,**as directed** agrees to repair or replace components of structural-sealant-glazed curtain walls that do not comply with requirements or that fail in materials or workmanship within Two **OR** Five **OR** 10, **as directed**, years from date of Substantial Completion.
2. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within Five **OR** 10 **OR** 20, **as directed**, years from date of Substantial Completion.

1.2 PRODUCTS

A. Materials
1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
   a. Sheet and Plate: ASTM B 209 (ASTM B 209M).
   b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
   c. Extruded Structural Pipe and Tubes: ASTM B 429.
   d. Structural Profiles: ASTM B 308/B 308M.
   e. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.
2. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer, complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
   a. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
   b. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
   c. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

B. Framing
   1. Framing Members: Manufacturer's standard formed- or extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.
   2. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
      a. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
      b. Reinforce members as required to receive fastener threads.
      c. Use exposed fasteners with countersunk Phillips screw heads finished to match framing system **OR** fabricated from Series 300 stainless steel, **as directed**.
   3. Anchors: Three-way adjustable anchors, with minimum adjustment of 1 inch (25.4 mm), that accommodate fabrication and installation tolerances in material and finish and are compatible with adjoining materials and recommended by manufacturer.
      a. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.
   4. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials **OR** Dead-soft, 0.018-inch- (0.457-mm-) thick stainless steel, ASTM A 240/A 240M of type recommended by manufacturer, **as directed**.
   5. Framing Sealants: Manufacturer's standard sealants with VOC content of 250g/L or less when calculated according to 40 CFR 59, Subpart D (EPA method 24), **as directed**.

C. Glazing
   1. Glazing: Comply with Division 08 Section "Glazing".
   2. Glazing Gaskets, Spacers, Setting Blocks, Sealant Backings, and Bond Breakers: Manufacturer's standard permanent, nonmigrating types compatible with sealants and suitable for joint movement and assembly performance requirements.
   3. Glazing Sealants: For structural-sealant-glazed curtain walls, as recommended by manufacturer for joint type, and as follows:
      a. Structural Sealant: ASTM C 1184, chemically curing silicone formulation that is compatible with system components with which it comes in contact, specifically formulated and tested for use as structural sealant and approved by structural-sealant manufacturer for use in curtain-wall assembly indicated.
         1) Provide sealants for use inside of the weatherproofing system that have a VOC content of 100 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
         2) Color: Black **OR** Gray **OR** As selected from manufacturer's full range of colors, **as directed**.
      b. Weatherseal Sealant: ASTM C 920 for Type S; Grade NS; Class 25; Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes in contact; recommended by structural-sealant, weatherseal-sealant, and structural-sealant-glazed curtain-wall manufacturers for this use.
         1) Provide sealants for use inside of the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
         2) Color: Matching structural sealant.

D. Operable Units
   1. Venting Windows: Comply with Division 08 Section "Aluminum Windows".
   2. Doors: Comply with Division 08 Section "Aluminum-framed Entrances And Storefronts".

E. Accessory Materials
   1. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.
   2. Cleaning Agent and Cloth: As recommended by structural-sealant manufacturer.

F. Fabrication
1. Form or extrude aluminum shapes before finishing.
2. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
3. Fabricate components that, when assembled, have the following characteristics:
   a. Profiles that are sharp, straight, and free of defects or deformations.
   b. Accurately fitted joints with ends coped or mitered.
   c. Physical and thermal isolation of glazing from framing members.
   d. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
   e. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
   f. Provisions for field replacement of glazing from exterior **OR** interior **OR** interior for vision glass and exterior for spandrel glazing or metal panels, **as directed**. Include accommodations for using temporary support device (dutchman) to retain glazing in place while sealant cures.
   g. Provisions for safety railings mounted on interior face of mullions **OR** between mullions at interior, **as directed**.
   h. Components curved to indicated radii.
   i. Internal guttering systems or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within structural-sealant-glazed curtain wall to exterior.
4. Factory-Assembled Frame Units:
   a. Rigidly secure nonmovement joints.
   b. Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion.
   c. Preparation includes, but is not limited to, cleaning and priming surfaces.
   d. Seal joints watertight unless otherwise indicated.
   e. Install glazing to comply with requirements in Division 08 Section "Glazing".
5. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

G. Aluminum Finishes
1. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
2. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
   a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Champagne **OR** Black **OR** Match sample **OR** As selected from full range of industry colors and color densities, **as directed**.
3. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
   a. Color and Gloss: As selected from manufacturer's full range, **as directed**.
4. High-Performance Organic Finish:
   a. Two-coat fluoropolymer finish complying with AAMA 2604 **OR** AAMA 2605, **as directed**, and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      OR
      Three-coat **OR** Four-coat, **as directed**, fluoropolymer finish complying with AAMA 2605 and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      OR

Two-coat fluoropolymer finish complying with AAMA 2604 and containing 100 percent FEVE resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

b. Color and Gloss: As selected from manufacturer's full range.

H. Source Quality Control

1. Perform quality-control procedures complying with ASTM C 1401 recommendations including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.

1.3 EXECUTION

A. Installation

1. General:
   a. Comply with manufacturer's written instructions.
   b. Do not install damaged components.
   c. Fit joints to produce hairline joints free of burrs and distortion.
   d. Rigidly secure nonmoving joints.
   e. Install anchors with separators and isolators to prevent metal corrosion, electrolytic deterioration, and impediments to movement of joints.
   f. Weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
   g. Seal joints watertight unless otherwise indicated.
2. Metal Protection:
   a. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.
   b. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
3. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within structural-sealant-glazed curtain walls to exterior.
4. Install components plumb and true in alignment with established lines and grades.
5. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.
6. Install glazing as specified in Division 08 Section "Glazing". Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.
7. Install weatherseal sealant according to Division 07 Section "Joint Sealants" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.

B. Erection Tolerances

1. Erection Tolerances: Install to comply with the following nonaccumulating maximum tolerances:
   a. Plumb: 1/8 inch in 10 feet (3 mm in 3 m); 1/4 inch in 40 feet (6 mm in 12 m).
   b. Level: 1/8 inch in 20 feet (3 mm in 6 m); 1/4 inch in 40 feet (6 mm in 12 m).
   c. Alignment:
      1) Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch (12.7 mm) wide, limit offset from true alignment to 1/16 inch (1.6 mm).
      2) Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch (12.7 to 25.4 mm) wide, limit offset from true alignment to 1/8 inch (3.2 mm).
      3) Where surfaces are separated by reveal or protruding element of 1 inch (25.4 mm) wide or more, limit offset from true alignment to 1/4 inch (6 mm).
   d. Location: Limit variation from plane to 1/8 inch in 12 feet (3 mm in 3.7 m); 1/2 inch (12.7 mm) over total length.

C. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Testing Services: Testing and inspecting of representative areas of structural-sealant-glazed curtain walls shall take place as installation proceeds to determine compliance of installed assemblies with specified requirements.
   a. Structural-Sealant Adhesion: Test structural sealant according to recommendations in ASTM C 1401, Destructive Test Method A, "Hand Pull Tab (Destructive)," Appendix X2.
      1) Test a minimum of two **OR** four **OR** six, **as directed**, areas on each building facade.
      2) Repair installation areas damaged by testing.
   b. Air Infiltration: Areas shall be tested for air leakage of 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article, but not more than 0.50 cfm/sq. ft. (2.25 L/s per sq. m), of fixed wall area when tested according to ASTM E 783 at a minimum static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa) **OR** 6.24 lbf/sq. ft. (300 Pa), **as directed**.
      1) Test Area: One bay wide, but not less than 30 feet (9.1 m), by one story of structural-sealant-glazed curtain wall.
      2) Perform a minimum of two **OR** three, **as directed**, tests in areas as directed by the Owner.
         OR
         Perform tests in each test area as directed by the Owner. Perform at least three tests, prior to 10, 35, and 70 percent completion.
   c. Water Penetration: Areas shall be tested according to ASTM E 1105 at a minimum uniform and cyclic static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft. (300 Pa), and shall not evidence water penetration.
      1) Test Area: One bay wide, but not less than 30 feet (9.1 m), by one story of structural-sealant-glazed curtain wall.
      2) Perform a minimum of two **OR** three, **as directed**, tests in areas as directed by the Owner.
         OR
         Perform tests in each test area as directed by the Owner. Perform at least three tests, prior to 10, 35, and 70 percent completion.
   d. Water Spray Test: Before installation of interior finishes has begun, areas designated by the Owner shall be tested according to AAMA 501.2 and shall not evidence water penetration.
      1) Test Area: A minimum area of 75 feet (23 m) by one story of structural-sealant-glazed curtain wall.
3. Structural-sealant-glazed curtain walls will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.

END OF SECTION 08912a

SECTION 08912b - SLOPED GLAZING ASSEMBLIES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for sloped glazing systems. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Conventionally glazed sloped glazing assemblies.
b. Two-sided, structural-sealant-glazed sloped glazing assemblies.
c. Four-sided, structural-sealant-glazed sloped glazing assemblies.

C. Performance Requirements
1. General Performance: Sloped glazing assemblies shall withstand movements of supporting structure (where applicable) without failure due to defective manufacture, fabrication, installation, or other defects in construction.
a. Sloped Glazing Assemblies: Comply with performance requirements specified, as determined by testing manufacturer's standard assemblies representing those indicated for this Project.
b. Failures also include, but are not limited to, the following:
1) Thermal stresses transferring to building structure.
2) Glass breakage.
3) Noise or vibration created by wind and thermal and structural movements.
4) Loosening or weakening of fasteners, attachments, and other components.
5) Failure of operating units.
6) Glazing-to-glazing contact.
2. Delegated Design: Design sloped glazing assemblies, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
3. Structural Performance: Sloped glazing assemblies shall withstand the wind loads, the effects of gravity loads, and loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
a. Wind Loads: As indicated on Drawings **OR as directed**.
1) Basic Wind Speed: 85 mph (38 m/s) **OR** 90 mph (40 m/s) **OR** 100 mph (44 m/s) **OR** 110 mph (49 m/s), **as directed**.
2) Exposure Category: A **OR** B **OR** C **OR** D, **as directed**.
b. Snow Loads: As indicated on Drawings **OR as directed**.
c. Concentrated Live Loads: As indicated on Drawings **OR as directed**, applied to framing members at locations that will produce greatest stress or deflection.
d. Uniform Live Loads: As indicated on Drawings **OR as directed**.
e. Load Combinations: Calculate according to requirements of applicable code indicated on Drawings **OR as directed**.
f. Blast Loads: As indicated on Drawings **OR as directed**.
g. Periodic Maintenance-Equipment Loads: As indicated on Drawings **OR as directed**.
4. Structural Performance: Provide sloped glazing assemblies tested according to ASTM E 330, as follows:
a. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.

b. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
c. Test Durations: As required by design wind velocity, but not less than 10 seconds.

5. Deflection of Framing Members: At design wind pressure, as follows:
   a. Deflection Normal to Glazing Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding L/175 of the glass edge length for each individual glazing lite **OR** 1/175 of clear span for spans up to 13 feet 6 inches (4.1 m) and to 1/240 of clear span plus 1/4 inch (6.35 mm) for spans more than 13 feet 6 inches (4.1 m), **as directed**, or an amount that restricts edge deflection of individual glazing lites to 3/4 inch (19.1 mm), whichever is less.
   b. Deflection Parallel to Glazing Plane: Limited to L/360 of clear span or 1/8 inch (3.2 mm), whichever is smaller **OR** amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch (3.2 mm), **as directed**.
6. Flexural Members: Design for lateral bracing of compression flanges by cross members with minimum depth equal to 50 percent of braced flexural member. Glazing does not provide lateral support.
7. Windborne-Debris-Impact-Resistance Performance: Pass missile-impact and cyclic-pressure tests when tested according to ASTM E 1886 and testing information in ASTM E 1996 for Wind Zone 1 **OR** Zone 2 **OR** Zone 3 **OR** Zone 4, **as directed**.
   a. Large-Missile Test: For glazed openings located within 30 feet (9.1 m) of grade.
   b. Small-Missile Test: For glazed openings located more than 30 feet (9.1 m) above grade.
8. Seismic Performance: Sloped glazing assemblies shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   a. Component Importance Factor is 1.5 **OR** 1.0, **as directed**.
9. Story Drift: Accommodate design displacement of adjacent stories indicated.
   a. Design Displacement: As indicated on Drawings **OR as directed**.
   b. Test Performance: Meet criteria for passing based on building occupancy type when tested according to AAMA 501.4 at design displacement and 1.5 times the design displacement.
10. Water Penetration under Static Pressure: No evidence of water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa) **OR** 10 lbf/sq. ft. (480 Pa) **OR** 15 lbf/sq. ft. (720 Pa), **as directed**.
11. Water Penetration under Dynamic Pressure: No evidence of water penetration through fixed glazing and framing areas when tested according to AAMA 501.1 at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa) **OR** 10 lbf/sq. ft. (480 Pa) **OR** 15 lbf/sq. ft. (720 Pa), **as directed**.
    a. Maximum Water Leakage: According to AAMA 501.1 **OR** No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation, **as directed**. Water leakage does not include water controlled by flashing and gutters that is drained to exterior.
12. Thermal Movements: Allow for thermal movements from the following maximum change (range) in ambient and surface temperature:
    a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
    b. Test Interior Ambient-Air Temperature: 75 deg F (24 deg C).
    c. Test Performance: No buckling, stress on glass, sealant failure, or excess stress on framing, anchors, and fasteners and no reduction of performance when tested according to AAMA 501.5.
13. Energy Performance: Sloped glazing assemblies shall have certified and labeled energy-performance ratings according to the NFRC.

a. Thermal Transmittance (U-Factor): Fixed glazing and framing areas shall have U-factor of not more than 0.45 Btu/sq. ft. x h x deg F (2.55 W/sq. m x K) **OR** 0.57 Btu/sq. ft. x h x deg F (3.23 W/sq. m x K) **OR** 0.69 Btu/sq. ft. x h x deg F (3.92 W/sq. m x K), **as directed**, as determined according to NFRC 100.
b. Solar Heat-Gain Coefficient: Fixed glazing and framing areas shall have an SHGC of not more than 0.35 **OR** 0.40 **OR** 0.45, **as directed**, as determined according to NFRC 200.
c. Air Infiltration: Maximum air leakage through fixed glazing and framing areas of 0.30 cfm/sq. ft. (1.50 L/s per sq. m) of fixed area as determined according to ASTM E 283 at a minimum static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa) **OR** 6.24 lbf/sq. ft. (300 Pa), **as directed**.
d. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC-certified CR rating of not less than 15 **OR** 25 **OR** 35 **OR** 45, as **directed**, as determined according to NFRC 500.

14. Sound Transmission: Fixed glazing and framing areas shall have the following characteristics:
    a. Outdoor-Indoor Transmission Class: Minimum 26 **OR** 30 **OR** 34, **as directed**, when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 1332.
15. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by structural-sealant glazing without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.
    a. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
    b. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant's internal strength.
16. Structural-Sealant Joints:
    a. Designed to carry gravity loads of glazing.
    b. Designed to produce tensile or shear stress of less than 20 psi (138 kPa).
    c. Design reviewed and approved by structural-sealant manufacturer.

D. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:
    a. Product Data for Credit EQ 4.1: For glazing sealants used inside the weatherproofing system, including printed statement of VOC content.
3. Shop Drawings: For sloped glazing assemblies. Include plans, elevations, sections, details, and attachments to other work.
    a. Include details of provisions for assembly expansion and contraction and for draining moisture within the assembly to the exterior.
    b. Include full-size isometric details of each vertical-to-horizontal intersection of assembly, showing the following:
        1) Joinery including concealed welds.
        2) Anchorage.
        3) Expansion provisions.
        4) Glazing.
        5) Flashing and drainage.
4. Samples: For each type of exposed finish required.
5. Delegated-Design Submittal: For sloped glazing assemblies indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
6. Qualification Data: For qualified Installer and testing agency.
7. Seismic Qualification Certificates: For sloped glazing assemblies, accessories, and components, from manufacturer.
    a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
8. Welding certificates.

9. Product test reports.
10. Preconstruction sealant test reports.
11. Quality-Control Program: Developed specifically for Project, including fabrication and installation, according to recommendations in ASTM C 1401. Include periodic quality-control reports.
12. Source quality-control reports.
13. Field quality-control reports.
14. Maintenance data.
15. Warranties: Sample of special warranties.

E. Quality Assurance
1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
2. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.
3. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
4. Structural-Sealant Glazing: Comply with ASTM C 1401 for design and installation.
5. Welding Qualifications: Qualify procedures and personnel according to the following:
   a. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   b. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
6. NFRC Certification: Provide NFRC-certified and -labeled sloped glazing assemblies.
7. Preinstallation Conference: Conduct conference at Project site.

F. Warranty
1. Special Assembly Warranty: Standard form in which manufacturer **OR** Installer, **as directed**, agrees to repair or replace components of sloped glazing assemblies that do not comply with requirements or that fail in materials or workmanship within Two **OR** Five **OR** 10, **as directed**, years from date of Substantial Completion.
2. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within Five **OR** 10 **OR** 20, **as directed**, years from date of Substantial Completion.

1.2 PRODUCTS

A. Materials
1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
   a. Sheet and Plate: ASTM B 209 (ASTM B 209M).
   b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
   c. Extruded Structural Pipe and Tubes: ASTM B 429.
   d. Structural Profiles: ASTM B 308/B 308M.
   e. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.
2. Steel Reinforcement: With manufacturer's standard, zinc-rich, corrosion-resistant primer, complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
   a. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
   b. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
   c. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

B. Framing
1. Framing Members: Manufacturer's standard, formed- or extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.

a. Framing-Member Type: Self-supporting **OR** Skin type, supported by structural-steel members indicated, **as directed**.
b. Glass Retention: Field-installed pressure caps on four sides **OR** Field-installed structural sealant at horizontal members (purlins) and pressure caps at rafters **OR** Factory-installed structural sealant on four sides, **as directed**.

2. Pressure Caps: Manufacturer's standard aluminum components that mechanically retain glazing.
   a. Include snap-on aluminum trim that conceals fasteners.
3. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning assembly components.
4. Fasteners and Accessories: Manufacturer's standard, corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
   a. At pressure caps, use ASTM A 193/A 193M stainless-steel screws.
   b. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
   c. Reinforce members as required to receive fastener threads.
   d. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system **OR** fabricated from Series 300 stainless steel, **as directed**.
5. Anchors: Three-way adjustable anchors, with minimum adjustment of 1 inch (25 mm), that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials, and recommended by manufacturer.
   a. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with requirements in ASTM A 123/A 123M or ASTM A 153/A 153M.
6. Anchor Bolts: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), galvanized steel.
7. Concealed Flashing: Manufacturer's standard, corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials **OR** Dead-soft, 0.018-inch- (0.457-mm-) thick stainless steel, ASTM A 240/A 240M; of type recommended by manufacturer, **as directed**.
8. Exposed Flashing and Closures: Manufacturer's standard aluminum components not less than 0.040 inch (1.016 mm) **OR** 0.060 inch (1.524 mm), **as directed**, thick.
9. Framing Sealants: Manufacturer's standard.

C. Glazing
1. General: Comply with Division 08 Section "Glazing".
2. Glazing Gaskets: Manufacturer's standard resilient elastomeric glazing gaskets, setting blocks, and shims or spacers **OR** As specified in Division 08 Section "Glazing", **as directed**.
3. Glazing Sealants: As recommended by manufacturer **OR** Comply with Division 08 Section "Glazing", **as directed**.
   a. Provide sealants for use inside the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
4. Glazing Sealants: For structural-sealant glazing, as recommended by manufacturer for joint type, and as follows:
   a. Structural Sealant: ASTM C 1184, chemically curing silicone formulation that is compatible with system components with which it comes in contact, specifically formulated and tested for use as structural sealant, and approved by structural-sealant manufacturer for use in sloped glazing assemblies indicated.
      1) Provide sealants for use inside the weatherproofing system that have a VOC content of 100 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
      2) Color: Black **OR** Gray **OR** As selected from manufacturer's full range of colors, **as directed**.
   b. Weatherseal Sealant: ASTM C 920, Type S, Grade NS, Class 25, Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes in contact; recommended by structural-sealant, weatherseal-sealant, and sloped glazing assembly manufacturers for this use.
      1) Provide sealants for use inside the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2) Color: Matching structural sealant.

5. Bond-Breaker Tape: Manufacturer's standard TFE-fluorocarbon or polyethylene material to which sealants will not develop adhesion.

D. Accessory Materials
1. Bituminous Paint: Cold-applied, asphalt-mastic paint complying with SSPC-Paint 33 requirements except containing no asbestos, formulated for 30-mil (0.76-mm) thickness per coat.
2. Cleaning Agent and Cloth: As recommended by structural-sealant manufacturer.

E. Fabrication
1. Form or extrude aluminum shapes before finishing.
2. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
3. Fabricate components that, when assembled, have the following characteristics:
   a. Profiles that are sharp, straight, and free of defects or deformations.
   b. Accurately fitted joints with ends coped or mitered.
   c. Physical and thermal isolation of glazing from framing members.
   d. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
   e. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
   f. Components curved to indicated radii.
   g. Internal guttering systems or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
4. Fabricate continuous, one-piece-type aluminum sill closures with weep holes.
5. Four-Sided, Structural-Sealant-Glazed Frame Units:
   a. Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion.
   b. Preparation includes, but is not limited to, cleaning and priming surfaces.
   c. Seal joints watertight unless otherwise indicated.
   d. Factory install glazing to comply with requirements in Division 08 Section "Glazing".
6. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

F. Aluminum Finishes
1. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
2. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
   a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Champagne **OR** Black **OR** Match sample **OR** As selected from full range of industry colors and color densities, **as directed**.
3. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
   a. Color and Gloss: As selected from manufacturer's full range, **as directed**.
4. High-Performance Organic Finish:
   a. Two-coat fluoropolymer finish complying with AAMA 2604 **OR** AAMA 2605, **as directed**, and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

      OR

      Three-coat **OR** Four-coat, **as directed**, fluoropolymer finish complying with AAMA 2605 and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in both

color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

OR

Two-coat fluoropolymer finish complying with AAMA 2604 and containing 100 percent FEVE resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

b. Color and Gloss: As selected from manufacturer's full range.

G. Source Quality Control

1. Four-Sided, Structural-Sealant Glazing: Perform quality-control procedures complying with recommendations in ASTM C 1401 including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.

1.3 EXECUTION

A. Installation

1. General:
   a. Comply with manufacturer's written instructions.
   b. Do not install damaged components.
   c. Fit joints to produce hairline joints free of burrs and distortion.
   d. Rigidly secure nonmovement joints.
   e. Install anchors with separators and isolators to prevent metal corrosion, electrolytic deterioration, and impediments to movement of joints.
   f. Weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
   g. Seal joints watertight unless otherwise indicated.
2. Metal Protection:
   a. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.
   b. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
   c. Where aluminum will contact pressure-treated wood, separate dissimilar materials by method recommended by sloped glazing assembly manufacturer.
3. Install continuous sill closure with weatherproof expansion joints and locked and sealed or welded corners. Locate weep holes at rafters.
4. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the sloped glazing assembly to exterior.
5. Install components plumb and true in alignment with established lines and grades.
6. Install glazing as specified in Division 08 Section "Glazing".
   a. Two-Sided, Structural-Sealant Glazing:
      1) Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.
      2) Install weatherseal sealant according to Division 08 Section "Glazing" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.

B. Erection Tolerances

1. General: Install sloped glazing assemblies to comply with the following maximum tolerances:
   a. Level: 1/8 inch in 20 feet (3 mm in 6 m); 1/4 inch in 40 feet (6 mm in 12 m).
   b. Alignment: Limit offset from true alignment to 1/32 inch (0.8 mm) where surfaces abut in line, edge to edge, at corners, or where a reveal or protruding element separates aligned surfaces by less than 3 inches (76 mm); otherwise limit offset to 1/8 inch (3 mm).

c. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet (3 mm in 3.7 m); 1/2 inch (13 mm) over total length.

C. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Testing Services: Testing and inspecting of representative areas of sloped glazing assemblies shall take place as installation proceeds to determine compliance of installed assemblies with specified requirements.
   a. Structural-Sealant Adhesion: Test structural sealant according to recommendations in ASTM C 1401, Destructive Test Method A, "Hand Pull Tab (Destructive)," Appendix X2.
      1) Test a minimum of two **OR** four **OR** six, **as directed**, areas on each assembly face.
      2) Repair installation areas damaged by testing.
   b. Air Infiltration: Areas shall be tested for air leakage of 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article, but not more than 0.50 cfm/sq. ft. (2.25 L/s per sq. m), of assembly surface area when tested according to ASTM E 783 at a minimum static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa) **OR** 6.24 lbf/sq. ft. (300 Pa), **as directed**.
      1) Test Area: One bay wide, but not less than 30 by 30 feet (9.1 by 9.1 m) of sloped glazing assembly.
      2) Perform a minimum of two **OR** three, **as directed**, tests in areas as directed by the Owner.
         OR
         Perform tests in each test area as directed by the Owner. Perform at least three tests prior to 10, 35, and 70 percent completion.
   c. Water Penetration: Areas shall be tested according to ASTM E 1105 at a minimum uniform and cyclic static-air-pressure difference of 0.67 times the static-air-pressure difference specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft. (300 Pa), and shall not evidence water penetration.
      1) Test Area: One bay wide, but not less than 30 by 30 feet (9.1 by 9.1 m) of sloped glazing assembly.
      2) Perform a minimum of two **OR** three tests in areas as directed by the Owner.
         OR
         Perform tests in each test area as directed by the Owner. Perform at least three tests prior to 10, 35, and 70 percent completion.
   d. Water-Spray Test: Before installation of interior finishes has begun, areas designated by the Owner shall be tested according to AAMA 501.2 and shall not evidence water penetration.
      1) Test Area: A minimum area of 30 by 30 feet (9.1 by 9.1 m) of sloped glazing assembly.
3. Sloped glazing assemblies will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.

END OF SECTION 08912b

SECTION 08950 - STRUCTURED-POLYCARBONATE-PANEL ASSEMBLIES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for structured-polycarbonate-panel assemblies. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes aluminum-framed assemblies glazed with multiwalled (structured) polycarbonate panels as follows:
   a. Wall assemblies.
   b. Roof (sloped, overhead) assemblies.
   c. Skylight assemblies.

C. Performance Requirements
1. Provide assemblies, including anchorage, capable of withstanding, without failure, the effects of the following:
   a. Structural loads.
   b. Thermal movements.
   c. Movements of supporting structure.
   d. Dimensional tolerances of building frame and other adjacent construction.
2. Failure includes the following:
   a. Deflection exceeding specified limits.
   b. Water leakage.
   c. Thermal stresses transferred to building structure.
   d. Noise or vibration created by wind and thermal and structural movements.
   e. Loosening or weakening of fasteners, attachments, and other components.

D. Structural Loads:
   a. Wind Loads: As indicated by structural design data on Drawings **OR as directed**.
   b. Snow Loads: As indicated by structural design data on Drawings **OR as directed**.
   c. Concentrated Live Loads on Overhead Assemblies: 300 lbf (1334 N) applied to assemblies at locations that will produce greatest stress or deflection.
   d. Seismic Loads: As indicated by earthquake design data on Drawings **OR as directed**.
   e. Load Combinations: Calculate according to requirements of applicable code indicated on Drawings **OR as directed**.
2. Deflection of Assemblies:
   a. Vertical Assemblies: Limited to 1/100 of clear span for each assembly component.
   b. Overhead Assemblies: Limited to 1/100 **OR** 1/180, **as directed**, of clear span for each assembly component.
3. Roof Assemblies: Class A **OR** B **OR** C, **as directed**, per ASTM E 108 or UL 790.
4. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

E. Performance Testing
1. Provide assemblies that comply with test-performance requirements indicated, as evidenced by reports of tests performed on manufacturer's standard assemblies by a qualified independent testing agency.

2. Structural-Performance Test: ASTM E 330.
   a. Performance at Design Load: When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
   b. Performance at Maximum Test Load: When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main supporting members exceeding 0.2 percent of span.
   c. Test Durations: As required by design wind velocity but not less than 10 seconds.
3. Air-Infiltration Test: ASTM E 283.
   a. Minimum Static-Air-Pressure Difference: 1.57 lbf/sq. ft. (75 Pa) **OR** 6.24 lbf/sq. ft. (300 Pa), **as directed**.
   b. Maximum Air Leakage: 0.06 cfm/sq. ft. (0.30 L/s per sq. m).
4. Test for Water Penetration under Static Pressure: ASTM E 331.
   a. Minimum Static-Air-Pressure Difference: 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft. (718 Pa).
   b. Water Leakage: None.
5. Test for Water Penetration under Dynamic Pressure: AAMA 501.1.
   a. Dynamic Pressure: 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft. (718 Pa).
   b. Water Leakage: None, as defined by AAMA 501.1 **OR** No uncontrolled water penetrating systems or appearing on systems' normally exposed interior surfaces from sources other than condensation, **as directed**. Water controlled by flashing and gutters that is drained to exterior and cannot damage adjacent materials or finishes is not considered water leakage.

F. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:
   a. Product Data for Credit EQ 4.1: For sealants used inside of the weatherproofing system, documentation including printed statement of VOC content.
3. Shop Drawings: For assemblies. Include plans, elevations, sections, details, and attachments to other work.
   a. Include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
4. Samples: For each exposed finish.
5. Field quality-control test reports.
6. Product test reports.
7. Maintenance data.
8. Special warranties specified in this Section.

G. Quality Assurance
1. Installer Qualifications: Entity capable of assuming engineering responsibility and performing work of this Section and who is acceptable to manufacturer.
2. Fire-Test-Response Characteristics: Where fire-test-response characteristics are indicated for assemblies and components, provide products identical to those tested per test method indicated by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
3. Welding: Qualify procedures and personnel according to AWS D1.2, "Structural Welding Code - Aluminum."
4. Preinstallation Conference: Conduct conference at Project site.

H. Warranty
1. Special Assembly Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of assemblies that fail in materials or workmanship within specified warranty period.
   a. Failures include, but are not limited to, the following:
      1) Structural failures including, but not limited to, excessive deflection.

2) Deterioration of metals, metal finishes, and other materials beyond normal weathering.
3) Water leakage.

b. Warranty Period: Two **OR** Five, **as directed**, years from date of Substantial Completion.

2. Special Structured-Polycarbonate-Panel Warranty: Manufacturer's standard form agreeing to replace polycarbonate sheet that breaks or develops defects from normal use that are attributed to manufacturing process and not to practices for maintaining and cleaning products contrary to manufacturer's written instructions.
   a. Defects include, but are not limited to, the following:
      1) Delamination.
      2) Color changes from original in excess of 3.0 units Delta E when measured per ASTM D 2244.
      3) Losses in light transmission beyond 6 percent from original when measured per ASTM D 1003.
   b. Warranty Period: 10 years from date of Substantial Completion.
3. Special Aluminum-Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes fail within specified warranty period. Warranty does not include normal weathering.
   a. Failures include, but are not limited to, checking, crazing, peeling, chalking, and fading of finishes.
   b. Warranty Period: Five **OR** 10 **OR** 20, **as directed**, years from date of Substantial Completion.

1.2 PRODUCTS

A. Aluminum Framing Systems
1. Aluminum: Alloy and temper recommended in writing by manufacturer for type of use and finish indicated.
   a. Sheet and Plate: ASTM B 209 (ASTM B 209M).
   b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
   c. Extruded Structural Pipe and Tubes: ASTM B 429.
2. Components: Manufacturer's standard extruded-aluminum members of thickness required and reinforced as required to support imposed loads.
   a. Construction: One-piece extruded-aluminum components **OR** Thermally broken; framing members are composite assemblies of two separate extruded-aluminum components permanently bonded by a material of low thermal conductance, **as directed**.
3. Exposed Flashing and Closures: Manufacturer's standard aluminum components not less than 0.040 inch (1.016 mm) **OR** 0.060 inch (1.524 mm), **as directed**, thick.
4. Framing Gaskets: Manufacturer's standard.
5. Framing Sealants: As recommended in writing by manufacturer **OR** specified in Division 07 Section "Joint Sealants", **as directed**.
   a. Provide sealants for use inside of the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Anchors, Fasteners, and Accessories: Manufacturer's standard, corrosion-resistant, nonstaining, and nonbleeding; compatible with adjacent materials.
   a. At closures, retaining caps, or battens, use ASTM A 193/A 193M, 300 series stainless-steel screws.
   b. Where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
   c. At movement joints, use slip-joint linings, spacers, and sleeves of material and type recommended in writing by manufacturer.
7. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.

8. Anchor Bolts: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), hot-dip zinc coating, ASTM A 153/A 153M, Class C **OR** mechanically deposited zinc coating, ASTM B 695, Class 50, **as directed**.
9. Framing System Fabrication:
    a. Fabricate components before finishing.
    b. Fabricate components that, when assembled, have the following characteristics:
        1) Profiles that are sharp, straight, and free of defects or deformations.
        2) Accurately fitted joints with ends coped or mitered.
        3) Internal guttering systems or other means to drain water passing joints, condensation occurring within components, and moisture migrating within assembly to exterior.
    c. Fabricate sill closures with weep holes and for installation as continuous component.
    d. Reinforce components as required to receive fastener threads.
    e. Weld components in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

B. Structured Polycarbonate Panels
1. General: Translucent, extruded-polycarbonate sheet with cellular cross section that provides isolated airspaces and that is coextruded with a UV-protective layer.
    a. Plastic Self-Ignition Temperature: 650 deg F (343 deg C) or more per ASTM D 1929.
    b. Burning Extent: 1 inch (25 mm) or less per ASTM D 635.
    c. Burning Rate: 2.5 in/.min. (1.06 mm/s) or less per ASTM D 635.
    d. Smoke-Developed Index: 450 or less per ASTM E 84, or 75 or less per ASTM D 2843.
    e. Flame-Spread Index: Not more than 25 per ASTM E 84.
    f. Exterior-Fire-Exposure Class: Class A **OR** B **OR** C, **as directed**, per ASTM E 108 or UL 790.
2. Panel U-Factor: Not more than 0.73 (4.15) **OR** 0.63 (3.58) **OR** 0.48 (2.73) **OR** 0.38 (2.16) **OR** 0.24 (1.36) **OR** 0.22 (1.25), **as directed**, measured in Btu/sq. ft. x h x deg F (W/sq. m x K) according to ASTM C 1363 and using procedures described in ASTM C 1199 and ASTM E 1423.
3. Color Stability: Not more than 3.0 units Delta E when measured according to ASTM D 2244 after outdoor weathering according to procedures in ASTM D 1435.
    a. Outdoor Weathering Conditions: 60 months in Arizona or 120 months in a moderate North American climate.
4. Impact Resistance: No failure at impact of 200 ft. x lbf (271 J) according to free-falling-ball impact test using a 3-1/2-inch- (89-mm-) diameter, 6.3-lb (2.9-kg) ball.

C. Accessory Materials
1. Insulating Materials: Specified in Division 07 Section "Building Insulation".
2. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.

D. Aluminum Finishes
1. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
3. Aluminum Anodic Finish: Class I, clear anodic coating complying with AAMA 611 **OR** Class I, color anodic coating complying with AAMA 611, **as directed**.
    a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** Match sample **OR** As selected from full range of industry colors and densities, **as directed**.
4. Aluminum High-Performance Organic Finish: Two-coat **OR** Three-coat, **as directed**, thermocured system with fluoropolymer topcoats containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2604 **OR** AAMA 2605, **as directed**.
    a. Color and Gloss: As selected from manufacturer's full range.

1.3 EXECUTION

A. Installation
   1. General:
      a. Comply with manufacturer's written instructions.
      b. Do not install damaged components.
      c. Fit joints between aluminum components to produce hairline joints free of burrs and distortion.
      d. Rigidly secure nonmovement joints.
      e. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
      f. Weld aluminum components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
      g. Seal joints watertight, unless otherwise indicated.
   2. Metal Protection: Where aluminum components will contact dissimilar materials, protect against galvanic action by painting contact surfaces with bituminous paint or by installing nonconductive spacers as recommended in writing by manufacturer for this purpose.
   3. Install continuous aluminum sill closures with weatherproof expansion joints and locked and sealed or welded corners. Locate weep holes at rafters.
   4. Install components to drain water passing joints, condensation occurring within aluminum members, and moisture migrating within assembly to exterior.
   5. Install components plumb and true in alignment with established lines and elevations.
   6. Install insulation materials as specified in Division 07 Section "Building Insulation".
   7. Erection Tolerances: Install assemblies to comply with the following maximum tolerances:
      a. Alignment: Limit offset from true alignment to 1/32 inch (0.8 mm) where surfaces abut in line, edge to edge, at corners, or where a reveal or protruding element separates aligned surfaces by less than 3 inches (76 mm); otherwise, limit offset to 1/8 inch (3.2 mm).
      b. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet (3.2 mm in 3.7 m); 1/2 inch (13 mm) over total length.

B. Field Quality Control
   1. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
   2. Testing Services: Testing and inspecting of representative areas to determine compliance of installed assemblies with specified requirements shall take place as follows and in successive stages as indicated on Drawings. Do not proceed with installation of the next area until test results for previously completed areas show compliance with requirements.
      a. Water Penetration under Static Pressure: Before installation of interior finishes has begun, areas shall be tested according to ASTM E 1105.
         1) Test Procedures: Test under uniform and cyclic static air pressure.
         2) Static-Air-Pressure Difference: as directed by the Owner.
         3) Water Penetration: None.
      b. Water-Spray Test: Before installation of interior finishes has begun, assemblies shall be tested according to AAMA 501.2 and shall not evidence water penetration.
   3. Repair or remove work where test results and inspections indicate that it does not comply with specified requirements.
   4. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

END OF SECTION 08950

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SECTION 08950a - FIBERGLASS-SANDWICH-PANEL ASSEMBLIES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of material for fiberglass-sandwich-panel assemblies. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes assemblies incorporating fiberglass sandwich panels and aluminum frame systems as follows:
   a. Wall assemblies.
   b. Roof (sloped, overhead) assemblies.
   c. Skylight assemblies.

C. Performance Requirements
1. Provide assemblies, including anchorage, capable of withstanding, without failure, the effects of the following:
   a. Structural loads.
   b. Thermal movements.
   c. Movements of supporting structure.
   d. Dimensional tolerances of building frame and other adjacent construction.
2. Failure includes the following:
   a. Deflection exceeding specified limits.
   b. Water leakage.
   c. Thermal stresses transferred to building structure.
   d. Noise or vibration created by wind and thermal and structural movements.
   e. Loosening or weakening of fasteners, attachments, and other components.
   f. Delamination of fiberglass-sandwich-panel faces from panel cores.
3. Structural Loads:
   a. Wind Loads: As indicated by structural design data on Drawings **OR as directed**.
   b. Snow Loads: As indicated by structural design data on Drawings **OR as directed**.
   c. Concentrated Live Loads on Overhead Assemblies: 300 lbf (1334 N) applied to assemblies at locations that will produce greatest stress or deflection.
   d. Seismic Loads: As indicated by earthquake design data on Drawings **OR as directed**.
   e. Load Combinations: Calculate according to requirements of applicable code indicated on Drawings **OR as directed**.
4. Deflection of Assemblies:
   a. Vertical Assemblies: Limited to 1/60 **OR** 1/90 **OR** 1/180, **as directed**, of clear span for each assembly component.
   b. Overhead Assemblies: Limited to 1/60 **OR** 1/90 **OR** 1/180, **as directed**, of clear span for each assembly component.
5. Roof Assemblies: Class A per ASTM E 108 or UL 790.
6. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

D. Performance Testing

1. Provide assemblies that comply with test-performance requirements indicated, as evidenced by reports of tests performed on manufacturer's standard assemblies by a qualified independent testing agency.
2. Structural-Performance Test: ASTM E 330.
   a. Performance at Design Load: When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
   b. Performance at Maximum Test Load: When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main supporting members exceeding 0.2 percent of span.
   c. Test Durations: As required by design wind velocity but not less than 10 seconds.
3. Air-Infiltration Test: ASTM E 283.
   a. Minimum Static-Air-Pressure Difference: 1.57 lbf/sq. ft. (75 Pa) **OR** 6.24 lbf/sq. ft. (300 Pa), **as directed**.
   b. Maximum Air Leakage: 0.06 cfm/sq. ft. (0.30 L/s per sq. m), **as directed**.
4. Test for Water Penetration under Static Pressure: ASTM E 331.
   a. Minimum Static-Air-Pressure Difference: 20 percent of positive wind-load design pressure, but not less than 10 lbf/sq. ft. (479 Pa).
   b. Water Leakage: None.
5. Test for Water Penetration under Dynamic Pressure: AAMA 501.1.
   a. Dynamic Pressure: 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft. (718 Pa).
   b. Water Leakage: None, as defined by AAMA 501.1 **OR** No uncontrolled water penetrating systems or appearing on systems' normally exposed interior surfaces from sources other than condensation, **as directed**. Water controlled by flashing and gutters that is drained to exterior and cannot damage adjacent materials or finishes is not considered water leakage.
6. Water-Penetration, Wind-Driven-Rain Test: Wind-driven-rain test in ICBO ES AC07, "Special Roofing Systems."
   a. Water Leakage: None.

E. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:
   a. Product Data for Credit EQ 4.1: For sealants used inside of the weatherproofing system, documentation including printed statement of VOC content.
3. Shop Drawings: For assemblies. Include plans, elevations, sections, details, and attachments to other work.
   a. Include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
4. Field quality-control test reports.
5. Product test reports.
6. Maintenance data.
7. Special warranties specified in this Section.

F. Quality Assurance
1. Installer Qualifications: Entity capable of assuming engineering responsibility, including preparation of Shop Drawings, and performing work of this Section and who is acceptable to manufacturer.
2. Manufacturer Qualifications: For fiberglass sandwich panels, a qualified manufacturer whose facilities, processes, and products are monitored by an independent, accredited quality-control agency for compliance with applicable requirements in ICBO ES AC04, "Sandwich Panels."
3. Fire-Test-Response Characteristics: Where fire-test-response characteristics are indicated for assemblies and components, provide products identical to those tested per test method indicated by an independent testing and inspecting agency acceptable to authorities having jurisdiction.

4. Welding: Qualify procedures and personnel according to AWS D1.2, "Structural Welding Code - Aluminum."
5. NFRC Certification: Provide fiberglass sandwich panels that are certified for U-factors indicated according to NFRC 100 and listed in its "National Fenestration Council Incorporated - Certified Products Directory."
6. Preinstallation Conference: Conduct conference at Project site.

G. Warranty
1. Special Assembly Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of assemblies that fail in materials or workmanship within specified warranty period.
   a. Failures include, but are not limited to, the following:
      1) Structural failures including, but not limited to, excessive deflection.
      2) Deterioration of metals, metal finishes, and other materials beyond normal weathering.
      3) Water leakage.
   b. Warranty Period: Two **OR** Five, **as directed**, years from date of Substantial Completion.
2. Special Fiberglass-Sandwich-Panel Warranty: Manufacturer's standard form in which manufacturer agrees to replace panels that exhibit defects in materials or workmanship.
   a. Defects include, but are not limited to, the following:
      1) Fiberbloom.
      2) Delamination of coating, if any, from exterior face sheet.
      3) Discoloration of exterior face sheet of more than 8.0 units Delta E when measured according ASTM D 2244.
      4) Delamination of panel face sheets from panel cores.
   b. Warranty Period: 10 years from date of Substantial Completion.
3. Special Aluminum-Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes fail within specified warranty period. Warranty does not include normal weathering.
   a. Failures include, but are not limited to, checking, crazing, peeling, chalking, and fading of finishes.
   b. Warranty Period: Five **OR** 10 **OR** 20, **as directed**, years from date of Substantial Completion.

1.2 PRODUCTS

A. Aluminum Frame Systems
1. Aluminum: Alloy and temper recommended in writing by manufacturer for type of use and finish indicated.
   a. Sheet and Plate: ASTM B 209 (ASTM B 209M).
   b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
   c. Extruded Structural Pipe and Tubes: ASTM B 429.
2. Components: Manufacturer's standard extruded-aluminum members of thickness required and reinforced as required to support imposed loads.
   a. Construction: One-piece extruded-aluminum components **OR** Thermally broken; framing members are composite assemblies of two separate extruded-aluminum components permanently bonded by a material of low thermal conductance, **as directed**.
3. Exposed Flashing and Closures: Manufacturer's standard aluminum components not less than 0.040 inch (1.016 mm) **OR** 0.060 inch (1.524 mm), **as directed**, thick.
4. Frame-System Gaskets: Manufacturer's standard.
5. Frame-System Sealants: As recommended in writing by manufacturer **OR** specified in Division 07 Section "Joint Sealants", **as directed**.
   a. Provide sealants for use inside of the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

6. Anchors, Fasteners, and Accessories: Manufacturer's standard, corrosion-resistant, nonstaining, and nonbleeding; compatible with adjacent materials.
   a. At closures, retaining caps, or battens, use ASTM A 193/A 193M, 300 series stainless-steel screws.
   b. Where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
   c. At movement joints, use slip-joint linings, spacers, and sleeves of material and type recommended in writing by manufacturer.
7. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.
8. Anchor Bolts: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), hot-dip zinc coating, ASTM A 153/A 153M, Class C **OR** mechanically deposited zinc coating, ASTM B 695, Class 50, **as directed**.
9. Frame System Fabrication:
   a. Fabricate components before finishing.
   b. Fabricate components that, when assembled, have the following characteristics:
      1) Profiles that are sharp, straight, and free of defects or deformations.
      2) Accurately fitted joints with ends coped or mitered.
      3) Internal guttering systems or other means to drain water passing joints, condensation occurring within components, and moisture migrating within the assembly to exterior.
   c. Fabricate sill closures with weep holes and for installation as continuous component.
   d. Reinforce components as required to receive fastener threads.
   e. Weld components in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

B. Fiberglass Sandwich Panels
1. Panel Construction: Assembly of uniformly colored, translucent, thermoset, fiberglass-reinforced-polymer face sheets bonded to both sides of a grid core and complying with requirements applicable to panel materials in ICBO ES AC04, "Sandwich Panels."
   a. Face-Sheet, Self-Ignition Temperature: 650 deg F (343 deg C) or more per ASTM D 1929.
   b. Face-Sheet Burning Extent: 1 inch (25 mm) or less per ASTM D 635.
   c. Face-Sheet, Smoke-Developed Index: 450 or less per ASTM E 84.
   d. Interior Face-Sheet, Flame-Spread Index: Not more than 25 **OR** 75, **as directed**, per ASTM E 84.
   e. Roof-Covering Class: Class A **OR** Class A, burning brand test (only), **as directed**, per ASTM E 108 or UL 790.
2. Panel Thickness: 2-3/4 inches (70 mm) **OR** 1-1/2 to 1-9/16 inches (38 to 40 mm), **as directed**.
3. Panel U-Factor: Not more than 0.70 (3.97) **OR** 0.53 (3.01) **OR** 0.44 (2.50) **OR** 0.40 (2.27) **OR** 0.29 (1.65) **OR** 0.28 (1.59) **OR** 0.26 (1.48) **OR** 0.24 (1.36) **OR** 0.23 (1.31) **OR** 0.22 (1.25) **OR** 0.18 (1.02) **OR** 0.15 (0.85) **OR** 0.14 (0.79) **OR** 0.10 (0.57), **as directed**, measured in Btu/sq. ft. x h x deg F (W/sq. m x K) according to NFRC 100 or ASTM C 1363 using procedures described in ASTM C 1199 and ASTM E 1423.
4. Panel Strength Characteristics:
   a. Maximum Panel Deflection: 3-1/2 inches (89 mm) when a 4-by-12-foot (1.2-by-3.6-m) panel is tested according to ASTM E 72 at 34 lbf/ sq. ft. (1.6 kPa), with a maximum 0.090-inch (2.3-mm) set deflection after 5 minutes.
   b. Panel Support Strength: Capable of supporting, without failure, a 300-lbf (1334 N) concentrated load when applied to a 3-inch- (76-mm-) diameter disk according to ASTM E 661.
5. Grid Core: Mechanically interlocked extruded-aluminum I-beams, with a minimum flange width of 7/16 inch (11.1 mm).
   a. Extruded Aluminum: ASTM B 221 (ASTM B 221M), in alloy and temper recommended in writing by manufacturer.

b. I-Beam Construction: One-piece extruded-aluminum components **OR** Thermally broken; two separate extruded-aluminum components permanently bonded by a material of low thermal conductance, **as directed**.
c. Grid Pattern: Inline rectangle, nominal 12 by 24 inches (305 by 610 mm) **OR** Staggered rectangle, nominal 12 by 24 inches (305 by 610 mm) **OR** Square, nominal 12 inches (305 mm) **OR** As indicated on Drawings, **as directed**.

6. Exterior Face Sheet:
   a. Thickness: 0.070 inches (1.778 mm) **OR** 0.060 inches (1.524 mm) **OR** 0.052 inches (1.321 mm), **as directed**.
   b. Color: White **OR** Crystal **OR** As selected from manufacturer's full range, **as directed**.
   c. Color Stability: Not more than 3.0 **OR** 4.0 **OR** 7.0, **as directed**, units Delta E when measured according to ASTM D 2244 after outdoor weathering in southern Florida according to procedures in ASTM D 1435 with panels mounted facing south and as follows:
      1) Panel Mounting Angle: Not more than 5 **OR** 45, **as directed**, degrees from horizontal.
      2) Exposure Period: 60 months **OR** 30 months **OR** 60 months for vertical assemblies, 30 months for components of Class A roof assemblies, **as directed**.
   d. Erosion Protection: Manufacturer's standard **OR** Integral, embedded glass erosion barrier **OR** Surface-applied, polyvinyl fluoride film not less than 1.0 mils (0.03 mm) thick, **as directed**.
   e. Impact Resistance: No fracture or tear at impact of 60 ft. x lbf (81 J) **OR** 70 ft. x lbf (95 J) **OR** 230 ft. x lbf (312 J), **as directed**, by a 3-1/4-inch- (83-mm-) diameter, 5-lb (2.3-kg) free-falling ball according to test procedure in UL 972.
7. Interior Face Sheet:
   a. Thickness: 0.045 inch (1.143 mm) **OR** 0.060 inch (1.524 mm), **as directed**.
   b. Color: White **OR** Crystal **OR** As selected from manufacturer's full range, **as directed**.
8. Fiberglass-Sandwich-Panel Adhesive: ASTM D 2559.
   a. Compatible with facing and core materials.
   b. Tensile and shear bond strength of aged adhesive ensures permanent adhesion of facings to cores, as evidenced by testing according to ASTM C 297 and ASTM D 1002 after accelerated aging procedures that comply with aging requirements for adhesives with high resistance to moisture in ICBO ES AC05, "Sandwich Panel Adhesives."
9. Panel Fabrication: Factory assemble and seal panels.
   a. Laminate face sheets to grid core under a controlled process using heat and pressure to produce straight adhesive bonding lines that cover width of core members and that have sharp edges.
      1) White spots indicating lack of bond at intersections of grid-core members are limited in number to 4 for every 40 sq. ft. (3.7 sq. m) of panel and limited in diameter to 3/64 inch (1.2 mm).
   b. Fabricate with grid pattern that is symmetrical about centerlines of each panel.
   c. Fabricate panel to allow condensation within panel to escape.
   d. Reinforce panel corners.

C. Accessory Materials
1. Insulating Materials: Specified in Division 07 Section "Building Insulation".
2. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.

D. Aluminum Finishes
1. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
3. Aluminum Anodic Finish: Class I, clear anodic coating complying with AAMA 611 **OR** Class I, color anodic coating complying with AAMA 611, **as directed**.

a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** Match sample **OR** As selected from full range of industry colors and densities, **as directed**.

4. Aluminum High-Performance Organic Finish: Two-coat **OR** Three-coat, **as directed**, thermocured system with fluoropolymer topcoats containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2604 **OR** AAMA 2605, **as directed**.
   a. Color: Match sample **OR** As selected from manufacturer's full range, **as directed**.

1.3 EXECUTION

A. Installation
   1. General:
      a. Comply with manufacturer's written instructions.
      b. Do not install damaged components.
      c. Fit joints between aluminum components to produce hairline joints free of burrs and distortion.
      d. Rigidly secure nonmovement joints.
      e. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
      f. Weld aluminum components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
      g. Seal joints watertight, unless otherwise indicated.
   2. Metal Protection: Where aluminum components will contact dissimilar materials, protect against galvanic action by painting contact surfaces with bituminous paint or by installing nonconductive spacers as recommended in writing by manufacturer for this purpose.
   3. Install continuous aluminum sill closure with weatherproof expansion joints and locked and sealed or welded corners. Locate weep holes at rafters.
   4. Install components to drain water passing joints, condensation occurring within aluminum members and panels, and moisture migrating within assembly to exterior.
   5. Install components plumb and true in alignment with established lines and elevations.
   6. Install insulation materials as specified in Division 07 Section "Building Insulation".
   7. Erection Tolerances: Install assemblies to comply with the following maximum tolerances:
      a. Alignment: Limit offset from true alignment to 1/32 inch (0.8 mm) where surfaces abut in line, edge to edge, at corners, or where a reveal or protruding element separates aligned surfaces by less than 3 inches (76 mm); otherwise, limit offset to 1/8 inch (3.2 mm).
      b. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet (3.2 mm in 3.7 m); 1/2 inch (13 mm) over total length.

B. Field Quality Control
   1. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
   2. Testing Services: Testing and inspecting of representative areas to determine compliance of installed assemblies with specified requirements shall take place as follows and in successive stages as indicated on Drawings. Do not proceed with installation of the next area until test results for previously completed areas show compliance with requirements.
      a. Water Penetration under Static Pressure: Before installation of interior finishes has begun, areas shall be tested according to ASTM E 1105.
         1) Test Procedures: Test under uniform and cyclic static air pressure.
         2) Static-Air-Pressure Difference: as directed by the Owner.
         3) Water Penetration: None.
      b. Water-Spray Test: Before installation of interior finishes has begun, assemblies shall be tested according to AAMA 501.2 and shall not evidence water penetration.
   3. Repair or remove work where test results and inspections indicate that it does not comply with specified requirements.

4. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

END OF SECTION 08950a

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Task	Specification	Specification Description
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08950	08630	Metal-Framed Skylights

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JOB ORDER CONTRACT

Technical Specifications

VOLUME III of V
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Task	Specification	Specification Description
09105	05410a	Cold-Formed Metal Framing

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SECTION 09110 - NON-LOAD-BEARING STEEL FRAMING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for non-load bearing steel framing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes non-load-bearing steel framing members for the following applications:
   a. Interior framing systems (e.g., supports for partition walls, framed soffits, furring, etc.).
   b. Interior suspension systems (e.g., supports for ceilings, suspended soffits, etc.).

C. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:
   a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
      1) Include statement indicating costs for each product having recycled content.

D. Quality Assurance
1. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
2. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

1.2 PRODUCTS

A. Non-Load-Bearing Steel Framing, General
1. Recycled Content of Steel Products: Provide products with average recycled content of steel products such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
2. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
   a. Steel Sheet Components: Comply with ASTM C 645 requirements for metal, unless otherwise indicated.
   b. Protective Coating: ASTM A 653/A 653M, G40 (Z120) **OR** ASTM A 653/A 653M, G60 (Z180) **OR** Coating with equivalent corrosion resistance of ASTM A 653/A 653M, G40 (Z120), **as directed**, hot-dip galvanized, unless otherwise indicated.

B. Suspension System Components
1. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch- (1.59-mm-) diameter wire, or double strand of 0.0475-inch- (1.21-mm-) diameter wire.
2. Hanger Attachments to Concrete:
   a. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E 488 by an independent testing agency.

1) Type: Cast-in-place anchor, designed for attachment to concrete forms **OR** Postinstalled, chemical anchor **OR** Postinstalled, expansion anchor, **as directed**.

b. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by an independent testing agency.

3. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162-inch (4.12-mm) diameter.
4. Flat Hangers: Steel sheet, in size indicated on Drawings **OR** 1 by 3/16 inch (25.4 by 4.76 mm) by length indicated, **as directed**.
5. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.0538 inch (1.37 mm) and minimum 1/2-inch- (12.7-mm-) wide flanges.
   a. Depth: As indicated on Drawings **OR** 2-1/2 inches (64 mm) **OR** 2 inches (51 mm) **OR** 1-1/2 inches (38 mm), **as directed**.
6. Furring Channels (Furring Members):
   a. Cold-Rolled Channels: 0.0538-inch (1.37-mm) bare-steel thickness, with minimum 1/2-inch- (12.7-mm-) wide flanges, 3/4 inch (19.1 mm) deep.
   b. Steel Studs: ASTM C 645.
      1) Minimum Base-Metal Thickness: As indicated on Drawings **OR** 0.0179 inch (0.45 mm) **OR** 0.0312 inch (0.79 mm), **as directed**.
      2) Depth: As indicated on Drawings **OR** 1-5/8 inches (41.3 mm) **OR** 2-1/2 inches (63.5 mm) **OR** 3-5/8 inches (92.1 mm), **as directed**.
   c. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch (22.2 mm) deep.
      1) Minimum Base Metal Thickness: As indicated on Drawings **OR** 0.0179 inch (0.45 mm) **OR** 0.0312 inch (0.79 mm), **as directed**.
   d. Resilient Furring Channels: 1/2-inch- (12.7-mm-) deep members designed to reduce sound transmission.
      1) Configuration: Asymmetrical **OR** Hat shaped, **as directed**.
7. Grid Suspension System for Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.

C. Steel Framing For Framed Assemblies
1. Steel Studs and Runners: ASTM C 645.
   a. Minimum Base-Metal Thickness: As indicated on Drawings **OR** 0.0179 inch (0.45 mm) **OR** 0.027 inch (0.7 mm) **OR** 0.0312 inch (0.79 mm), **as directed**.
   b. Depth: As indicated on Drawings **OR** 3-5/8 inches (92.1 mm) **OR** 6 inches (152.4 mm) **OR** 4 inches (101.6 mm) **OR** 2-1/2 inches (63.5 mm) **OR** 1-5/8 inches (41.3 mm), **as directed**.
2. Slip-Type Head Joints: Where indicated, provide one of the following:
   a. Single Long-Leg Runner System: ASTM C 645 top runner with 2-inch- (50.8-mm-) deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top runner and with continuous bridging located within 12 inches (305 mm) of the top of studs to provide lateral bracing.
   b. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch- (50.8-mm-) deep flanges in thickness not less than indicated for studs and fastened to studs, and outer runner sized to friction fit inside runner.
   c. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
3. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
4. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
   a. Minimum Base-Metal Thickness: As indicated on Drawings **OR** 0.0179 inch (0.45 mm) **OR** 0.027 inch (0.7 mm) **OR** 0.0312 inch (0.79 mm), **as directed**.

5. Cold-Rolled Channel Bridging: 0.0538-inch (1.37-mm) bare-steel thickness, with minimum 1/2-inch- (12.7-mm-) wide flanges.
   a. Depth: As indicated on Drawings **OR** 1-1/2 inches (38.1 mm), **as directed**.
   b. Clip Angle: Not less than 1-1/2 by 1-1/2 inches (38.1 by 38.1 mm), 0.068-inch- (1.73-mm-) thick, galvanized steel.
6. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
   a. Minimum Base Metal Thickness: As indicated on Drawings **OR** 0.0179 inch (0.45 mm) **OR** 0.0312 inch (0.79 mm), **as directed**.
   b. Depth: As indicated on Drawings **OR** 7/8 inch (22.2 mm) **OR** 1-1/2 inches (38.1 mm), **as directed**.
7. Resilient Furring Channels: 1/2-inch- (12.7-mm-) deep, steel sheet members designed to reduce sound transmission.
   a. Configuration: Asymmetrical **OR** Hat shaped, **as directed**.
8. Cold-Rolled Furring Channels: 0.0538-inch (1.37-mm) bare-steel thickness, with minimum 1/2-inch- (12.7-mm-) wide flanges.
   a. Depth: As indicated on Drawings **OR** 3/4 inch (19.1 mm), **as directed**.
   b. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum bare-steel thickness of 0.0312 inch (0.79 mm).
   c. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch- (1.59-mm-) diameter wire, or double strand of 0.0475-inch- (1.21-mm-) diameter wire.
9. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (31.8 mm), wall attachment flange of 7/8 inch (22.2 mm), minimum bare-metal thickness of 0.0179 inch (0.45 mm), and depth required to fit insulation thickness indicated.

D. Auxiliary Materials
1. General: Provide auxiliary materials that comply with referenced installation standards.
   a. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
2. Isolation Strip at Exterior Walls: Provide one of the following:
   a. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), nonperforated.
   b. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch (3.2 mm) thick, in width to suit steel stud size.

1.3 EXECUTION

A. Preparation
1. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
   a. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.
2. Coordination with Sprayed Fire-Resistive Materials:
   a. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling runners (tracks) to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches (600 mm) o.c.
   b. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

B. Installation, General
1. Installation Standard: ASTM C 754, except comply with framing sizes and spacing indicated.

a. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C 841 that apply to framing installation.
b. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C 1063 that apply to framing installation.
c. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C 844 that apply to framing installation.
d. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

2. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
3. Install bracing at terminations in assemblies.
4. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

C. Installing Suspension Systems
1. Install suspension system components in sizes and spacings indicated on Drawings, but not less than those required by referenced installation standards for assembly types and other assembly components indicated.
2. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
3. Suspend hangers from building structure as follows:
a. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
1) Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
b. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
1) Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
c. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
d. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
e. Do not attach hangers to steel roof deck.
f. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
g. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
h. Do not connect or suspend steel framing from ducts, pipes, or conduit.
4. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.
5. Seismic Bracing: Sway-brace suspension systems with hangers used for support.
6. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
7. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet (3 mm in 3.6 m) measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

D. Installing Framed Assemblies
1. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

2. Install studs so flanges within framing system point in same direction.
   a. Space studs as follows:
      1) Single-Layer Application: 16 inches (406 mm) **OR** 24 inches (610 mm) **OR** 400 mm **OR** 600 mm, **as directed**, o.c., unless otherwise indicated.
      2) Multilayer Application: 16 inches (406 mm) **OR** 24 inches (610 mm) **OR** 400 mm **OR** 600 mm, **as directed**, o.c., unless otherwise indicated.
      3) Tile backing panels: 16 inches (406 mm) **OR** 400 mm, **as directed**, o.c., unless otherwise indicated.
3. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.
   a. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
   b. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
      1) Install two studs at each jamb, unless otherwise indicated.
      2) Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (12.7-mm) clearance from jamb stud to allow for installation of control joint in finished assembly.
      3) Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
   c. Other Framed Openings: Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
   d. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
      1) Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
   e. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
   f. Curved Partitions:
      1) Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
      2) Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of not less than 2 studs at ends of arcs, place studs 6 inches (150 mm) o.c.
4. Direct Furring:
   a. Screw to wood framing.
   b. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.
5. Z-Furring Members:
   a. Erect insulation (specified in Division 07 Section "Building Insulation") vertically and hold in place with Z-furring members spaced 24 inches (610 mm) **OR** 600 mm, **as directed**, o.c.
   b. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (600 mm) o.c.
   c. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches (300 mm) from corner and cut insulation to fit.
6. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

END OF SECTION 09110

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SECTION 09205 - GYPSUM VENEER PLASTER

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for gypsum veneer plastering. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Gypsum veneer plaster and gypsum base for veneer plaster.
b. Gypsum veneer plaster over cementitious backer units.
c. Gypsum veneer plaster over masonry surfaces.
d. Gypsum veneer plaster over monolithic concrete surfaces.

C. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Show locations, fabrication, and installation of control joints, and reveals and trim; include plans, elevations, sections, details of components, and attachments to other work.
3. Samples: For the following products:
a. Trim Accessories: Full-size Sample in 12-inch (300-mm) length for each trim accessory.
b. Textured Finishes: Manufacturer's standard size for each textured finish and on rigid backing.
4. LEED Submittals:
a. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content.
b. Product Data for Credit MR 4.1 and MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
1) Include statement indicating costs for each product having recycled content.

D. Quality Assurance
1. Source Limitations: Obtain gypsum veneer plaster products, including gypsum base for veneer plaster, **OR** cementitious base units, **as directed**, joint reinforcing tape, and embedding material, from a single manufacturer.
2. Fire-Resistance-Rated Assemblies: Provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by a testing and inspecting agency.
3. STC-Rated Assemblies: Provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by a testing and inspecting agency.

E. Delivery, Storage, And Handling
1. Deliver materials in original packages, containers, and bundles bearing brand name and identification of manufacturer or supplier.
2. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.
3. Stack panels flat on leveled supports off floor or slab to prevent sagging.

F. Project Conditions
1. Environmental Limitations: Comply with ASTM C 843 requirements or gypsum veneer plaster manufacturer's written recommendations, whichever are more stringent.

2. Room Temperatures: Maintain not less than 55 deg F (13 deg C) or more than 80 deg F (27 deg C) for 7 days before application of gypsum base and gypsum veneer plaster, continuously during application, and after application until veneer plaster is dry.
3. Avoid conditions that result in gypsum veneer plaster drying too rapidly.
   a. Distribute heat evenly; prevent concentrated or uneven heat on veneer plaster.
   b. Maintain relative humidity levels, for prevailing ambient temperature, that produce normal drying conditions.
   c. Ventilate building spaces in a manner that prevents drafts of air from contacting surfaces during veneer plaster application until it is dry.
4. Do not install panels that are wet, moisture damaged, or mold damaged.
   a. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
   b. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

1.2 PRODUCTS

A. Gypsum Veneer Plaster Materials
1. One-Component Gypsum Veneer Plaster: ASTM C 587, formulated for application directly over substrate without use of separate base-coat material.
2. High-Strength, One-Component Gypsum Veneer Plaster: ASTM C 587, ready-mixed, smooth, finish-coat veneer plaster containing mill-mixed, fine silica sand; with a compressive strength of 3000 psi (20 MPa) when tested according to ASTM C 472; and formulated for application directly over substrate without use of separate base-coat material.
3. Two-Component Gypsum Veneer Plaster: ASTM C 587, with separate formulations; one for base-coat and one for finish-coat application over substrates.
4. High-Strength, Two-Component Gypsum Veneer Plaster: ASTM C 587, ready-mixed, base-coat plaster and smooth finish-coat veneer plaster containing mill-mixed, fine silica sand; with a compressive strength of 3000 psi (20 MPa) when tested according to ASTM C 472.
5. Radiant-Heat, Two-Component Gypsum Veneer Plaster: ASTM C 587, and approved in writing by gypsum veneer plaster manufacturer for application with embedded electric heating cables.
   a. Provide ready-mixed **OR** job-aggregated, **as directed**, components, as standard for manufacturer, to comply with manufacturer's written recommendations.
   b. Aggregate: For job-aggregated base coat and texture finish coat, provide white silica sand passing a No. 30 (0.6-mm) sieve.

B. Panel Products
1. Recycled Content: Provide gypsum panel products with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 25 percent by weight.
2. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.
3. Gypsum Base for Veneer Plaster: ASTM C 588/C 588M.
   a. Regular Type: In thickness indicated **OR** 1/2 inch (13 mm) thick, unless otherwise indicated, **as directed**.
   b. Type X: In thickness indicated **OR** 5/8 inch (16 mm) thick, **as directed**.
   c. Foil-Backed, Regular-Type Core: In thickness indicated **OR** 1/2 inch (13 mm) thick, unless otherwise indicated, **as directed**.
   d. Type C: In thickness indicated **OR** 5/8 inch (16 mm) thick **OR** 1/2 inch (13 mm) thick, **as directed**.
   e. Abuse-Resistant Base: With specially reinforced core for greater resistance to surface indentation, 5/8-inch (16-mm) thick, Type X core **OR** 1/2-inch (13-mm) thick, regular-type core, **as directed**.

f. High-Impact Base: With Type X core, plastic film laminated to back side for greater resistance to through-penetration (impact resistance), and in thickness indicated **OR** 5/8 inch (16 mm) thick, **as directed**.
   1) Plastic-Film Thickness: 0.010 inch (0.254 mm) **OR** 0.020 inch (0.508 mm) **OR** 0.030 inch (0.762 mm) **OR** 0.081 inch (2.057 mm), **as directed**.

g. Moisture- and Mold-Resistant Base: With moisture- and mold-resistant core, glass-mat facing on both sides of panel, and in thickness indicated **OR** 5/8-inch (16-mm) thick, Type X core **OR** 1/2-inch (13-mm) thick, regular-type core, **as directed**.
   1) Mold Resistance: ASTM D 3273; no mold growth after four weeks' exposure.

4. Backing Panels for Multilayer Applications: ASTM C 588/C 588M gypsum base or ASTM C 36/C 36M gypsum board, as recommended by gypsum veneer plaster manufacturer, for application method and thicknesses indicated.
   a. Core: Matching face layer, unless otherwise indicated.
   b. Thickness: Matching face layer, unless otherwise indicated.
5. Cementitious Backer Units: ANSI A118.9, in thickness indicated **OR** 1/2 inch (13 mm) thick, **as directed**.

C. Trim Accessories
1. Standard Trim: ASTM C 1047, provided or approved by manufacturer for use in gypsum veneer plaster applications indicated.
   a. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet **OR** Galvanized or aluminum-coated steel sheet or rolled zinc **OR** Plastic **OR** Paper-faced galvanized steel sheet, **as directed**.
   b. Shapes:
      1) Cornerbead.
      2) Bullnose bead.
      3) LC-Bead: J-shaped; exposed long flange receives joint compound.
      4) L-Bead: L-shaped; exposed long flange receives joint compound.
      5) U-Bead: J-shaped; exposed short flange does not receive joint compound.
      6) Curved-Edge Cornerbead: With notched or flexible flanges.
      7) Control joints.
2. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.
   a. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221 (ASTM B 221M), Alloy 6063-T5.
   b. Finish: Manufacturer's standard Architectural Class II, Clear Anodic Finish AA-M12C22A31, complying with AAMA 611 **OR** chemical conversion coat finish **OR** prime paint finish, **as directed**.

D. Joint Reinforcing Materials
1. General: Comply with joint strength requirements in ASTM C 587 and with gypsum veneer plaster manufacturer's written recommendations for each application indicated.
2. Joint Tape:
   a. Gypsum Base for Veneer Plaster: As recommended by gypsum veneer plaster manufacturer for applications indicated **OR** Paper **OR** Open-mesh, glass fiber, **as directed**.
   b. Cementitious Backer Units: As recommended by cementitious backer unit manufacturer.
3. Embedding Material for Joint Tape:
   a. Gypsum Base for Veneer Plaster: As recommended by gypsum veneer plaster manufacturer for use with joint-tape material and gypsum veneer plaster applications indicated.
   b. Cementitious Backer Units: As recommended by cementitious backer unit manufacturer for applications indicated.

E. Auxiliary Materials
1. General: Provide auxiliary materials that comply with referenced product standards and manufacturer's written recommendations.

2. Bonding Agent: ASTM C 631, polyvinyl acetate.
3. Laminating Adhesive: Adhesive or joint compound recommended by manufacturer for directly adhering gypsum base face-layer panels to backing-layer panels in multilayer construction.
   a. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
4. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
   a. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
5. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
6. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing), produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
   a. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
   b. Recycled Content: Provide blankets with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 25 percent by weight.
7. Acoustical Sealant: As specified in Division 07 Section "Building Insulation".
   a. Provide sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
8. Patching Mortar: Dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 (1.18-mm) sieve, using only enough water for handling and placing.

F. Gypsum Veneer Plaster Mixes
   1. Mechanically mix gypsum veneer plaster materials to comply with ASTM C 843 and with gypsum veneer plaster manufacturer's written recommendations.

1.3 EXECUTION

A. Preparation
   1. Monolithic Concrete Substrates: Prepare according to gypsum veneer plaster manufacturer's written recommendations and as follows:
      a. Clean surfaces to remove dust, loose particles, grease, oil, incompatible curing compounds, form-release agents, and other foreign matter and deposits that could impair bond with gypsum veneer plaster.
      b. Remove ridges and protrusions greater than 1/8 inch (3 mm) and fill depressions greater than 1/4 inch (6 mm) with patching mortar. Allow to set and dry.
      c. Apply bonding agent on dry and cured concrete substrates.
   2. Masonry Substrates: Prepare according to gypsum veneer plaster manufacturer's written recommendations and as follows:
      a. Clean surfaces to remove dirt, grease, oil, and other foreign matter and deposits that could impair bond with gypsum veneer plaster.
      b. Apply bonding agent on dry masonry substrates.

B. Installing Panels, General
   1. Gypsum Base for Veneer Plaster: Apply according to ASTM C 844 unless manufacturer's written recommendations are more stringent.
      a. Do not allow gypsum base to degrade from exposure to sunlight as evidenced by fading of paper facing.
      b. Erection Tolerance: No more than 1/16-inch (1.6-mm) offsets between planes of gypsum base panels, and 1/8 inch in 8 feet (3 mm in 2.4 m) noncumulative, for level, plumb, warp, and bow.

2. Install sound attenuation blankets before installing gypsum base for veneer plaster unless blankets are readily installed after panels have been installed on one side.
3. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
4. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.6 mm) of open space between panels. Do not force into place.
5. Locate edge and end joints over supports except in ceiling applications where intermediate supports or back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints, other than control joints, at corners of framed openings.
6. Attach panels to steel studs so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
7. Attach panels to framing provided at openings and cutouts.
8. Form control joints with space between edges of adjoining panels.
9. Cover both sides of steel stud partition framing with panels in concealed spaces, including above ceilings, except in internally braced chases.
    a. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.74 sq. m) in area.
    b. Fit panels around ducts, pipes, and conduits.
    c. Where partitions intersect open concrete coffers, concrete joists, and other structural members projecting below underside of floor/roof slabs and decks, cut panels to fit profile formed by coffers, joists, and other structural members; allow 1/4- to 3/8-inch- (6.4- to 9.5-mm-) wide joints; seal joints with acoustical sealant.
10. Wood Framing: Install panels over wood framing, with "floating" internal corner construction. Do not attach panels across the flat grain of wide-dimension lumber, including floor joists and headers. "Float" panels over these members or provide control joints to counteract wood shrinkage.
11. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
12. Fastener Spacing: Comply with ASTM C 844, manufacturer's written recommendations, and fire-resistance-rating requirements.
    a. Space screws a maximum of 12 inches (305 mm) o.c. along framing members for wall or ceiling application.
    b. Space fasteners in cementitious backer units a maximum of 8 inches (200 mm) o.c. along framing members for wall applications and 6 inches (150 mm) o.c. along framing members for ceiling applications.

C. Installing Panels
1. Install gypsum base panels for veneer plaster in the following locations:
    a. Regular Type: As indicated on Drawings **OR** Vertical surfaces, unless otherwise indicated, **as directed**.
    b. Ceiling Type: As indicated on Drawings **OR** Ceiling surfaces, **as directed**.
    c. Type X: As indicated on Drawings **OR** Where required for fire-resistance-rated assembly **OR** Vertical surfaces, unless otherwise indicated, **as directed**.
    d. Type C: As indicated on Drawings **OR** Where required for specific fire-resistance-rated assembly indicated, **as directed**.
    e. Foil-Backed, Regular-Type Core: As indicated on Drawings **OR as directed**.
    f. Abuse-Resistant Base: As indicated on Drawings **OR as directed**.
    g. High-Impact Base: As indicated on Drawings **OR as directed**.
    h. Moisture- and Mold-Resistant Base: As indicated on Drawings **OR as directed**.
2. Single-Layer Application:

a. On ceilings, apply gypsum base panels before wall panels, to the greatest extent possible and at right angles to framing, unless otherwise indicated.
b. On walls, apply gypsum base panels vertically and parallel **OR** horizontally and perpendicular, **as directed**, to framing, unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
1) Stagger abutting end joints not less than one framing member in alternate courses of panels.
2) At stairwells and other walls higher than 30 feet (9.0 m), install gypsum base panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
c. On Z-furring, apply gypsum base panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.

3. Multilayer Application on Ceilings: Apply backing panels for ceilings before applying backing panels for partitions; apply gypsum-base face layers in same sequence. Apply backing panels at right angles to framing members and offset gypsum-base face-layer joints a minimum of 16 inches (400 mm) from parallel backing panel joints, unless otherwise required by fire-resistance-rated assembly.
4. Multilayer Application on Partitions: Apply backing panels indicated and gypsum-base face layers vertically (parallel to framing) with joints of backing panels located over stud or furring members and gypsum-base face-layer joints offset at least one stud or furring member from backing-panel joints, unless otherwise required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
a. Z-Furring: Apply backing panels vertically (parallel to framing) and gypsum-base face layer either vertically or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of backing panels over furring members.
5. Single-Layer Fastening Methods: Apply gypsum base panels to supports with steel drill screws.
6. Multilayer Fastening Methods: Fasten backing panels and gypsum-base face layers separately to supports with screws **OR** with screws; fasten gypsum-base face layers with adhesive and supplementary fasteners, **as directed**.
7. Curved Partitions: Comply with gypsum base manufacturer's written installation recommendations.
8. Cementitious Backer Units: Install according to ANSI A108.11.
a. Where cementitious backer units abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

D. Installing Trim Accessories
1. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
2. Control Joints: Install at locations indicated on Drawings **OR** according to ASTM C 844 and in specific locations approved by the Owner, **as directed**.
3. Trim: Install in the following locations:
a. Cornerbead: Use at outside corners, unless otherwise indicated.
b. Bullnose Bead: Use at outside corners **OR** where indicated, **as directed**.
c. LC-Bead: Use at exposed panel edges.
d. L-Bead: Use where indicated.
e. U-Bead: Use at exposed panel edges **OR** where indicated, **as directed**.
f. Curved-Edge Cornerbead: Use at curved openings.
4. Aluminum Trim:
a. Install aluminum trim according to manufacturer's written recommendations.
b. Apply and embed joint tape over flanges of aluminum trim accessories if recommended by trim manufacturer.

E. Installing Joint Reinforcement

1. Gypsum Base for Veneer Plaster: Reinforce interior angles and flat joints with joint tape and embedding material to comply with ASTM C 843 and with gypsum veneer plaster manufacturer's written recommendations.
2. Abuse-Resistant Base: Reinforce joints between abuse-resistant panels with joint tape and embedding material according to panel manufacturer's written recommendations.
3. Impact-Resistant Base: Reinforce joints between impact-resistant panels with joint tape and embedding material according to panel manufacturer's written recommendations.
4. Moisture- and Mold-Resistant Base: Reinforce joints between moisture- and mold-resistant panels with joint tape and embedding material according to panel manufacturer's written recommendations.
5. Cementitious Backer Units: Reinforce joints between cementitious backer units with joint tape and embedding material according to unit manufacturer's written recommendations.

F. Gypsum Veneer Plastering
1. Bonding Agent: Apply bonding agent on dry monolithic concrete **OR** masonry **OR** abuse-resistant base panels **OR** cementitious backer units, **as directed**, according to gypsum veneer plaster manufacturer's written recommendations.
2. Gypsum Veneer Plaster Application: Comply with ASTM C 843 and with veneer plaster manufacturer's written recommendations.
    a. One-Component Gypsum Veneer Plaster: Trowel apply base coat over substrate to uniform thickness of 1/16 to 3/32 inch (1.6 to 2.4 mm). Fill all voids and imperfections. Allow plaster to set, then scratch and immediately double back with gypsum veneer plaster to uniform total thickness of 3/16 inch (4.8 mm).
    b. Two-Component Gypsum Veneer Plaster:
        1) Base Coat: Trowel apply base coat over substrate to uniform thickness of 1/16 to 3/32 inch (1.6 to 2.4 mm). Fill all voids and imperfections.
        2) Finish Coat: Trowel apply finish-coat plaster over base-coat plaster to uniform thickness of 1/16 to 3/32 inch (1.6 to 2.4 mm).
    c. Where gypsum veneer plaster abuts only metal door frames, windows, and other units, groove finish coat to eliminate spalling.
    d. Do not apply veneer plaster to gypsum base if paper facing has degraded from exposure to sunlight. Before applying veneer plaster, use remedial methods to restore bonding capability to degraded paper facing according to manufacturer's written recommendations and as approved by the Owner.
3. Radiant-Heat, Two-Component Gypsum Veneer Plaster Ceilings: Comply with ASTM C 843 and with radiant-heat veneer plaster manufacturer's written recommendations.
    a. Base Coat: Apply plaster base coat to sufficiently cover electric heating cables. Trowel plaster parallel in direction of cables to uniform thickness of 3/16 inch (4.8 mm). Completely cover cables.
    b. Finish Coat: After base coat has developed sufficient bond, apply finish coat. Trowel plaster to uniform thickness of 1/16 to 3/32 inch (1.6 to 2.4 mm).
4. Concealed Surfaces: Do not omit gypsum veneer plaster behind cabinets, furniture, furnishings, and similar removable items. Omit veneer plaster in the following areas where it will be concealed from view in the completed Work unless otherwise indicated or required to maintain fire-resistance and STC ratings:
    a. Above suspended ceilings.
    b. Behind wood paneling.
5. Gypsum Veneer Plaster Finish: Smooth-troweled finish, unless otherwise indicated **OR** Textured finish matching the Owner's sample, **as directed**.

G. Protection
1. Protect installed gypsum veneer plaster from damage from weather, condensation, construction, and other causes during remainder of the construction period.
2. Remove and replace gypsum veneer plaster and gypsum base panels that are wet, moisture damaged, or mold damaged.

a. Indications that gypsum base panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
b. Indications that gypsum base panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 09205

SECTION 09205a - PORTLAND CEMENT PLASTER

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for portland cement plaster. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Interior portland cement plasterwork on metal lath, unit masonry and monolithic concrete.
b. Exterior portland cement plasterwork (stucco) on metal lath, unit masonry and monolithic concrete.

C. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
1) Include statement indicating costs for each product having recycled content.
b. Product Data for Credit EQ 4.1: For sealants, including printed statement of VOC content.
3. Shop Drawings: Show locations and installation of control and expansion joints including plans, elevations, sections, details of components, and attachments to other work.
4. Samples: For each type of factory-prepared, colored or textured finish coat indicated; 12 by 12 inches (305 by 305 mm), and prepared on rigid backing.

D. Quality Assurance
1. Fire-Resistance Ratings: Where indicated, provide portland cement plaster assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
a. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.
2. Sound-Transmission Characteristics: Where indicated, provide portland cement plaster assemblies identical to those of assemblies tested for STC ratings per ASTM E 90 and classified according to ASTM E 413 by a qualified testing agency.
3. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
1. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.

F. Project Conditions
1. Comply with ASTM C 926 requirements.
2. Interior Plasterwork: Maintain room temperatures at greater than 40 deg F (4.4 deg C) for at least 48 hours before plaster application, and continuously during and after application.
a. Avoid conditions that result in plaster drying out during curing period. Distribute heat evenly; prevent concentrated or uneven heat on plaster.
b. Ventilate building spaces as required to remove water in excess of that required for hydrating plaster in a manner that prevents drafts of air from contacting surfaces during plaster application and until plaster is dry.
3. Exterior Plasterwork:

a. Apply and cure plaster to prevent plaster drying out during curing period. Use procedures required by climatic conditions, including moist curing, providing coverings, and providing barriers to deflect sunlight and wind.
b. Apply plaster when ambient temperature is greater than 40 deg F (4.4 deg C).
c. Protect plaster coats from freezing for not less than 48 hours after set of plaster coat has occurred.

4. Factory-Prepared Finishes: Comply with manufacturer's written recommendations for environmental conditions for applying finishes.

1.2 PRODUCTS

A. Metal Lath
1. Expanded-Metal Lath: ASTM C 847 with ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coating.
a. Recycled Content: Provide steel products with average recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
b. Diamond-Mesh Lath: Flat **OR** Self-furring, **as directed**, 2.5 lb/sq. yd. (1.4 kg/sq. m) **OR** 3.4 lb/sq. yd. (1.8 kg/sq. m), **as directed**.
c. Flat Rib Lath: Rib depth of not more than 1/8 inch (3.1 mm), 2.75 lb/sq. yd. (1.5 kg/sq. m) **OR** 3.4 lb/sq. yd. (1.8 kg/sq. m), **as directed**.
d. 3/8-Inch (9.5-mm) Rib Lath: 3.4 lb/sq. yd. (1.8 kg/sq. m) **OR** 4 lb/sq. yd. (2.2 kg/sq. m), **as directed**.
2. Wire-Fabric Lath:
a. Welded-Wire Lath: ASTM C 933; self-furring, 1.4 lb/sq. yd. (0.8 kg/sq. m) **OR** 1.95 lb/sq. yd. (1.1 kg/sq. m), **as directed**.
b. Woven-Wire Lath: ASTM C 1032; self-furring, with stiffener wire backing, 1.1 lb/sq. yd. (0.6 kg/sq. m) **OR** 1.4 lb/sq. yd. (0.8 kg/sq. m), **as directed**.
3. Paper Backing: FS UU-B-790, Type I, Grade D, Style 2 vapor-permeable paper **OR** Grade B, Style 1a vapor-retardant paper, **as directed**.
a. Provide paper-backed lath unless otherwise indicated **OR** at exterior locations **OR** in locations indicated on Drawings, **as directed**.

B. Accessories
1. General: Comply with ASTM C 1063 and coordinate depth of trim and accessories with thicknesses and number of plaster coats required.
2. Metal Accessories:
a. Foundation Weep Screed: Fabricated from hot-dip galvanized-steel sheet, ASTM A 653/A 653M, G60 (Z180) zinc coating.
b. Cornerite: Fabricated from metal lath with ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coating.
c. External-Corner Reinforcement: Fabricated from metal lath with ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coating.
d. Cornerbeads: Fabricated from zinc or zinc-coated (galvanized) steel.
1) Small nose cornerbead with expanded flanges; use unless otherwise indicated.
2) Small nose cornerbead with perforated flanges; use on curved corners.
3) Small nose cornerbead with expanded flanges reinforced by perforated stiffening rib; use on columns and for finishing masonry corners.
4) Bull nose cornerbead, radius 3/4 inch (19.1 mm) minimum, with expanded flanges; use at locations indicated on Drawings.
e. Casing Beads: Fabricated from zinc or zinc-coated (galvanized) steel; square-edged style; with expanded flanges.

f. Control Joints: Fabricated from zinc or zinc-coated (galvanized) steel; one-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on plaster face of control joint.
g. Expansion Joints: Fabricated from zinc or zinc-coated (galvanized) steel; folded pair of unperforated screeds in M-shaped configuration; with expanded flanges.
h. Two-Piece Expansion Joints: Fabricated from zinc or zinc-coated (galvanized) steel; formed to produce slip-joint and square-edged reveal that is adjustable from 1/4 to 5/8 inch (6.34 to 16 mm) wide; with perforated flanges.

3. Plastic Accessories: Fabricated from high-impact PVC.
   a. Cornerbeads: With perforated flanges.
      1) Small nose cornerbead; use unless otherwise indicated.
      2) Bull nose cornerbead, radius 3/4 inch (19.1 mm) minimum; use at locations indicated on Drawings.
   b. Casing Beads: With perforated flanges in depth required to suit plaster bases indicated and flange length required to suit applications indicated.
      1) Square-edge style; use unless otherwise indicated.
      2) Bull-nose style, radius 3/4 inch (19.1 mm) minimum; use at locations indicated on Drawings.
   c. Control Joints: One-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on plaster face of control joint.
   d. Expansion Joints: Two-piece type, formed to produce slip-joint and square-edged 1/2-inch- (13-mm-) **OR** 1-inch- (25-mm-) **OR** 1-1/2-inch- (38-mm-), **as directed**, wide reveal; with perforated concealed flanges.

C. Miscellaneous Materials
1. Water for Mixing: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.
2. Fiber for Base Coat: Alkaline-resistant glass or polypropylene fibers, 1/2 inch (13 mm) long, free of contaminants, manufactured for use in portland cement plaster.
3. Bonding Compound: ASTM C 932.
4. Steel Drill Screws: For metal-to-metal fastening, ASTM C 1002 or ASTM C 954, as required by thickness of metal being fastened; with pan head that is suitable for application; in lengths required to achieve penetration through joined materials of no fewer than three exposed threads.
5. Fasteners for Attaching Metal Lath to Substrates: Complying with ASTM C 1063.
6. Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, not less than 0.0475-inch (1.21-mm) diameter, unless otherwise indicated.
7. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
   a. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
   b. Recycled Content: Provide blankets with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 25 percent by weight.
8. Acoustical Sealant: As specified in Division 7 Section "Joint Sealants".
   a. Provide sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Plaster Materials
1. Portland Cement: ASTM C 150, Type I **OR** Type II, **as directed**.
   a. Color for Finish Coats: White **OR** Gray, **as directed**.
2. Masonry Cement: ASTM C 91, Type N.
   a. Color for Finish Coats: White **OR** Gray, **as directed**.
3. Plastic Cement: ASTM C 1328.
4. Colorants for Job-Mixed Finish Coats: Colorfast mineral pigments that produce finish plaster color to match sample.

5. Lime: ASTM C 206, Type S; or ASTM C 207, Type S.
6. Sand Aggregate: ASTM C 897.
   a. Color for Job-Mixed Finish Coats: White **OR** In color matching sample, **as directed**.
7. Perlite Aggregate: ASTM C 35.
8. Exposed Aggregates for Finish Coats: For marblecrete finish, clean, sound, crushed marble matching color and size gradation of sample.
9. Ready-Mixed Finish-Coat Plaster: Mill-mixed portland cement, aggregates, coloring agents, and proprietary ingredients.
   a. Color: As selected from manufacturer's full range.
10. Acrylic-Based Finish Coatings: Factory-mixed acrylic-emulsion coating systems, formulated with colorfast mineral pigments and fine aggregates; for use over portland cement plaster base coats. Include manufacturer's recommended primers and sealing topcoats for acrylic-based finishes.
    a. Color: As selected from manufacturer's full range.

E. Plaster Mixes
1. General: Comply with ASTM C 926 for applications indicated.
   a. Fiber Content: Add fiber to base-coat mixes after ingredients have mixed at least two minutes. Comply with fiber manufacturer's written instructions for fiber quantities in mixes, but do not exceed 1 lb of fiber/cu. yd. (0.6 kg of fiber/cu. m) of cementitious materials.
2. Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork as follows:
   a. Portland Cement Mixes:
      1) Scratch Coat: For cementitious material, mix 1 part portland cement and 0 to 3/4 **OR** 3/4 to 1-1/2, **as directed**, parts lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
      2) Brown Coat: For cementitious material, mix 1 part portland cement and 0 to 3/4 **OR** 3/4 to 1-1/2, **as directed**, parts lime. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.
   b. Masonry Cement Mixes:
      1) Scratch Coat: 1 part masonry cement and 2-1/2 to 4 parts aggregate.
      2) Brown Coat: 1 part masonry cement and 3 to 5 parts aggregate, but not less than volume of aggregate used in scratch coat.
   c. Portland and Masonry Cement Mixes:
      1) Scratch Coat: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
      2) Brown Coat: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.
   d. Plastic Cement Mixes:
      1) Scratch Coat: 1 part plastic cement and 2-1/2 to 4 parts aggregate.
      2) Brown Coat: 1 part plastic cement and 3 to 5 parts aggregate, but not less than volume of aggregate used in scratch coat.
   e. Portland and Plastic Cement Mixes:
      1) Scratch Coat: For cementitious material, mix 1 part plastic cement and 1 part portland cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
      2) Brown Coat: For cementitious material, mix 1 part plastic cement and 1 part portland cement. Use 3 to 5 parts aggregate per part of cementitious material, but not less than volume of aggregate used in scratch coat.
3. Base-Coat Mixes: Single base coats for two-coat plasterwork as follows:
   a. Portland Cement Mix: For cementitious material, mix 1 part portland cement and 0 to 3/4 part lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
   b. Portland and Masonry Cement Mix: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
   c. Plastic Cement Mix: Use 1 part plastic cement and 2-1/2 to 4 parts aggregate.

4. Base-Coat Mixes: Single base coats for two-coat plasterwork as follows:
   a. Portland Cement Mix: For cementitious material, mix 1 part portland cement and 3/4 to 1-1/2 parts lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
   b. Masonry Cement Mix: Use 1 part masonry cement and 2-1/2 to 4 parts aggregate.
   c. Plastic Cement Mix: Use 1 part plastic cement and 2-1/2 to 4 parts aggregate.
5. Job-Mixed Finish-Coat Mixes:
   a. Portland Cement Mix: For cementitious materials, mix 1 part portland cement and 3/4 to 1-1/2 **OR** 1-1/2 to 2, **as directed**, parts lime. Use 1-1/2 to 3 parts aggregate per part of cementitious material.
   b. Masonry Cement Mix: 1 part masonry cement and 1-1/2 to 3 parts aggregate.
   c. Portland and Masonry Cement Mix: For cementitious materials, mix 1 part portland cement and 1 part masonry cement. Use 1-1/2 to 3 parts aggregate per part of cementitious material.
   d. Plastic Cement Mix: 1 part plastic cement and 1-1/2 to 3 parts aggregate.
6. Factory-Prepared Finish-Coat Mixes: For ready-mixed finish-coat plasters or acrylic-based finish coatings, comply with manufacturer's written instructions.

1.3 EXECUTION

A. Examination
   1. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
   2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
   1. Protect adjacent work from soiling, spattering, moisture deterioration, and other harmful effects caused by plastering.
   2. Prepare solid substrates for plaster that are smooth or that do not have the suction capability required to bond with plaster according to ASTM C 926.

C. Installation, General
   1. Fire-Resistance-Rated Assemblies: Install components according to requirements for design designations from listing organization and publication indicated on Drawings.
   2. Sound Attenuation Blankets: Where required, install blankets before installing lath unless blankets are readily installed after lath has been installed on one side.
   3. Acoustical Sealant: Where required, seal joints between edges of plasterwork and abutting construction with acoustical sealant.

D. Installing Metal Lath
   1. Expanded-Metal Lath: Install according to ASTM C 1063.
      a. Partition Framing and Vertical Furring: Install flat diamond-mesh **OR** flat rib **OR** welded-wire **OR** woven-wire, **as directed**, lath.
      b. Flat-Ceiling and Horizontal Framing: Install flat diamond-mesh **OR** flat rib **OR** 3/8-inch (9.5-mm) rib lath **OR** welded-wire **OR** woven-wire, **as directed**, lath.
      c. Curved-Ceiling Framing: Install flat diamond-mesh **OR** welded-wire **OR** flat woven-wire, **as directed**, lath.
      d. On Solid Surfaces, Not Otherwise Furred: Install self-furring, diamond-mesh **OR** welded-wire **OR** woven-wire, **as directed**, lath.

E. Installing Accessories
   1. Install according to ASTM C 1063 and at locations indicated on Drawings.
   2. Reinforcement for External Corners:
      a. Install lath-type, external-corner reinforcement at exterior locations.
      b. Install cornerbead at interior and exterior, **as directed**, locations.

3. Control Joints: Install control joints at locations indicated on Drawings **OR** in specific locations approved for visual effect as follows, **as directed**:
   a. As required to delineate plasterwork into areas (panels) of the following maximum sizes:
      1) Vertical Surfaces: 144 sq. ft. (13.4 sq. m).
      2) Horizontal and other Nonvertical Surfaces: 100 sq. ft. (9.3 sq. m).
   b. At distances between control joints of not greater than 18 feet (5.5 m) o.c.
   c. As required to delineate plasterwork into areas (panels) with length-to-width ratios of not greater than 2-1/2:1.
   d. Where control joints occur in surface of construction directly behind plaster.
   e. Where plasterwork areas change dimensions, to delineate rectangular-shaped areas (panels) and to relieve the stress that occurs at the corner formed by the dimension change.

F. Plaster Application
1. General: Comply with ASTM C 926.
   a. Do not deviate more than plus or minus 1/4 inch in 10 feet (6.4 mm in 3 m) from a true plane in finished plaster surfaces, as measured by a 10-foot (3-m) straightedge placed on surface.
   b. Finish plaster flush with metal frames and other built-in metal items or accessories that act as a plaster ground unless otherwise indicated. Where casing bead does not terminate plaster at metal frame, cut base coat free from metal frame before plaster sets and groove finish coat at junctures with metal.
   c. Provide plaster surfaces that are ready to receive field-applied finishes indicated.
2. Bonding Compound: Apply on unit masonry and concrete plaster bases.
3. Walls; Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork, on masonry or on concrete; 3/4-inch (19-mm) thickness.
   a. Portland cement mixes.
   b. Masonry cement mixes.
   c. Portland and masonry cement mixes.
   d. Plastic cement mixes.
   e. Portland and plastic cement mixes.
4. Ceilings; Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork; 1/2 inch (13 mm) thick **OR** 3/4 inch (19 mm) thick on concrete, **as directed**.
   a. Portland cement mixes.
   b. Masonry cement mixes.
   c. Portland and masonry cement mixes.
   d. Plastic cement mixes.
   e. Portland and plastic cement mixes.
5. Walls; Base-Coat Mix: Scratch coat for two-coat plasterwork, 3/8 inch (10 mm) thick on concrete masonry **OR** 1/4 inch (6 mm) thick on concrete, **as directed**.
   a. Portland cement mixes.
   b. Masonry cement mixes.
   c. Portland and masonry cement mixes.
   d. Plastic cement mixes.
   e. Portland and plastic cement mixes.
6. Ceilings; Base-Coat Mix: Scratch coat for two-coat plasterwork, 1/4 inch (6 mm) thick on concrete.
   a. Portland cement mixes.
   b. Masonry cement mixes.
   c. Portland and masonry cement mixes.
   d. Plastic cement mixes.
   e. Portland and plastic cement mixes.
7. Plaster Finish Coats: Apply to provide float **OR** dash **OR** scraped trowel-textured **OR** skip trowel-textured **OR** brocade (knock-down dash) **OR** trowel sweep **OR** combed **OR** sacked (California mission) **OR** English **OR** marblecrete, **as directed**, finish to match sample.

8. Acrylic-Based Finish Coatings: Apply coating system, including primers, finish coats, and sealing topcoats, according to manufacturer's written instructions.
9. Concealed Exterior Plasterwork: Where plaster application will be used as a base for adhered finishes, omit finish coat.
10. Concealed Interior Plasterwork:
    a. Where plaster application will be concealed behind built-in cabinets, similar furnishings, and equipment, apply finish coat.
    b. Where plaster application will be concealed above suspended ceilings and in similar locations, finish coat may be omitted.
    c. Where plaster application will be used as a base for adhesive application of tile and similar finishes, omit finish coat.

G. Plaster Repairs
1. Repair or replace work to eliminate cracks, dents, blisters, buckles, crazing and check cracking, dry outs, efflorescence, sweat outs, and similar defects and where bond to substrate has failed.

H. Protection
1. Remove temporary protection and enclosure of other work. Promptly remove plaster from door frames, windows, and other surfaces not indicated to be plastered. Repair floors, walls, and other surfaces stained, marred, or otherwise damaged during plastering.

END OF SECTION 09205a

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SECTION 09205b - GYPSUM BOARD RENOVATION

GENERAL

Description Of Work

1. This specification covers the furnishing and installation of materials for gypsum board renovation. Products shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

Submittals

2. Quality Assurance/Control Submittals
   a. Certificates: Manufacturer's written certification that gypsum products meet or exceed specified requirements.

Quality Assurance

3. Regulatory Requirements:
   a. Gypsum Board Partitions: Listed and labeled for fire-protective ratings as indicated or scheduled.
   b. Gypsum Board Floor/Ceilings and Roof/Ceiling Assemblies: Listed and labeled for fire protective ratings as indicated or scheduled.
   c. Fire-Rated Assemblies: Comply with UL 05, FM P8016, or GA 600 for required fire-rated assembly.

Delivery, Storage, And Handling

4. Storage and Protection: Store wallboard off ground to protect it from weather and damage due to moisture damage.
   a. Wallboard: Dry, free of warpage, and have bundling tape intact immediatly prior to use.

Project Conditions

5. Environmental Requirements: Comply with Detailed Scope of Work.
   a. During gypsum-panel application and finishing, maintain indoor temperatures within range of 13 degrees C (55 degrees F) to 21 degrees C (70 degrees F). Provide adequate ventilation to carry off excess moisture.
6. Existing Conditions: See Division 1 Section “Summary of Work”. Do not interfere with use of occupied buildings or portions of buildings. Maintain free and safe passage to and from occupied areas.
7. Protection: Protect grounds, plantings, buildings and any other facilities or property from damage caused by construction operations.

Scheduling And Sequencing

8. Scheduling and Completion: Comply with Detailed Scope of Work.

PRODUCTS

Materials

9. Materials for Patching, Extending, and Matching:

a. Provide same products or types of construction as in existing structure, as needed to patch, extend, or match existing work.
   1) Generally, Contract Documents will not define products present in existing construction. Determine products by Inspection and any necessary testing.
   2) Patching, extending, and matching of existing work and systems shall result in a complete, finished system.
b. Presence of product, finish, or type of construction requires that patching, extending, or matching be performed as necessary to make work complete and consistent.

Metals

10. Partition Metals: ASTM C 645, galvanized steel:
    a. Interior Steel Studs: Minimum 0.46 mm (25 gage), provide sizes and gages to match existing or as indicated.
       1) Provide minimum of 0.84 mm (20 gage) studs both sides of hollow metal frames.
    b. Steel Stud Runners: Match studs. Provide long leg runners for slip joint at structure above to allow for deflection.
    c. Furring Channels: Hat-shaped furring channels, minimum 0.46 mm (25 gage).
    d. Resilient Furring Channels: Manufacturer's standard product designed to reduce sound transmission by resilient attachment of gypsum board, 13 mm (1/2 inch) deep.
    e. Sheet-Metal Reinforcement (Altemate to Wood Blocking): 1.52 mm (16 gage) minimum.
11. Suspended Coiling Metals:
    a. Runner Channels: ASTM C 754 cold-rolled steel channels with rust-inhibitive finish.
       1) 50 mm (2 Inches) deep, 88 kg per 100 m (590 pounds per 1,000 LF).
       2) 38 mm (1-1/2 inch) deep, 70 kg per 100 m (475 pounds per 1,000 LF).
       3) 19 mm (3/4 Inch) deep, 45 kg per 100 m (300 pounds per 1,000 LF).
    b. Furring Channels: Hat-shaped galvanized-steel furring channels, minimum 0.46 mm (25 gage).
    c. Steel Studs: Galvanized steel as specified above, minimum 0.46 mm (25 gage).
    d. Wire for Hangers and Ties: ASTM A 641, Class 1 zinc coating, soft temper.
       1) Hanger Wire: Minimum 4.1 mm (8 gage).
       2) Tie Wire: 6 mm (16 gage).

Gypsum Board And Related Materials

12. Gypsum Board: GA216 and ASTM C 36
    a. Size: 12.7 mm and 15.9 mm (1/2 inch and 5/8 inch) thick to match existing, as indicated or scheduled. Provide boards 1 200 mm (48 inches) wide by length required to minimize cross joints.
    b. Regular Tapered-edge gypsum panels.
       1) Provide Type X gypsum panels at fire-rated assemblies.
    c. Water-Resistant: ASTM C 630, paintable, tapered-edge gypsum panels.
       1) Provide Type X water-resistant gypsum panels at fire-rated assemblies.
13. Cementitious Backer Units (CBU): ANSI A118.9, nailable/screwable backer board composed of stable portland cement, aggregates, and reinforcements with ability to remain unaffected by prolonged exposure to moisture, 12.7 mm (112 inch) thick.
14. Fasteners:
    a. Screws: ASTM C 1002, drywall screws, corrosion resistant. Provide types as recommended by manufacturer for each application.
       1) Wallboard to Metal Framing: Minimum 25 mm (1 inch), Type S.
       2) Wall board to Wood Framing: Minimum 32 mm (1-1/4 inch) Type W bugle head.

3) Wall board to Wallboard: Type G.
b. Nails: ASTM C 514.
15. Accessories: GA 216 and ASTM C 1047, galvanized steel.
a. Comer Bead: GA 216 Type CB-114 x 114.
b. Metal Trim (Casing Beads): GA 216 Type L, in depth to match gypsum-board thickness.
c. Control Joint: V-shaped control joint.
d. Adhesive: ASTM C 557 multi-purpose adhesive.
16. Finishing Materials: ASTM C 475.
a. Joint Tape: Provide type as recommended by panel manufacturer.
b. Joint Treatment: Joint compound, adhesive, water, and fasteners.
17. Sound-Isolation Materials:
a. Sound Insulation: ASTM C 665, Type I (unfaced) mineral fiber blankets, 3.7 to 4.9 kg per sq m (3/4 to 1 PCF), thickness as indicated, scheduled, or required by fire-rated assembly.
b. Acoustical Sealant:
1) Concealed: ASTM C 919 nondrying, non-hardening, and non-skinning; non-bleeding; and non-staining.
2) Exposed: ASTM C 919 non-oxidizing and skinning; permanently elastic; and paintable.
c. Ductwork Penetrations Packing: Low-density fiberglass.

EXECUTION

Examination
18. Units, Spaces, and Areas to be Renovated: Comply with Detailed Scope of Work.
a. Existing Conditions: Before beginning installation, examine substrates and framing to receive gypsum board for defects or conditions adversely affecting quality and execution of installation.

Preparation
19. Dust Protection: Comply with Detailed Scope of Work.
20. Building Occupation: Carry out demolition and renovation work to cause as little inconvenience to occupants as possible. See Detailed Scope of Work.
21. Protection: Comply with Detailed Scope of Work.
a. Protection: Provide drapes and drop cloths necessary to protect walls, floors, ductwork and piping, electrical work, etc. during drywall finishing operations.
22. Selective Demolition: Comply with Detailed Scope of Work.

Laying Out Work
23. Discrepancies: Verity dimensions and elevations indicated in layout of existing work.
a. Prior to commencing work, carefully compare and check Drawings (if any) for discrepancies in locations or elevations of work to be executed.
b. Refer discrepancies among Drawings (if any), Specifications, and existing conditions to the Owner or adjustment before work affected is performed.
1) Failure to make such notification shall place responsibility on Contractor to carry out work in satisfactory, workmanlike mariner.
c. Contractor: Responsible for location and elevation of construction indicated by Construction Documents.

Performance

24. Patching: Patch and extend existing work using skilled mechanics capable of matching existing quality of workmanship.
    a. Quality of Patched or Extended Work: Not less than specified for new work. If similar new work is not specified, equal to existing work.
25. Damaged Surfaces: Comply with Detailed Scope of Work.
26. Transitions from Existing to New Work: Comply with Detailed Scope of Work.

Erection Of Drywall Stud Partitions

27. Reference Standard: Erect steel framing in accordance with ASTM C 754.
28. Layouts: Align partition studs accurately according to partition layout.
29. Anchoring: Anchor runner channels to concrete slabs with concrete stub nails or power-driven anchors at 600 mm (24 inches) OC. Anchor runner channels to coiling grid, where applicable, with stove bolts. Where studs extend above ceiling system, install headers where required to receive runners.
30. Studs: Position studs vertically in runners. Where studs are located adjacent to openings or partition intersections and comers. anchor studs to runners with manufacturer's metal lock fastener or with 13 mm (1/2 inch) Type S pan-head screws.
    a. Space studs at 400 mm (16 Inches) and 600 mm (24 inches) OC as indicated or scheduled.
        1) Cementitious Backer Units (CBU): Space studs at maximum of 400 mm (16 inches) OC.
        2) Limiting Heights: Comply with ASTM C 754 for transverse load of 240 Pa (5 lb-force/SF) without exceeding either allowable stress or deflection of L/240. Comers and Intersections: Locate studs no more than 50 mm (2 inches) from abutting partitions, comers, etc.
    b. Openings: Locate studs not more than 50 mm (2 inches) from opening frames. Anchor studs to frame anchor clips by bolt or screw attachment. Install headers over openings as recommended by the manufacturer.
        1) Solid-Core Wood Doors and Hollow Metal Doors: Provide two full-height studs at jambs fastened together back to back.
        2) Fire-Rated Openings: Comply with GA 219.
31. Bracing: Provide diagonal bracing at head of studs that terminate above the ceiling level. Bracing shall consist of metal studs bent to V-shape and extending at 45 degrees from partition head to structure above. Locate bracing 1 200 mm (48 inches) maximum OC.
32. Wood Blocking or Metal Reinforcement:
    a. Wood Blocking: See Division 6 Section "Rough Carpentry."
    b. Install metal reinforcement of size required for support of toilet and bath accessories, hardware, cabinets, shelving, counters, and other wall-mounted items.
    c. Set true to line, level, or plumb well-secured in stud wall and flush with back of drywall or other wall finish.
    d. Coordinate exact locations with other sections.

Miscellaneous Framing And Furring

33. General: Provide necessary framing and furring for special framing at recesses, offsets, specialty Items, and at wall-mounted casework, shelving, and equipment.
34. Furring Channels: Install furring channels over back-up material. Position channels vertically at 600 mm (24 inches) OC. Use power-activated fasteners or stub nails at 600 mm (24 Inches) OC along alternating flanges. Shim channels level as required.
    a. Cementitious Backer Units (CBU): Space furring at maximum of 400 mm (16 inches) OC.

35. Resilient Furring Channels: Screw-attach In accordance with manufacturer's recommendations.
    a. Spacing: 600 mm (24 inches) OC for framing at 16 inches OC and 400 mm (16 inches) OC for framing at 24 Inches OC.

Ceiling Grillage Erection

36. Reference Standard: Erect steel framing In accordance with ASTM C 754.
37. Hangers: Install wire hangers spaced not over 1 200 mm (48 inches) OC in direction of 38 mm (1-1/2 inch) main runner channels and within 150 mm (6 inches) of ends of main runners or interruptions of ceiling continuity. Hang from structure above.
38. Runners: Place main runners not over 1 200 mm (48 inches) OC. Provide, position, and level hangers with hangers saddle-tied along runners. Space furring channels at 600 mm (24 inches) OC at right angles to runner channels and secure with furring channel clips.
39. Reinforcement: At light troffers or other openings, reinforce grillage with 19 mm (314 inch) cold-rolled channels wired atop and parallel to main runner channels.
    a. Provide lateral seismic bracing as required by code.
40. Special Shapes: Provide necessary framing and suspension for off sets, verticals, etc.

Insulation

41. Sound Insulation: Place sound Insulation blankets in partitions tight within spaces, around cut openings. behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.
    a. Ductwork Penetrations: Provide one-inch wide clearance around ductwork and pack with fiberglass ready for joint sealers.

Installation Of Gypsum Drywall

42. Reference Standards: Apply and finish gypsum board in accordance with GA 216 and ASTM C 840.
43. Partition Gypsum Board Layout: Apply gypsum wallboard panels vertically with abutting ends and edges occurring over stud flanges or furring.
    a. Joints on Opposite Sides of Partitions: Stagger; joints shall not occur over same stud.
    b. Two Layer Construction: Stagger Joints between layers.
44. Ceiling Gypsum Board: Apply gypsum board of maximum practical length with long dimensions at right angles to furring channels. End and edge joints shall occur over furring channels with end joints staggered. Properly support gypsum board around cutouts and openings.
45. Fasteners: Apply board to studs or furring with drywall screws spaced 300 mm (12 inches) OC in field of board and 200 mm (8 inches) OC staggered along abutting edges.
46. Water-Resistant: Apply gypsum wallboard manufacturer's recommended sealant to raw cut edges and screw heads.
47. Cementitious Backer Units (CBU): Install in accordance with ANSI A108.11 and manufacturer's recommendations.
48. Accessories:
    a. Comer Bead: Apply as recommended by manufacturer at exposed outer corners.
    b. Trim (Casing Beads): Apply as recomrnended by manufacturer, where gypsum board abuts other materials, and as indicated.
    c. Control Joints: Comply with GA 216.
        1) Walls: Install at not more than 9 m (30 feet) OC.
        2) Ceilings: Install at not more than 15 m (50 feet) OC and where framing changes direction.
        3) Coordinate locations with the Owner.
49. Access Panels: Securely install access panels furnished under other sections. Set plumb and square to align with finish surface.

50. Acoustical Sealant: Seal perimeter and penetrations on both sides of sound-rated partitions and partitions with sound-attenuation blankets with minimum of single 6 mm (1/4 inch) bead of sealant
    a. Locations:
        1) Seal around gypsum-board perimeter in angle formed by gypsum-board panels and abutting dissimilar materials.
        2) Seal intersections of gypsum board with dissimilar materials.
        3) Seal pipe. conduit, ductwork, penetrations, etc.
        4) Seal around cutouts for lights, cabinets, pipes, ductwork, electrical boxes, etc.
        5) Seal gypsum board panel terminations in door and window frarnes.
        6) Seal control-joint locations before installing control Joints to panels.
    b. Installation: Comply with ASTM C 919 and requirements of indicated sound-rated assembly. Provide number and positions of beads to comply with sound rating of assembly.
51. Tolerances: Gypsum-board surface plane within plus or minus 3 mm in 3 000 mm (1/8 inch in 10 feet).
52. Finishing: Finish in accordance with GA 214.
    a. Concealed Locations (Not Exposed to View in Rooms): Level 1
    b. Beneath Tile: Level 2.
    c. Other Finished Areas: Level 4. Finish joints, trim, and fastener dimples. Sand smooth.
    d. Cementitious Backer Units (CBU): Treat joints in accordance with ANSI A108.11 and manufacturer's recommendations.

END OF SECTION 09205b

Task	Specification	Specification Description
09205	09210	Gypsum Plaster

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SECTION 09210 - GYPSUM PLASTER

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for gypsum plaster. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Gypsum plasterwork on expanded-metal lath, unit masonry and monolithic concrete.
b. Solid-plaster partitions.

C. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
1) Include statement indicating costs for each product having recycled content.
b. Product Data for Credit EQ 4.1: For sealants, including printed statement of VOC content.
3. Shop Drawings: Show locations and installation of control and expansion joints including plans, elevations, sections, details of components, and attachments to other work.

D. Quality Assurance
1. Fire-Resistance Ratings: Where indicated, provide gypsum plaster assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
a. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.
2. Sound Transmission Characteristics: Where indicated, provide gypsum plaster assemblies identical to those of assemblies tested for STC ratings per ASTM E 90 and classified according to ASTM E 413 by a qualified testing agency.

E. Delivery, Storage, And Handling
1. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.

F. Project Conditions
1. Comply with ASTM C 842 requirements or gypsum plaster manufacturer's written recommendations, whichever are more stringent.
2. Room Temperatures: Maintain temperatures at not less than 55 deg F (13 deg C) or greater than 80 deg F (27 deg C) for at least seven days before application of gypsum plaster, continuously during application, and for seven days after plaster has set or until plaster has dried.
3. Avoid conditions that result in gypsum plaster drying out too quickly.
a. Distribute heat evenly; prevent concentrated or uneven heat on plaster.
b. Maintain relative humidity levels for prevailing ambient temperature that produce normal drying conditions.
c. Ventilate building spaces in a manner that prevents drafts of air from contacting surfaces during plaster application and until plaster is dry.

1.2 PRODUCTS

A. Steel Framing For Solid-Plaster Partitions
1. Components, General: Comply with ASTM C 841. For steel sheet components not included in ASTM C 841, comply with ASTM C 645 requirements for metal unless otherwise indicated.
2. Channel Studs: Cold-rolled channels, 3/4 inch (19.1 mm) **OR** 1-1/2 inches (38.1 mm), **as directed**, deep.
3. Runners: L-runners with perforated or plain legs to suit lath attachment requirements, in 0.033-inch (0.84-mm) base-metal thickness where attached to overhead support and in 0.043-inch (1.1-mm) base-metal thickness where attached to floor.

B. Expanded-Metal Lath
1. Expanded-Metal Lath: ASTM C 847, cold-rolled carbon-steel sheet, ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coated.
a. Recycled Content: Provide steel products with average recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
b. Paper Backing: Kraft paper factory bonded to back of lath.
c. Diamond-Mesh Lath: Flat **OR** Self-furring, **as directed**, 2.5 lb/sq. yd. (1.4 kg/sq. m) **OR** 3.4 lb/sq. yd. (1.8 kg/sq. m), **as directed**.
d. Flat Rib Lath: Rib depth of not more than 1/8 inch (3.1 mm), 2.75 lb/sq. yd. (1.5 kg/sq. m) **OR** 3.4 lb/sq. yd. (1.8 kg/sq. m), **as directed**.
e. 3/8-Inch (9.5-mm) Rib Lath: 3.4 lb/sq. yd. (1.8 kg/sq. m) **OR** 4 lb/sq. yd. (2.2 kg/sq. m), **as directed**.

C. Accessories
1. General: Comply with ASTM C 841 and coordinate depth of trim and accessories with thicknesses and number of plaster coats required.
2. Metal Accessories:
a. Cornerite: Fabricated from expanded-metal lath with ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coating.
b. Striplath: Fabricated from expanded-metal lath with ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coating.
c. Cornerbeads: Fabricated from zinc or zinc-coated (galvanized) steel.
1) Small nose cornerbead with expanded flanges; use unless otherwise indicated.
2) Small nose cornerbead with perforated flanges; use on curved corners.
3) Small nose cornerbead with expanded flanges reinforced by perforated stiffening rib; use on columns and for finishing unit masonry corners.
4) Bull nose cornerbead, radius 3/4 inch (19.1 mm) minimum, with expanded flanges; use at locations indicated on Drawings.
d. Casing Beads: Fabricated from zinc or zinc-coated (galvanized) steel; square-edged style; with expanded flanges.
e. Control Joints: Fabricated from zinc or zinc-coated (galvanized) steel; one-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on plaster face of control joint.
f. Expansion Joints: Fabricated from zinc or zinc-coated (galvanized) steel; folded pair of unperforated screeds in M-shaped configuration; with expanded flanges.
g. Two-Piece Expansion Joints: Fabricated from zinc or zinc-coated (galvanized) steel; formed to produce slip-joint and square-edged reveal that is adjustable from 1/4 to 5/8 inch (6 to 16 mm) wide; with perforated flanges.
3. Plastic Accessories: Fabricated from high-impact PVC.
a. Cornerbeads: With perforated flanges.
1) Small nose cornerbead; use unless otherwise indicated.
2) Bull nose cornerbead, radius 3/4 inch (19.1 mm) minimum; use at locations indicated on Drawings.

b. Casing Beads: With perforated flanges in depth required to suit plaster bases indicated and flange length required to suit applications indicated.
   1) Square-edge style; use unless otherwise indicated.
   2) Bull-nose style, radius 3/4 inch (19.1 mm) minimum; use at locations indicated on Drawings.
c. Control Joints: One-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on plaster face of control joint.
d. Expansion Joints: Two-piece type, formed to produce slip-joint and square-edged 1/2-inch- (13-mm-) **OR** 1-inch- (25.4-mm-) **OR** 1-1/2-inch- (38.1-mm-), **as directed**, wide reveal; with perforated concealed flanges.

4. Aluminum Trim: Extruded accessories of profiles and dimensions indicated on Drawings.
   a. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221 (ASTM B 221M), Alloy 6063-T5.
   b. Finish: Mill **OR** Chemical-conversion coating, ASTM D 1730, Type B, compatible with field-applied finish coatings specified, **as directed**.

D. Miscellaneous Materials
1. Water for Mixing and Finishing Plaster: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.
2. Bonding Compound: ASTM C 631.
3. Steel Drill Screws: For metal-to-metal fastening, ASTM C 1002 or ASTM C 954, as required by thickness of metal being fastened; with pan head that is suitable for application; in lengths required to achieve penetration through joined materials of no fewer than three exposed threads.
4. Fasteners for Attaching Metal Lath to Substrates: Complying with ASTM C 841.
5. Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, not less than 0.0475-inch (1.21-mm) diameter, unless otherwise indicated.
6. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
   a. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of rated assembly.
   b. Recycled Content: Provide blankets with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 25 percent by weight.
7. Acoustical Sealant: As specified in Division 7 Section "Joint Sealants."
   a. Provide sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Base-Coat Plaster Materials
1. Base-Coat Plasters, General: ASTM C 28/C 28M.
2. Lightweight Gypsum Ready-Mixed Plaster: With mill-mixed perlite aggregate.
3. Gypsum Neat Plaster: For use with job-mixed aggregates.
4. Gypsum Wood-Fibered Plaster:
5. High-Strength Gypsum Neat Plaster: With a minimum, average, dry compressive strength of 2800 psi (19 MPa) per ASTM C 472 for a mix of 100 lb (45 kg) of plaster and 2 cu. ft. (0.06 cu. m) of sand.
6. Aggregates for Base-Coat Plasters: ASTM C 35, sand and perlite.

F. Finish-Coat Plaster Materials
1. Gypsum Gaging Plaster: ASTM C 28/C 28M.
2. Gypsum Ready-Mixed Finish Plaster: Manufacturer's standard, mill-mixed, gaged, interior finish.
3. High-Strength Gypsum Gaging Plaster: ASTM C 28/C 28M, with a minimum, average, dry compressive strength of 5000 psi (34 MPa) per ASTM C 472 for a neat mix.
4. Gypsum Keene's Cement: ASTM C 61/C 61M.
5. Lime: ASTM C 206, Type S, special finishing hydrated lime.

6. Lime: ASTM C 206, Type N, normal finishing hydrated lime.
7. Aggregates for Float Finishes: ASTM C 35, sand **OR** perlite, **as directed**; graded per ASTM C 842.

G. Plaster Mixes
1. Mixing: Comply with ASTM C 842 and manufacturer's written instructions for applications indicated.

1.3 EXECUTION

A. Examination
1. Examine nonstructural and structural metal framing, substrates, and hollow-metal frames, for compliance with requirements and other conditions affecting performance of the Work.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Protect adjacent work from soiling, spattering, moisture deterioration, and other harmful effects caused by plastering.

C. Installation, General
1. Fire-Resistance-Rated Assemblies: Install components according to requirements for design designations from listing organization and publication indicated on Drawings.
2. STC-Rated Assemblies: Install components according to requirements for design designations from listing organization and publication indicated on Drawings.
   a. Seal construction at perimeters, behind control and expansion joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations.
   b. Comply with ASTM C 919 and manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
3. Sound Attenuation Blankets: Where required, install blankets before installing lath unless blankets are readily installed after lath has been installed on one side.
4. Acoustical Sealant: Where required, seal joints between edges of plasterwork and abutting construction with acoustical sealant.

D. Installing Steel Framing For Solid-Plaster Partitions
1. Install according to ASTM C 841.
2. Framing for Solid-Plaster Partitions: Provide channel stud to support expanded-metal lath construction.
   a. Space channel studs at 16 inches (406 mm) **OR** 24 inches (610 mm), **as directed**, o.c. unless otherwise indicated.
3. Framing for Studless Solid-Plaster Partition: Provide top and bottom L-track runners to support expanded-metal lath.

E. Installing Expanded-Metal Lath
1. Expanded-Metal Lath: Install according to ASTM C 841.
   a. Partition Framing and Vertical Furring: Install flat diamond-mesh **OR** flat rib, **as directed**, lath.
   b. Flat-Ceiling and Horizontal Framing: Install flat diamond-mesh **OR** flat rib, **as directed**, lath.
   c. Curved-Ceiling Framing: Install flat diamond-mesh lath.
   d. On Solid Surfaces, Not Otherwise Furred: Install self-furring, diamond-mesh lath.
   e. Solid-Plaster Partitions: Where supported by channel studs, install flat rib **OR** flat diamond-mesh, **as directed**, lath.

f. Studless Solid-Plaster Partitions: Install 3/8-inch (9.5-mm) rib lath.

F. Installing Accessories
1. General: Install according to ASTM C 841.
2. Cornerbeads: Install at external corners.
3. Casing Beads: Install at terminations of plasterwork, except where plaster passes behind and is concealed by other work and where metal screeds, bases, or frames act as casing beads.
4. Control Joints: Install control joints at locations indicated on Drawings **OR** with spacing between joints in either direction not exceeding the following and in specific locations approved by Architect for visual effect, **as directed**:
   a. Partitions: 30 feet (9 m).
   b. Ceilings: 50 feet (15 m) **OR** 30 feet (9 m), **as directed**.

G. Plaster Application
1. General: Comply with ASTM C 842.
   a. Do not deviate more than plus or minus 1/8 inch in 10 feet (3.1 mm in 3 m) from a true plane in finished plaster surfaces, as measured by a 10-foot (3-m) straightedge placed on surface.
   b. Grout hollow-metal frames, bases, and similar work occurring in plastered areas, with base-coat plaster material, before lathing where necessary. Except where full grouting is indicated or required for fire-resistance rating, grout at least 6 inches (152 mm) at each jamb anchor.
   c. Finish plaster flush with metal frames and other built-in metal items or accessories that act as a plaster ground unless otherwise indicated. Where casing bead does not terminate plaster at metal frame, cut base coat free from metal frame before plaster sets and groove finish coat at junctures with metal.
   d. Provide plaster surfaces that are ready to receive field-applied finishes indicated.
2. Bonding Compound: Apply on unit masonry and concrete plaster bases.
3. Base Coats:
   a. Base Coats over Expanded-Metal Lath: High-strength gypsum **OR** Gypsum neat, **as directed**, plaster with job-mixed sand for scratch and brown coats.
   b. Base Coats over Expanded-Metal Lath:
      1) Scratch Coat: Gypsum wood-fibered plaster; neat or with job-mixed sand.
      2) Brown Coat: Gypsum wood-fibered plaster with job-mixed sand **OR** neat plaster with job-mixed sand **OR** lightweight ready-mixed plaster **OR** neat plaster with job-mixed perlite, **as directed**.
   c. Base Coats over Unit Masonry: Gypsum wood-fibered plaster with job-mixed sand **OR** neat plaster with job-mixed sand **OR** lightweight ready-mixed plaster, **as directed**.
   d. Base-Coat Mix over Monolithic Concrete: Gypsum neat plaster with job-mixed sand.
4. Finish Coats:
   a. Finish-Coat Mix for Smooth-Troweled Finishes: Gypsum gaging plaster **OR** Gypsum ready-mixed finish plaster **OR** High-strength gypsum gaging plaster **OR** Gypsum Keene's cement, **as directed**.
   b. Finish-Coat Mix for Float Finishes: Gypsum gaging plaster **OR** Gypsum Keene's cement, **as directed**.
   c. Finish-Coat Mix for Sprayed Finishes: Gypsum ready-mixed finish plaster.
   d. Finish-Coat Mix for Textured Finishes: Gypsum ready-mixed finish plaster.
5. Plaster Finishes:
   a. Provide troweled finish unless otherwise indicated **OR** where indicated, **as directed**.
   b. Provide float finish unless otherwise indicated **OR** where indicated, **as directed**.
   c. Provide sprayed finish unless otherwise indicated **OR** where indicated, **as directed**.
      1) Sprayed Finish: Match sample.
   d. Provide textured finish where indicated.
      1) Textured Finish: Match sample.
6. Concealed Plaster:

a. Where plaster application will be concealed behind built-in cabinets, similar furnishings, and equipment, apply finish coat.
b. Where plaster application will be concealed above suspended ceilings and in similar locations, finish coat may be omitted.
c. Where plaster application will be used as a base for adhesive application of tile and similar finishes, finish coat may be omitted.

H. Plaster Repairs
1. Repair or replace work to eliminate cracks, dents, blisters, buckles, crazing and check cracking, dry outs, efflorescence, sweat outs, and similar defects and where bond to substrate has failed.

I. Cleaning And Protection
1. Remove temporary protection and enclosure of other work. Promptly remove plaster from door frames, windows, and other surfaces not indicated to be plastered. Repair floors, walls, and other surfaces stained, marred, or otherwise damaged during plastering.

END OF SECTION 09210

Task	Specification	Specification Description
09210	09205	Gypsum Veneer Plaster

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SECTION 09250 - GYPSUM BOARD

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for gypsum board. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Interior gypsum board.
b. Exterior gypsum board for ceilings and soffits.
c. Tile backing panels.

C. Submittals
1. Product Data: For each type of product indicated.
2. Samples: For the following products:
a. Trim Accessories: Full-size Sample in 12-inch- (300-mm-) long length for each trim accessory indicated.
b. Textured Finishes: Manufacturer's standard size for each textured finish indicated and on same backing indicated for Work.
3. LEED Submittals:
a. Product Data for Credit MR 4.1 and MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
1) Include statement indicating costs for each product having recycled content.
b. Product Data for Credit EQ 4.1: For adhesives used to laminate gypsum board panels to substrates, including printed statement of VOC content.

D. Quality Assurance
1. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
2. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

E. Storage And Handling
1. Store materials inside under cover and keep them dry and protected against damage from weather, condensation, direct sunlight, construction traffic, and other causes. Stack panels flat to prevent sagging.

F. Project Conditions
1. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.
2. Do not install interior products until installation areas are enclosed and conditioned.
3. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.
a. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
b. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

1.2 PRODUCTS

A. Panels, General
1. Recycled Content: Provide gypsum panel products with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 25 percent by weight.
2. Size: Provide in maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

B. Interior Gypsum Board
1. General: Complying with ASTM C 36/C 36M or ASTM C 1396/C 1396M, as applicable to type of gypsum board indicated and whichever is more stringent.
2. Regular Type:
a. Thickness: 1/2 inch (12.7 mm).
b. Long Edges: Tapered **OR** Tapered and featured (rounded or beveled) for prefilling, **as directed**.
3. Type X:
a. Thickness: 5/8 inch (15.9 mm).
b. Long Edges: Tapered **OR** Tapered and featured (rounded or beveled) for prefilling, **as directed**.
4. Type C:
a. Thickness: As required by fire-resistance-rated assembly indicated on Drawings.
b. Long Edges: Tapered.
5. Flexible Type: Manufactured to bend to fit radii and to be more flexible than standard regular-type gypsum board of same thickness.
a. Thickness: 1/4 inch (6.4 mm).
b. Long Edges: Tapered.
6. Ceiling Type: Manufactured to have more sag resistance than regular-type gypsum board.
a. Thickness: 1/2 inch (12.7 mm).
b. Long Edges: Tapered.
7. Foil-Backed Type:
a. Core: As indicated on Drawings **OR** 3/8 inch (9.5 mm), regular type **OR** 1/2 inch (12.7 mm), regular type **OR** 5/8 inch (15.9 mm), Type X **OR** Type C as required by fire-resistance-rated assembly indicated on Drawings, **as directed**.
b. Long Edges: Tapered **OR** Tapered and featured (rounded or beveled) for prefilling, **as directed**.
8. Abuse-Resistant Type: Manufactured to produce greater resistance to surface indentation, through-penetration (impact resistance), and abrasion than standard, regular-type and Type X gypsum board.
a. Core: As indicated on Drawings **OR** 1/2 inch (12.7 mm), regular type **OR** 5/8 inch (15.9 mm), Type X, **as directed**.
b. Long Edges: Tapered.
9. High-Impact Type: Manufactured with Type X core, plastic film laminated to back side for greater resistance to through-penetration (impact resistance).
a. Core: As indicated on Drawings **OR** 5/8 inch (15.9 mm) thick, **as directed**.
b. Plastic-Film Thickness: 0.010 inch (0.254 mm) **OR** 0.020 inch (0.508 mm) **OR** 0.030 inch (0.762 mm) **OR** 0.081 inch (2.057 mm), **as directed**.
10. Moisture- and Mold-Resistant Type: With moisture- and mold-resistant core and surfaces.
a. Core: 5/8 inch (15.9 mm), Type X.
b. Long Edges: Tapered.

C. Exterior Gypsum Board For Ceilings And Soffits
1. Exterior Gypsum Soffit Board: ASTM C 931/C 931M or ASTM C 1396/C 1396M, with manufacturer's standard edges.

1) Core: As indicated **OR** 1/2 inch (12.7 mm), regular type **OR** 5/8 inch (15.9 mm), Type X, **as directed**.

2. Glass-Mat Gypsum Sheathing Board: ASTM C 1177/C 1177M.
   a. Core: As indicated **OR** 1/2 inch (12.7 mm), regular type **OR** 5/8 inch (15.9 mm), Type X, **as directed**.

D. Tile Backing Panels
1. Water-Resistant Gypsum Backing Board: ASTM C 630/C 630M or ASTM C 1396/C 1396M.
   a. Core: As indicated on Drawings **OR** 1/2 inch (12.7 mm), regular type **OR** 5/8 inch (15.9 mm), Type X **OR** Type C as required by fire-resistance-rated assembly indicated on Drawings, **as directed**.
2. Glass-Mat, Water-Resistant Backing Board:
   a. Complying with ASTM C 1178/C 1178M.
   b. Complying with ASTM C1177/C 1177M.
   c. Core: As indicated on Drawings **OR** 1/2 inch (12.7 mm), regular type **OR** 5/8 inch (15.9 mm), Type X, **as directed**.
3. Cementitious Backer Units: ANSI A118.9.
   a. Thickness: As indicated on Drawings **OR** 1/2 inch (12.7 mm), **as directed**.

E. Trim Accessories
1. Interior Trim: ASTM C 1047.
   a. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet **OR** Galvanized or aluminum-coated steel sheet or rolled zinc **OR** Plastic **OR** Paper-faced galvanized steel sheet, **as directed**.
   b. Shapes:
      1) Cornerbead.
      2) Bullnose bead.
      3) LC-Bead: J-shaped; exposed long flange receives joint compound.
      4) L-Bead: L-shaped; exposed long flange receives joint compound.
      5) U-Bead: J-shaped; exposed short flange does not receive joint compound.
      6) Expansion (control) joint.
      7) Curved-Edge Cornerbead: With notched or flexible flanges.
2. Exterior Trim: ASTM C 1047.
   a. Material: Hot-dip galvanized steel sheet, plastic, or rolled zinc.
   b. Shapes:
      1) Cornerbead.
      2) LC-Bead: J-shaped; exposed long flange receives joint compound.
      3) Expansion (Control) Joint: One-piece, rolled zinc with V-shaped slot and removable strip covering slot opening.
3. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.
   a. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221 (ASTM B 221M), Alloy 6063-T5.
   b. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.

F. Joint Treatment Materials
1. General: Comply with ASTM C 475/C 475M.
2. Joint Tape:
   a. Interior Gypsum Wallboard: Paper.
   b. Exterior Gypsum Soffit Board: Paper.
   c. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
   d. Tile Backing Panels: As recommended by panel manufacturer.
3. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
   a. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.

b. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping **OR** drying-type, all-purpose, **as directed**, compound.
   1) Use setting-type compound for installing paper-faced metal trim accessories.
c. Fill Coat: For second coat, use setting-type, sandable topping **OR** drying-type, all-purpose, **as directed**, compound.
d. Finish Coat: For third coat, use setting-type, sandable topping **OR** drying-type, all-purpose, **as directed**, compound.
e. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound **OR** drying-type, all-purpose compound **OR** high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat to produce Level 5 finish, **as directed**.

4. Joint Compound for Exterior Applications:
   a. Exterior Gypsum Soffit Board: Use setting-type taping compound and setting-type, sandable topping compound.
   b. Glass-Mat Gypsum Sheathing Board: As recommended by sheathing board manufacturer.
5. Joint Compound for Tile Backing Panels:
   a. Water-Resistant Gypsum Backing Board: Use setting-type taping compound and setting-type, sandable topping compound.
   b. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.
   c. Cementitious Backer Units: As recommended by backer unit manufacturer.

G. Auxiliary Materials
1. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
2. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
   a. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
   a. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
   b. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
4. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
   a. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
   b. Recycled Content: Provide blankets with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 25 percent by weight.
5. Acoustical Sealant: As specified in Division 07 Section "Joint Sealants".
   a. Provide sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Thermal Insulation: As specified in Division 07 Section "Building Insulation".
7. Vapor Retarder: As specified in Division 07 Section "Building Insulation".

H. Texture Finishes
1. Primer: As recommended by textured finish manufacturer.
2. Polystyrene Aggregate Ceiling Finish: Water-based, job-mixed, polystyrene aggregate finish with flame-spread and smoke-developed indexes of not more than 25 when tested according to ASTM E 84.
   a. Texture: Fine **OR** Medium **OR** Coarse, **as directed**.
3. Aggregate Finish: Water-based, job-mixed, aggregated, drying-type texture finish for spray application.

a. Texture: Light spatter **OR** Spatter knock-down, **as directed**.

4. Acoustical Finish: Water-based, chemical-setting or drying-type, job-mixed texture finish for spray application.
   a. Application Thickness: 1/2 inch (12.7 mm).
   b. Fire-Test-Response Characteristics: Indices when tested according to ASTM E 84 as follows:
      1) Flame Spread: Less than 25.
      2) Smoke Developed: Less than 450.
   c. NRC: 0.55 according to ASTM C 423.

1.3 EXECUTION

A. Examination
1. Examine areas and substrates, with Installer present, and including welded hollow-metal frames and framing, for compliance with requirements and other conditions affecting performance.
2. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Applying And Finishing Panels, General
1. Comply with ASTM C 840.
2. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
3. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.5 mm) of open space between panels. Do not force into place.
4. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
5. Form control and expansion joints with space between edges of adjoining gypsum panels.
6. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
   a. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.7 sq. m) in area.
   b. Fit gypsum panels around ducts, pipes, and conduits.
   c. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- (6.4- to 9.5-mm-) wide joints to install sealant.
7. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations, and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
8. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
9. Wood Framing: Install gypsum panels over wood framing, with floating internal corner construction. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members, or provide control joints to counteract wood shrinkage.
10. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

11. Install sound attenuation blankets before installing gypsum panels, unless blankets are readily installed after panels have been installed on one side.

C. Applying Interior Gypsum Board
   1. Install interior gypsum board in the following locations:
      a. Regular Type: As indicated on Drawings **OR** Vertical surfaces, unless otherwise indicated, **as directed**.
      b. Type X: As indicated on Drawings **OR** Where required for fire-resistance-rated assembly **OR** Vertical surfaces, unless otherwise indicated, **as directed**.
      c. Type C: As indicated on Drawings **OR** Where required for specific fire-resistance-rated assembly indicated, **as directed**.
      d. Flexible Type: As indicated on Drawings **OR** Apply in double layer at curved assemblies, **as directed**.
      e. Ceiling Type: As indicated on Drawings **OR** Ceiling surfaces, **as directed**.
      f. Foil-Backed Type: As indicated on Drawings **OR as directed**.
      g. Abuse-Resistant Type: As indicated on Drawings **OR as directed**.
      h. High-Impact Type: As indicated on Drawings **OR as directed**.
      i. Moisture- and Mold-Resistant Type: As indicated on Drawings **OR as directed**.
   2. Single-Layer Application:
      a. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing, unless otherwise indicated.
      b. On partitions/walls, apply gypsum panels vertically (parallel to framing) **OR** horizontally (perpendicular to framing), **as directed**, unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
         1) Stagger abutting end joints not less than one framing member in alternate courses of panels.
         2) At stairwells and other high walls, install panels horizontally, unless otherwise indicated or required by fire-resistance-rated assembly.
      c. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
      d. Fastening Methods: Apply gypsum panels to supports with steel drill screws.
   3. Multilayer Application:
      a. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints 1 framing member, 16 inches (400 mm) minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
      b. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
      c. On Z-furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
      d. Fastening Methods: Fasten base layers and face layers separately to supports with screws **OR** Fasten base layers with screws; fasten face layers with adhesive and supplementary fasteners, **as directed**.
   4. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.
   5. Curved Surfaces:

a. Install panels horizontally (perpendicular to supports) and unbroken, to extent possible, across curved surface plus 12-inch- (300-mm-) long straight sections at ends of curves and tangent to them.
b. For double-layer construction, fasten base layer to studs with screws 16 inches (400 mm) o.c. Center gypsum board face layer over joints in base layer, and fasten to studs with screws spaced 12 inches (300 mm) o.c.

D. Applying Exterior Gypsum Panels For Ceilings And Soffits
1. Apply panels perpendicular to supports, with end joints staggered and located over supports.
a. Install with 1/4-inch (6.4-mm) open space where panels abut other construction or structural penetrations.
b. Fasten with corrosion-resistant screws.

E. Applying Tile Backing Panels
1. Water-Resistant Gypsum Backing Board: Install at showers, tubs, and where indicated. Install with 1/4-inch (6.4-mm) gap where panels abut other construction or penetrations.
2. Glass-Mat, Water-Resistant Backing Panel: Comply with manufacturer's written installation instructions and install at showers, tubs, and where indicated **OR** locations indicated to receive tile, **as directed**. Install with 1/4-inch (6.4-mm) gap where panels abut other construction or penetrations.
3. Cementitious Backer Units: ANSI A108.11, at showers, tubs, and where indicated **OR** locations indicated to receive tile, **as directed**.
4. Areas Not Subject to Wetting: Install regular-type gypsum wallboard panels to produce a flat surface except at showers, tubs, and other locations indicated to receive water-resistant panels.
5. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

F. Installing Trim Accessories
1. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
2. Control Joints: Install control joints at locations indicated on Drawings **OR** according to ASTM C 840 and in specific locations approved by the Owner for visual effect, **as directed**.
3. Interior Trim: Install in the following locations:
a. Cornerbead: Use at outside corners, unless otherwise indicated.
b. Bullnose Bead: Use at outside corners **OR** where indicated, **as directed**.
c. LC-Bead: Use at exposed panel edges.
d. L-Bead: Use where indicated.
e. U-Bead: Use at exposed panel edges **OR** where indicated, **as directed**.
f. Curved-Edge Cornerbead: Use at curved openings.
4. Exterior Trim: Install in the following locations:
a. Cornerbead: Use at outside corners.
b. LC-Bead: Use at exposed panel edges.
5. Aluminum Trim: Install in locations indicated on Drawings.

G. Finishing Gypsum Board
1. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
2. Prefill open joints, rounded or beveled edges, and damaged surface areas.
3. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.
4. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
a. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
b. Level 2: Panels that are substrate for tile **OR** Panels that are substrate for acoustical tile **OR** Where indicated on Drawings, **as directed**.

c. Level 3: For surfaces receiving medium- or heavy-textured finishes before painting or heavy wallcoverings where lighting conditions are not critical **OR** Where indicated on Drawings, **as directed**.
d. Level 4: For surfaces receiving light-textured finishes, wallcoverings, and flat paints **OR** At panel surfaces that will be exposed to view, unless otherwise indicated, **as directed**. This is generally the standard exposed finish. Gloss and semi-gloss enamel paints are not usually recommended over this level of finish. ASTM C 840 requires application of "drywall primer" on surfaces before final decoration
    1) Primer and its application to surfaces are specified in other Division 07.
e. Level 5: For surfaces receiving gloss and semigloss enamels and other surfaces subject to severe lighting **OR** Where indicated on Drawings, **as directed**.
    1) Primer and its application to surfaces are specified in other Division 07.
f. Glass-Mat Gypsum Sheathing Board: Finish according to manufacturer's written instructions for use as exposed soffit board.
g. Glass-Mat, Water-Resistant Backing Panels: Finish according to manufacturer's written instructions.
h. Cementitious Backer Units: Finish according to manufacturer's written instructions.

H. Applying Texture Finishes
1. Surface Preparation and Primer: Prepare and apply primer to gypsum panels and other surfaces receiving texture finishes. Apply primer to surfaces that are clean, dry, and smooth.
2. Texture Finish Application: Mix and apply finish using powered spray equipment, to produce a uniform texture free of starved spots or other evidence of thin application or of application patterns.
3. Prevent texture finishes from coming into contact with surfaces not indicated to receive texture finish by covering them with masking agents, polyethylene film, or other means. If, despite these precautions, texture finishes contact these surfaces, immediately remove droppings and overspray to prevent damage according to texture-finish manufacturer's written recommendations.

I. Protection
1. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
2. Remove and replace panels that are wet, moisture damaged, and mold damaged.
    a. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
    b. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 09250

SECTION 09250a - GYPSUM BOARD SHAFT-WALL ASSEMBLIES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for gypsum board shaft-wall assemblies. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes gypsum board shaft-wall assemblies for the following:
   a. Shaft-wall enclosures.
   b. Chase enclosures.
   c. Stair enclosures.
   d. Horizontal enclosures.

C. Submittals
1. Product Data: For each gypsum board shaft-wall assembly indicated.
2. LEED Submittals:
   a. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
   b. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
      1) Include statement indicating costs for each product having recycled content.

D. Quality Assurance
1. Fire-Resistance Ratings: Provide materials and construction identical to those of assemblies with fire-resistance ratings determined according to ASTM E 119 by a testing and inspecting agency.
2. STC-Rated Assemblies: Provide materials and construction identical to those of assemblies tested according to ASTM E 90 and classified according to ASTM E 413 by a testing and inspecting agency.
3. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
1. Deliver materials in original packages, containers, and bundles bearing brand name and identification of manufacturer or supplier.
2. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.
3. Stack panels flat on leveled supports off floor or slab to prevent sagging.

F. Project Conditions
1. Environmental Limitations: Comply with ASTM C 840 requirements or with gypsum board manufacturer's written recommendations, whichever are more stringent.
2. Do not install interior products until installation areas are enclosed and conditioned.
3. Do not install panels that are wet, moisture damaged, or mold damaged.
   a. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
   b. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

A. Gypsum Board Shaft-Wall Assemblies, General
   1. Provide materials and components complying with requirements of fire-resistance-rated assemblies indicated.
      a. Provide panels in maximum lengths available to eliminate or minimize end-to-end butt joints.
      b. Provide auxiliary materials complying with gypsum board shaft-wall assembly manufacturer's written recommendations.

B. Panel Products
   1. Recycled Content: Provide gypsum panel products with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 25 percent by weight.
   2. Gypsum Liner Panels: Comply with ASTM C 442/C 442M.
      a. Type X: Manufacturer's proprietary liner panels with moisture-resistant paper faces.
         1) Core: 1 inch (25.4 mm) thick.
         2) Long Edges: Double bevel.
      b. Moisture- and Mold-Resistant Type X: Manufacturer's proprietary liner panels with moisture- and mold-resistant core and surfaces; comply with ASTM D 3273.
         1) Core: 1 inch (25.4 mm) thick.
         2) Long Edges: Double bevel.
   3. Gypsum Base for Gypsum Veneer Plaster: As specified in Division 09 Section "Gypsum Veneer Plastering".
   4. Gypsum Board: As specified in Division 09 Section "Gypsum Board".
   5. Water-Resistant Gypsum Backing Board: As specified in Division 09 Section "Gypsum Board".
   6. Cementitious Backer Units: As specified in Division 09 Section "Ceramic Tile".

C. Non-Load-Bearing Steel Framing
   1. Framing Members: Comply with ASTM C 754 for conditions indicated.
   2. Steel Sheet Components: Comply with ASTM C 645 requirements for metal, unless otherwise indicated.
      a. Recycled Content: Provide steel sheet with average recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
      b. Protective Coating: ASTM A 653/A 653M, G40 (Z120) **OR** ASTM A 653/A 653M, G60 (Z180) **OR** Coating with equivalent corrosion resistance of ASTM A 653/A 653M, G40 (Z120), **as directed**, hot-dip galvanized, unless otherwise indicated.

D. Auxiliary Materials
   1. General: Provide auxiliary materials that comply with referenced product standards and manufacturer's written recommendations.
   2. Trim Accessories: Cornerbead, edge trim, and control joints of material and shapes specified in Division 09 Section(s) "Gypsum Veneer Plastering" OR "Gypsum Board", **as directed**, that comply with gypsum board shaft-wall assembly manufacturer's written recommendations for application indicated.
   3. Gypsum Base Joint-Reinforcing Materials: As specified in Division 09 Section "Gypsum Veneer Plastering".
   4. Gypsum Veneer Plaster: As specified in Division 09 Section "Gypsum Veneer Plastering".
   5. Gypsum Board Joint-Treatment Materials: As specified in Division 09 Section "Gypsum Board".
   6. Laminating Adhesive: Adhesive or joint compound recommended by manufacturer for directly adhering gypsum face-layer panels and gypsum-base face-layer panels to backing-layer panels in multilayer construction.
      a. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

7. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
   a. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
8. Track Fasteners: Power-driven fasteners of size and material required to withstand loading conditions imposed on shaft-wall assemblies without exceeding allowable design stress of track, fasteners, or structural substrates in which anchors are embedded.
   a. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing per ASTM E 488 conducted by a qualified testing agency.
   b. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing per ASTM E 1190 conducted by a qualified testing agency.
9. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing), produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
   a. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
   b. Recycled Content: Provide blankets with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 25 percent by weight.
10. Acoustical Sealant: As specified in Division 07 Section "Building Insulation".
    a. Provide sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Gypsum Board Shaft-Wall Assemblies
1. Basis-of-Design Product: As indicated on Drawings by design designation of a qualified testing agency.
2. Fire-Resistance Rating: As indicated **OR** 1 hour **OR** 2 hours **OR** 3 hours **OR** 4 hours, **as directed**.
3. STC Rating: As indicated **OR** 51, minimum, **as directed**.
4. Studs: Manufacturer's standard profile for repetitive members, corner and end members, and fire-resistance-rated assembly indicated.
   a. Depth: As indicated **OR** 2-1/2 inches (64 mm) **OR** 4 inches (102 mm) **OR** 6 inches (152 mm), **as directed**.
   b. Minimum Base-Metal Thickness: As indicated **OR** 0.0179 inch (0.45 mm) **OR** 0.0220 inch (0.55 mm) **OR** 0.0329 inch (0.84 mm), **as directed**.
5. Runner Tracks: Manufacturer's standard J-profile track with long-leg length as standard with manufacturer, but at least 2 inches (51 mm) long and in depth matching studs.
   a. Minimum Base-Metal Thickness: As indicated **OR** Matching steel studs **OR** 0.0179 inch (0.45 mm) **OR** 0.0220 inch (0.55 mm) **OR** 0.0329 inch (0.84 mm), **as directed**.
6. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
7. Jamb Struts: Manufacturer's standard J-profile strut with long-leg length of 3 inches (76 mm), in depth matching studs, and not less than 0.0329 inch (0.84 mm) thick.
8. Room-Side Finish: As indicated **OR** Gypsum board **OR** Gypsum veneer plaster **OR** Cementitious backer units, **as directed**.
9. Shaft-Side Finish: As indicated **OR** As indicated by fire-resistance-rated assembly design designation, **as directed**.
10. Insulation: Sound attenuation blankets.

2.2 EXECUTION

A. Preparation

1. Sprayed Fire-Resistive Materials: Coordinate with gypsum board shaft-wall assemblies so both elements of Work remain complete and undamaged. Patch or replace sprayed fire-resistive materials removed or damaged during installation of shaft-wall assemblies to comply with requirements specified in Division 07 Section "Sprayed Fire-resistive Materials".
   a. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling runner tracks to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches (610 mm) o.c.
2. After sprayed fire-resistive materials are applied, remove only to extent necessary for installation of gypsum board shaft-wall assemblies and without reducing the fire-resistive material thickness below that which is required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

B. Installation
1. General: Install gypsum board shaft-wall assemblies to comply with requirements of fire-resistance-rated assemblies indicated, manufacturer's written installation instructions, and the following:
   a. ASTM C 754 for installing steel framing except comply with framing spacing indicated.
   b. Division 09 Section(s) "Gypsum Veneer Plastering" OR "Gypsum Board", **as directed**, for applying and finishing panels.
   c. Division 09 Section "Ceramic Tile" for cementitious backer units.
2. Do not bridge architectural or building expansion joints with shaft-wall assemblies; frame both sides of expansion joints with furring and other support.
3. Install supplementary framing in gypsum board shaft-wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, and similar items that cannot be supported directly by shaft-wall assembly framing.
   a. At elevator hoistway entrance door frames, provide jamb struts on each side of door frame.
   b. Where handrails directly attach to gypsum board shaft-wall assemblies, provide galvanized steel reinforcing strip with 0.0312-inch (0.79-mm) minimum thickness of base (uncoated) metal, accurately positioned and secured behind at least 1 gypsum base for veneer plaster **OR** gypsum board **OR** cementitious backer unit, **as directed**, face-layer panel.
4. Integrate stair hanger rods with gypsum board shaft-wall assemblies by locating cavity of assemblies where required to enclose rods.
5. At penetrations in shaft wall, maintain fire-resistance rating of shaft-wall assembly by installing supplementary steel framing around perimeter of penetration and fire protection behind boxes containing wiring devices, elevator call buttons, elevator floor indicators, and similar items.
6. Isolate perimeter of gypsum panels from building structure to prevent cracking of panels, while maintaining continuity of fire-rated construction.
7. Firestop Tracks: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
8. Control Joints: Install control joints at locations indicated on Drawings **OR** according to ASTM C 840 and in specific locations approved by the Owner, **as directed**, while maintaining fire-resistance rating of gypsum board shaft-wall assemblies.
9. Seal gypsum board shaft walls with acoustical sealant at perimeter of each assembly where it abuts other work and at joints and penetrations within each assembly. Install acoustical sealant to withstand dislocation by air-pressure differential between shaft and external spaces; maintain an airtight and smoke-tight seal; and comply with ASTM C 919 requirements or with manufacturer's written instructions, whichever are more stringent.
10. In elevator shafts where gypsum board shaft-wall assemblies cannot be positioned within 4 inches (102 mm) of the shaft face of structural beams, floor edges, and similar projections into shaft, install 1/2- or 5/8-inch- (13- or 16-mm-) thick, gypsum board cants covering tops of projections. No recesses allowed (at steel beams especially).

a. Slope cant panels at least 75 degrees from horizontal. Set base edge of panels in adhesive and secure top edges to shaft walls at 24 inches (610 mm) o.c. with screws fastened to shaft-wall framing.
b. Where steel framing is required to support gypsum board cants, install framing at 24 inches (610 mm) o.c. and extend studs from the projection to shaft-wall framing.

11. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3mm) from the plane formed by faces of adjacent framing.

C. Protection
1. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
2. Remove and replace panels that are wet, moisture damaged, or mold damaged.
a. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
b. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 09250a

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Task	Specification	Specification Description
09250	01352	No Specification Required
09270	09250	Gypsum Board
09305	09205	Gypsum Veneer Plaster
09305	09250	Gypsum Board
09305	09250a	Gypsum Board Shaft-Wall Assemblies
09305	09310	Ceramic Tile

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SECTION 09310 - CERAMIC TILE

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for ceramic tile. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Ceramic tile.
b. Stone thresholds.
c. Waterproof membrane.
d. Crack isolation membrane.
e. Tile backing panels.
f. Metal edge strips.

C. Definitions
1. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.
2. ANSI A108 Series: ANSI A108.01, ANSI A108.02, ANSI A108.1A, ANSI A108.1B, ANSI A108.1C, ANSI A108.4, ANSI A108.5, ANSI A108.6, ANSI A108.8, ANSI A108.9, ANSI A108.10, ANSI A108.11, ANSI A108.12, ANSI A108.13, ANSI A108.14, ANSI A108.15, ANSI A108.16, and ANSI A108.17, which are contained in "American National Standard Specifications for Installation of Ceramic Tile."
3. Module Size: Actual tile size plus joint width indicated.
4. Face Size: Actual tile size, excluding spacer lugs.

D. Performance Requirements
1. Static Coefficient of Friction: For tile installed on walkway surfaces, provide products with the following values as determined by testing identical products per ASTM C 1028:
a. Level Surfaces: Minimum 0.6.
b. Step Treads: Minimum 0.6.
c. Ramp Surfaces: Minimum 0.8.

E. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:
a. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
3. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
4. Samples:
a. Full-size units of each type and composition of tile and for each color and finish required. For ceramic mosaic tile in color blend patterns, provide full sheets of each color blend.
OR
Assembled samples mounted on a rigid panel, with grouted joints, for each type and composition of tile and for each color and finish required. Make samples at least 12 inches (300 mm) square, but not fewer than 4 tiles. Use grout of type and in color or colors approved for completed Work.

b. Full-size units of each type of trim and accessory for each color and finish required.
c. Stone thresholds in 6-inch (150-mm) lengths.
d. Metal edge strips in 6-inch (150-mm) lengths.

5. Qualification Data: For qualified Installer.
6. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.
7. Product Certificates: For each type of product, signed by product manufacturer.
8. Material Test Reports: For each tile-setting and -grouting product and special purpose tile.

F. Quality Assurance
1. Source Limitations for Tile: Obtain tile of each type and color or finish **OR** tile of each type **OR** tile of each color or finish **OR** tile, **as directed**, from one source or producer.
a. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.
2. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from one manufacturer and each aggregate from one source or producer.
3. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer for each product:
a. Stone thresholds.
b. Waterproof membrane.
c. Crack isolation membrane.
d. Joint sealants.
e. Cementitious backer units.
f. Metal edge strips.
4. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.
2. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
3. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
4. Store liquid materials in unopened containers and protected from freezing.
5. Handle tile that has temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

H. Project Conditions
1. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

1.2 PRODUCTS

A. Products, General
1. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
a. Provide tile complying with Standard grade requirements unless otherwise indicated.
2. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 1.2 articles, ANSI standards referenced by TCA installation methods specified in tile installation schedules, and other requirements specified.

3. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.
4. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.
   a. Where tile is indicated for installation in swimming pools, on exteriors or in wet areas, do not use back- or edge-mounted tile assemblies unless tile manufacturer specifies in writing that this type of mounting is suitable for installation indicated and has a record of successful in-service performance.
5. Factory-Applied Temporary Protective Coating: Where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by precoating with continuous film of petroleum paraffin wax, applied hot. Do not coat unexposed tile surfaces.

B. Tile Products
1. Tile Type: Factory-mounted unglazed **OR** glazed, **as directed**, ceramic mosaic tile.
   a. Composition: Porcelain **OR** Impervious natural clay or porcelain **OR** Vitreous or impervious natural clay or porcelain, **as directed**.
   b. Module Size: 1 by 1 inch (25.4 by 25.4 mm) **OR** 1 by 2 inches (25.4 by 50.8 mm) **OR** 2 by 2 inches (50.8 by 50.8 mm), **as directed**.
   c. Thickness: 1/4 inch (6.35 mm).
   d. Face: Plain **OR** Pattern of design indicated, **as directed**, with cushion edges.
   e. Surface (for unglazed tile): Smooth, without **OR** Slip-resistant, with, **as directed**, abrasive admixture.
   f. Finish (for glazed tile): Bright, opaque **OR** Bright, clear **OR** Mat, opaque **OR** Mat, clear **OR** Semimat, opaque **OR** Semimat, clear **OR** Vellum, opaque **OR** Vellum, clear **OR** Crystalline, **as directed**, glaze.
   g. Tile Color and Pattern: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   h. Grout Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   i. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile, **as directed**. Provide shapes as follows, selected from manufacturer's standard shapes:
      1) Base Cove: Cove, module size 1 by 1 inch (25.4 by 25.4 mm) **OR** 2 by 1 inch (50.8 by 25.4 mm), **as directed**.
      2) Base Cap for Portland Cement Mortar Installations: Bead (bullnose), module size 1 by 1 inch (25.4 by 25.4 mm) **OR** 2 by 1 inch (50.8 by 25.4 mm), **as directed**.
      3) Base Cap for Thin-Set Mortar Installations: Surface bullnose, module size 1 by 1 inch (25.4 by 25.4 mm) **OR** 2 by 1 inch (50.8 by 25.4 mm) **OR** 2 by 2 inches (50.8 by 50.8 mm), **as directed**.
      4) Wainscot Cap for Portland Cement Mortar Installations: Bead (bullnose), module size 1 by 1 inch (25.4 by 25.4 mm) **OR** 2 by 1 inch (50.8 by 25.4 mm), **as directed**.
      5) Wainscot Cap for Thin-Set Mortar Installations: Surface bullnose, module size 1 by 1 inch (25.4 by 25.4 mm) **OR** 2 by 1 inch (50.8 by 25.4 mm) **OR** 2 by 2 inches (50.8 by 50.8 mm), **as directed**.
      6) Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it, same size as adjoining flat tile.
      7) External Corners for Portland Cement Mortar Installations: Bead (bullnose), module size 1 by 1 inch (25.4 by 25.4 mm) **OR** 2 by 1 inch (50.8 by 25.4 mm), **as directed**.
      8) External Corners for Thin-Set Mortar Installations: Surface bullnose, module size 1 by 1 inch (25.4 by 25.4 mm) **OR** 2 by 1 inch (50.8 by 25.4 mm) **OR** 2 by 2 inches (50.8 by 50.8 mm), **as directed**.
      9) Internal Corners: Cove, module size 1 by 1 inch (25.4 by 25.4 mm) **OR** 2 by 1 inch (50.8 by 25.4 mm), **as directed**.
      OR

Internal Corners: Field-butted square corners. For coved base and cap, use angle pieces designed to fit with stretcher shapes.

10) Tapered Transition Tile: Shape designed to effect transition between thickness of tile floor and adjoining floor finishes of different thickness, tapered to provide reduction in thickness from 1/2 to 1/4 inch (12.7 to 6.35 mm) across nominal 4-inch (100-mm) dimension.

2. Tile Type: Unglazed **OR** Glazed, **as directed**, square-edged quarry tile.
   a. Face Size: 3 by 3 inches (76 by 76 mm) **OR** 4 by 4 inches (102 by 102 mm) **OR** 6 by 3 inches (152 by 76 mm) **OR** 6 by 6 inches (152 by 152 mm) **OR** 8 by 3-7/8 inches (203 by 98 mm) **OR** 8 by 8 inches (203 by 203 mm), **as directed**.
   b. Thickness: 3/8 inch (9.5 mm) **OR** 1/2 inch (12.7 mm) **OR** 3/4 inch (19 mm), **as directed**.
   c. Wearing Surface (for unglazed tile): Nonabrasive, smooth **OR** Abrasive aggregate embedded in surface, **as directed**.
   d. Finish (for glazed tile): Bright, opaque **OR** Bright, clear **OR** Mat, opaque **OR** Mat, clear **OR** Semimat, opaque **OR** Semimat, clear **OR** Vellum, opaque **OR** Vellum, clear **OR** Crystalline, **as directed**, glaze.
   e. Tile Color and Pattern: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   f. Grout Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   g. For furan-grouted quarry tile, precoat with temporary protective coating.
   h. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile, **as directed**. Provide shapes as follows, selected from manufacturer's standard shapes:
      1) Base: Coved with surface bullnose top edge, **as directed**, face size 6 by 6 inches (152 by 152 mm) **OR** 8 by 3-7/8 inches (203 by 98 mm), **as directed**.
      2) Wainscot Cap: Surface bullnose, face size 6 by 6 inches (152 by 152 mm) **OR** 8 by 3-7/8 inches (203 by 98 mm), **as directed**.
      3) Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it, same size as adjoining flat tile.
3. Tile Type: Unglazed **OR** Glazed, **as directed**, paver tile.
   a. Composition: Porcelain **OR** Impervious natural clay or porcelain **OR** Vitreous or impervious natural clay or porcelain **OR** Natural clay or porcelain, **as directed**.
   b. Face Size: 3 by 3 inches (76 by 76 mm) **OR** 4 by 4 inches (102 by 102 mm) **OR** 6 by 6 inches (152 by 152 mm) **OR** 7-3/4 by 3-7/8 inches (197 by 98 mm) **OR** 7-7/8 by 7-7/8 inches (200 by 200 mm) **OR** 11-13/16 by 11-13/16 inches (300 by 300 mm) **OR** 165 by 333 mm **OR** 200 by 250 mm **OR** 250 by 250 mm **OR** 165 by 333 mm **OR** 333 by 333 mm **OR** 400 by 400 mm, **as directed**.
   c. Thickness: 1/4 inch (6.35 mm) **OR** 3/8 inch (9.5 mm) **OR** 1/2 inch (12.7 mm), **as directed**.
   d. Face: Plain with square or cushion edges **OR** Plain with square edges **OR** Plain with cushion edges **OR** Pattern of design indicated, with square or cushion edges **OR** As indicated, **as directed**.
   e. Finish (for glazed tile): Bright, opaque **OR** Bright, clear **OR** Mat, opaque **OR** Mat, clear **OR** Semimat, opaque **OR** Semimat, clear **OR** Vellum, opaque **OR** Vellum, clear **OR** Crystalline, **as directed**, glaze.
   f. Tile Color and Pattern: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   g. Grout Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
4. Tile Type: Glazed wall tile **OR** Decorative thin wall tile, **as directed**.
   a. Module Size: 4-1/4 by 4-1/4 inches (108 by 108 mm) **OR** 6 by 4-1/4 inches (152 by 108 mm) **OR** 6 by 6 inches (152 by 152 mm) **OR** 200 by 200 mm **OR** 250 by 250 mm **OR** 200 by 300 mm, **as directed**.
   b. Thickness: 5/16 inch (8 mm).

c. Face: Plain with modified square edges or cushion edges **OR** Plain with modified square edges **OR** Plain with cushion edges **OR** Pattern of design indicated, with manufacturer's standard edges, **as directed**.
d. Finish: Bright, opaque **OR** Bright, clear **OR** Mat, opaque **OR** Mat, clear **OR** Semimat, opaque **OR** Semimat, clear **OR** Vellum, opaque **OR** Vellum, clear **OR** Crystalline, **as directed**, glaze.
e. Tile Color and Pattern: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
f. Grout Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
g. Mounting: Factory, back mounted.
h. Mounting: Pregrouted sheets of tiles factory assembled and grouted with manufacturer's standard white silicone rubber.
i. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile, **as directed**. Provide shapes as follows, selected from manufacturer's standard shapes:
1) Base for Portland Cement Mortar Installations: Coved, module size 4-1/4 by 4-1/4 inches (108 by 108 mm) **OR** 6 by 6 inches (152 by 152 mm) **OR** 6 by 3-3/4 inches (152 by 95 mm), **as directed**.
2) Base for Thin-Set Mortar Installations: Straight, module size 4-1/4 by 4-1/4 inches (108 by 108 mm) **OR** 6 by 6 inches (152 by 152 mm) **OR** 6 by 2 inches (152 by 51 mm), **as directed**.
3) Wainscot Cap for Portland Cement Mortar Installations: Bullnose cap, module size 4-1/4 by 4-1/4 inches (108 by 108 mm) **OR** 6 by 6 inches (152 by 152 mm) **OR** 6 by 2 inches (152 by 51 mm), **as directed**.
4) Wainscot Cap for Thin-Set Mortar Installations: Surface bullnose, module size 4-1/4 by 4-1/4 inches (108 by 108 mm) **OR** 6 by 6 inches (152 by 152 mm) **OR** 6 by 2 inches (152 by 51 mm), **as directed**.
5) Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it, same size as adjoining flat tile.
6) External Corners for Portland Cement Mortar Installations: Bullnose shape with radius of at least 3/4 inch (19 mm) unless otherwise indicated.
7) External Corners for Thin-Set Mortar Installations: Surface bullnose, same size as adjoining flat tile.
8) Internal Corners: Field-butted square corners. For coved base and cap use angle pieces designed to fit with stretcher shapes.

5. Accessories: Provide vitreous china accessories of type and size indicated, suitable for installing by same method as adjoining wall tile.
a. One soap holder with grab handle, **as directed**, for each shower and tub indicated.
b. One paper holder at each water closet.
c. Color and Finish: Match adjoining glazed wall tile **OR** As indicated by manufacturer's designations **OR** As selected from manufacturer's full range **OR** White, bright glaze, **as directed**.

C. Thresholds
1. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.
a. Bevel edges at 1:2 slope, with lower edge of bevel aligned with or up to 1/16 inch (1.5 mm) above adjacent floor surface. Finish bevel to match top surface of threshold. Limit height of threshold to 1/2 inch (12.7 mm) or less above adjacent floor surface.
2. Granite Thresholds: ASTM C 615, with polished **OR** honed, **as directed**, finish.
a. Description: Uniform, fine **OR** medium, **as directed**,-grained, white **OR** gray **OR** black, **as directed**, stone without veining.
OR
Description: Match sample.

3. Marble Thresholds: ASTM C 503, with a minimum abrasion resistance of 10 **OR** 12, **as directed**, per ASTM C 1353 or ASTM C 241 and with honed finish.
   a. Description: Uniform, fine- to medium-grained white stone with gray veining.
      OR
      Description: Match sample.
4. Slate Thresholds: ASTM C 629, Classification I Exterior **OR** II Interior, **as directed**, with fine, even grain and honed finish.
   a. Description: Uniform, black **OR** blue-black **OR** gray **OR** blue-gray **OR** green, **as directed**, stone and unfading.
      OR
      Description: Match sample.

D. Tile Backing Panels
1. Cementitious Backer Units: ANSI A118.9 or ASTM C 1325, in maximum lengths available to minimize end-to-end butt joints.
   a. Thickness: 1/4 inch (6.4 mm) **OR** 1/2 inch (12.7 mm) **OR** 5/8 inch (15.9 mm) **OR** As indicated, **as directed**.
2. Fiber-Cement Underlayment: ASTM C 1288, in maximum lengths available to minimize end-to-end butt joints.
   a. Thickness: 1/4 inch (6.4 mm) **OR** 1/2 inch (12.7 mm) **OR** As indicated, **as directed**.

E. Waterproof Membrane
1. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
2. Chlorinated Polyethylene Sheet: Nonplasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric; 0.030-inch (0.76-mm) nominal thickness.
3. PVC Sheet: Two layers of PVC sheet heat-fused together and to facings of nonwoven polyester; 0.040-inch (1.01-mm) nominal thickness.
4. Polyethylene Sheet: Polyethylene faced on both sides with fleece webbing; 0.008-inch (0.203-mm) nominal thickness.
5. Fabric-Reinforced, Modified-Bituminous Sheet: Self-adhering, SBS-modified-bituminous sheet with woven reinforcement facing; 0.040-inch (1.01-mm) nominal thickness.
6. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of liquid-latex rubber or elastomeric polymer and continuous fabric reinforcement.
7. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.
8. Latex-Portland Cement: Flexible mortar consisting of cement-based mix and latex additive.
9. Urethane Waterproofing and Tile-Setting Adhesive: One-part, liquid-applied urethane, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), in a consistency suitable for trowel application and intended for use as both waterproofing and tile-setting adhesive in a two-step process.

F. Crack Isolation Membrane
1. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.12 for standard **OR** high, **as directed**, performance and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
2. Chlorinated Polyethylene Sheet: Nonplasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric; 0.030-inch (0.76-mm) nominal thickness.
3. PVC Sheet: Two layers of PVC sheet heat-fused together and to facings of nonwoven polyester; 0.040-inch (1.01-mm) nominal thickness.
4. Polyethylene Sheet: Polyethylene faced on both sides with fleece webbing; 0.008-inch (0.203-mm) nominal thickness.
5. Corrugated Polyethylene: Corrugated polyethylene with dovetail-shaped corrugations and with anchoring webbing on the underside; 3/16-inch (4-mm) nominal thickness.

6. Fabric-Reinforced, Modified-Bituminous Sheet: Self-adhering, modified-bituminous sheet with fabric reinforcement facing; 0.040-inch (1.01-mm) nominal thickness.
7. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of liquid-latex rubber or elastomeric polymer and fabric reinforcement.
8. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.
9. Latex-Portland Cement: Flexible mortar consisting of cement-based mix and latex additive.
10. Urethane Crack Isolation Membrane and Tile-Setting Adhesive: One-part, liquid-applied urethane, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), in a consistency suitable for trowel application and intended for use as both waterproofing and tile-setting adhesive in a two-step process.

G. Setting Materials
1. Portland Cement Mortar (Thickset) Installation Materials: ANSI A108.02.
   a. Cleavage Membrane: Asphalt felt, ASTM D 226, Type I (No. 15); or polyethylene sheeting, ASTM D 4397, 4.0 mils (0.1 mm) thick.
   b. Reinforcing Wire Fabric: Galvanized, welded wire fabric, 2 by 2 inches (50.8 by 50.8 mm) by 0.062-inch (1.57-mm) diameter; comply with ASTM A 185 and ASTM A 82 except for minimum wire size.
   c. Expanded Metal Lath: Diamond-mesh lath complying with ASTM C 847.
      1) Base Metal and Finish for Interior Applications: Uncoated or zinc-coated (galvanized) steel sheet, with uncoated steel sheet painted after fabrication into lath.
      2) Base Metal and Finish for Exterior Applications: Zinc-coated (galvanized) steel sheet.
      3) Configuration over Studs and Furring: Flat.
      4) Configuration over Solid Surfaces: Self furring.
      5) Weight: 2.5 lb/sq. yd. (1.4 kg/sq. m) **OR** 3.4 lb/sq. yd. (1.8 kg/sq. m), **as directed**.
   d. Latex Additive: Manufacturer's standard, acrylic resin or styrene-butadiene-rubber water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed.
2. Dry-Set Portland Cement Mortar (Thin Set): ANSI A118.1.
   a. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.1.
3. Latex-Portland Cement Mortar (Thin Set): ANSI A118.4.
   a. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
      OR
      Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site.
   b. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.
4. Medium-Bed, Latex-Portland Cement Mortar: Comply with requirements in ANSI A118.4. Provide product that is approved by manufacturer for application thickness of 5/8 inch (16 mm).
   a. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
      OR
      Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site.
5. EGP (Exterior Glue Plywood) Latex-Portland Cement Mortar (Thin Set): ANSI A118.11.
   a. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
   b. Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site.
6. Water-Cleanable, Tile-Setting Epoxy: ANSI A118.3, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

a. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 140 deg F (60 deg C) and 212 deg F (100 deg C), respectively, and certified by manufacturer for intended use.

7. Chemical-Resistant Furan Mortar: ANSI A118.5, with carbon filler.
8. Organic Adhesive: ANSI A136.1, Type I, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

H. Grout Materials

1. Sand-Portland Cement Grout: ANSI A108.10, composed of white or gray cement and white or colored aggregate as required to produce color indicated.
2. Standard Cement Grout: ANSI A118.6.
3. Polymer-Modified Tile Grout: ANSI A118.7.
   a. Polymer Type: Ethylene vinyl acetate or acrylic additive, in dry, redispersible form, prepackaged with other dry ingredients.
      OR
      Polymer Type: Acrylic resin or styrene-butadiene rubber in liquid-latex form for addition to prepackaged dry-grout mix.
4. Water-Cleanable Epoxy Grout: ANSI A118.3.
   a. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 140 deg F (60 deg C) and 212 deg F (100 deg C), respectively, and certified by manufacturer for intended use.
5. Chemical-Resistant Furan Grout: ANSI A118.5, with carbon filler.
6. Grout for Pregrouted Tile Sheets: Same product used in factory to pregrout tile sheets.

I. Elastomeric Sealants

1. General: Provide sealants, primers, backer rods, and other sealant accessories that comply with the following requirements and with the applicable requirements in Division 7 Section "Joint Sealants."
   a. Use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   b. Use primers, backer rods, and sealant accessories recommended by sealant manufacturer.
2. Colors: Provide colors of exposed sealants to match colors of grout in tile adjoining sealed joints unless otherwise indicated.
3. One-Part, Mildew-Resistant Silicone Sealant: ASTM C 920; Type S; Grade NS; Class 25; Uses NT, G, A, and, as applicable to nonporous joint substrates indicated, O; formulated with fungicide, intended for sealing interior ceramic tile joints and other nonporous substrates that are subject to in-service exposures of high humidity and extreme temperatures.
4. Multipart, Pourable Urethane Sealant for Use T: ASTM C 920; Type M; Grade P; Class 25; Uses T, M, A, and, as applicable to joint substrates indicated, O.
5. Chemical-Resistant Sealants: For chemical-resistant floors, provide chemical-resistant elastomeric sealant of type recommended and produced by chemical-resistant mortar and grout manufacturer for type of application indicated, with proven service record and compatibility with tile and other setting materials, and with chemical resistance equivalent to mortar/grout.

J. Miscellaneous Materials

1. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.
2. Metal Edge Strips: Angle or L-shape, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring applications; half-hard brass **OR** white zinc alloy **OR** nickel silver **OR** stainless-steel, ASTM A 666, 300 Series, **as directed**, exposed-edge material.

3. Temporary Protective Coating: Either product indicated below that is formulated to protect exposed surfaces of tile against adherence of mortar and grout; compatible with tile, mortar, and grout products; and easily removable after grouting is completed without damaging grout or tile.
   a. Petroleum paraffin wax, fully refined and odorless, containing at least 0.5 percent oil with a melting point of 120 to 140 deg F (49 to 60 deg C) per ASTM D 87.
   b. Grout release in form of manufacturer's standard proprietary liquid coating that is specially formulated and recommended for use as temporary protective coating for tile.
4. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.
5. Grout Sealer: Manufacturer's standard silicone product for sealing grout joints and that does not change color or appearance of grout.

K. Mixing Mortars And Grout
1. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
2. Add materials, water, and additives in accurate proportions.
3. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

1.3 EXECUTION

A. Examination
1. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.
   a. Verify that substrates for setting tile are firm, dry, clean, free of coatings that are incompatible with tile-setting materials including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
   b. Verify that concrete substrates for tile floors installed with adhesives, bonded mortar bed or thin-set mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
      1) Verify that surfaces that received a steel trowel finish have been mechanically scarified.
      2) Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
   c. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
   d. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with adhesives or thin-set mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
2. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot (1:50) toward drains.
3. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

4. Field-Applied Temporary Protective Coating: If indicated under tile type or needed to prevent grout from staining or adhering to exposed tile surfaces, precoat them with continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.

C. Tile Installation
1. Comply with TCA's "Handbook for Ceramic Tile Installation" for TCA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 Series "Specifications for Installation of Ceramic Tile" that are referenced in TCA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
   a. For the following installations, follow procedures in the ANSI A108 Series of tile installation standards for providing 95 percent mortar coverage:
      1) Exterior tile floors.
      2) Tile floors in wet areas.
      3) Tile swimming pool decks.
      4) Tile floors in laundries.
      5) Tile floors composed of tiles 8 by 8 inches (200 by 200 mm) or larger.
      6) Tile floors composed of rib-backed tiles.
2. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
3. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
4. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
   a. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
   b. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
   c. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.
5. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
   a. Ceramic Mosaic Tile: 1/16 inch (1.6 mm).
   b. Quarry Tile: 1/4 inch (6.35 mm) **OR** 3/8 inch (9.5 mm), **as directed**.
   c. Paver Tile: 1/4 inch (6.35 mm) **OR** 3/8 inch (9.5 mm), **as directed**.
   d. Glazed Wall Tile: 1/16 inch (1.6 mm).
   e. Decorative Thin Wall Tile: 1/16 inch (1.6 mm).
6. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.
7. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
   a. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.
   b. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants".
8. Stone Thresholds: Install stone thresholds in same type of setting bed as adjacent floor unless otherwise indicated.
   a. At locations where mortar bed (thickset) would otherwise be exposed above adjacent floor finishes, set thresholds in latex-portland cement mortar (thin set).
   b. Do not extend cleavage membrane, waterproofing or crack isolation membrane under thresholds set in dry-set portland cement or latex-portland cement mortar. Fill joints between such thresholds and adjoining tile set on cleavage membrane, waterproofing or crack isolation membrane with elastomeric sealant.

9. Metal Edge Strips: Install at locations indicated **OR** where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with top of tile **OR** where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with or below top of tile and no threshold is indicated, **as directed**.
10. Grout Sealer: Apply grout sealer to cementitious grout joints in tile floors according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

D. Tile Backing Panel Installation
1. Install cementitious backer units and fiber-cement underlayment and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated. Use latex-portland cement mortar for bonding material unless otherwise directed in manufacturer's written instructions.

E. Waterproofing Installation
1. Install waterproofing to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness and bonded securely to substrate.
2. Do not install tile or setting materials over waterproofing until waterproofing has cured and been tested to determine that it is watertight.

F. Crack Isolation Membrane Installation
1. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness and bonded securely to substrate.
2. Do not install tile or setting materials over crack isolation membrane until membrane has cured.

G. Cleaning And Protecting
1. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
   a. Remove epoxy and latex-portland cement grout residue from tile as soon as possible.
   b. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.
   c. Remove temporary protective coating by method recommended by coating manufacturer and that is acceptable to tile and grout manufacturer. Trap and remove coating to prevent drain clogging.
2. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.
3. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
4. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

H. Exterior Tile Installation Schedule
1. Exterior Floor Installations:
   a. Tile Installation F101: Cement mortar bed (thickset) bonded to concrete **OR** over waterproof membrane on concrete **OR** over waterproof membrane on concrete where indicated and bonded to concrete where membrane is not indicated, **as directed**; TCA F101 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
      1) Tile Type: as directed by the Owner.
      2) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.

3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

b. Tile Installation F102: Thin-set mortar on concrete **OR** over waterproof membrane on concrete **OR** over waterproof membrane on concrete where indicated and on concrete where membrane is not indicated, **as directed**; TCA F102.
1) Tile Type: as directed by the Owner.
2) Thin-Set Mortar: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **directed**, portland cement mortar.
3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

2. Exterior Wall Installations, Masonry or Concrete:
a. Tile Installation W201: Cement mortar bed (thickset) on metal lath over waterproof membrane; TCA W201 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
1) Tile Type: as directed by the Owner.
2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
3) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed,** portland cement mortar.
4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

b. Tile Installation W202: Thin-set mortar; TCA W202.
1) Tile Type: as directed by the Owner.
2) Thin-Set Mortar: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

I. Interior Tile Installation Schedule
1. Interior Floor Installations, Concrete Subfloor:
a. Tile Installation F111: Cement mortar bed (thickset) with cleavage membrane; TCA F111 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
1) Tile Type: as directed by the Owner.
2) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

b. Tile Installation F112: Cement mortar bed (thickset) bonded to concrete; TCA F112 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
1) Tile Type: as directed by the Owner.
2) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

c. Tile Installation F113: Thin-set mortar; TCA F113.
1) Tile Type: as directed by the Owner.
2) Thin-Set Mortar: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.

3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

d. Tile Installation F114: Cement mortar bed (thickset) with cleavage membrane; epoxy **OR** furan, **as directed**, grout; TCA F114 and ANSI A108.1B.
   1) Tile Type: as directed by the Owner.
   2) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
   3) Grout: Water-cleanable epoxy **OR** Chemical-resistant furan, **s directed**, grout.

e. Tile Installation F115: Thin-set mortar; epoxy **OR** furan, **as directed**, grout; TCA F115.
   1) Tile Type: as directed by the Owner.
   2) Thin-Set Mortar: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
   3) Grout: Water-cleanable epoxy **OR** Chemical-resistant furan, **as directed**, grout.

f. Tile Installation F116: Organic adhesive **OR** Water-cleanable, tile-setting epoxy, **as directed**; TCA F116.
   1) Tile Type: as directed by the Owner.
   2) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

g. Tile Installation F121: Cement mortar bed (thickset) on waterproof membrane; TCA F121 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
   1) Tile Type: as directed by the Owner.
   2) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
   3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

h. Tile Installation F122: Thin-set mortar on waterproof membrane; TCA F122.
   1) Tile Type: as directed by the Owner.
   2) Thin-Set Mortar: Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
   3) Grout: Polymer-modified sanded **OR** unsanded, **as directed**, grout.

i. Tile Installation F125A: Thin-set mortar on crack isolation membrane; TCA F125A.
   1) Tile Type: as directed by the Owner.
   2) Thin-Set Mortar: Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
   3) Grout: Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

j. Tile Installation F131: Water-cleanable, tile-setting epoxy; epoxy grout; TCA F131.
   1) Tile Type: as directed by the Owner.
   2) Grout: Water-cleanable epoxy grout.

k. Tile Installation F132: Water-cleanable, tile-setting epoxy on cured cement mortar bed bonded to concrete subfloor **OR** installed over cleavage membrane, **as directed**; epoxy grout; TCA F132.
   1) Tile Type: as directed by the Owner.
   2) Grout: Water-cleanable epoxy grout.

l. Tile Installation F133: Chemical-resistant furan mortar **OR** Water-cleanable, tile-setting epoxy, **as directed**; furan grout. TCA F133 except use water-cleanable, tile-setting epoxy instead of chemical-resistant furan mortar for setting tile.
   1) Tile Type: as directed by the Owner.
   2) Grout: Chemical-resistant furan grout.

2. Interior Floor Installations, Wood Subfloor:
   a. Tile Installation F121: Cement mortar bed (thickset) on waterproof membrane; TCA F121 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.

1) Tile Type: as directed by the Owner.
2) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

b. Tile Installation F141: Cement mortar bed (thickset) with cleavage membrane; TCA F141 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
1) Tile Type: as directed by the Owner.
2) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

c. Tile Installation F142: Organic adhesive; TCA F142.
1) Tile Type: as directed by the Owner.
2) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

d. Tile Installation F143: Water-cleanable, tile-setting epoxy; epoxy grout; TCA F143.
1) Tile Type: as directed by the Owner.
2) Grout: Water-cleanable epoxy grout.

e. Tile Installation F144: Thin-set mortar on cementitious backer units or fiber cement underlayment; TCA F144.
1) Tile Type: as directed by the Owner.
2) Thin-Set Mortar: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

f. Tile Installation F150/160: Thin-set mortar on exterior-glue plywood; TCA F150 or TCA F160.
1) Tile Type: as directed by the Owner.
2) Thin-Set Mortar: EGP latex-portland cement mortar.
3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

3. Interior Radiant Heat Floor Installations, Concrete Subfloor:

a. Tile Installation RH110: Thin-set mortar on crack isolation membrane; hydronic piping installed in concrete; TCA RH110.
1) Tile Type: as directed by the Owner.
2) Thin-Set Mortar: Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

b. Tile Installation RH115: Thin-set mortar; electric radiant system encapsulated in thin-set mortar; TCA RH115.
1) Tile Type: as directed by the Owner.
2) Thin-Set Mortar: Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

c. Tile Installation RH116: Thin-set mortar on crack isolation membrane; electric radiant system encapsulated in cementitious self-leveling underlayment; TCA RH116.
   1) Tile Type: as directed by the Owner.
   2) Cementitious Self-Leveling Underlayment: Specified in Division 03 Section "Hydraulic-cement-based Underlayment".
   3) Thin-Set Mortar: Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
   4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

4. Interior Radiant Heat Floor Installations, Wood Subfloor:
   a. Tile Installation RH130: Thin-set mortar on exterior-glue plywood; electric radiant system encapsulated in thin-set mortar; TCA RH130.
      1) Tile Type: as directed by the Owner.
      2) Thin-Set Mortar: EGP latex-portland cement mortar.
      3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
   b. Tile Installation RH135: Thin-set mortar on cementitious backer units or fiber cement underlayment; electric radiant system encapsulated in thin-set mortar; TCA RH135.
      1) Tile Type: as directed by the Owner.
      2) Thin-Set Mortar: Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
      3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
   c. Tile Installation RH140: Thin-set mortar on crack isolation membrane; electric radiant system encapsulated in cementitious self-leveling underlayment; TCA RH140.
      1) Tile Type: as directed by the Owner.
      2) Cementitious Self-Leveling Underlayment: Specified in Division 03 Section "Hydraulic-cement-based Underlayment".
      3) Thin-Set Mortar: Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
      4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
5. Interior Wall Installations, Masonry or Concrete:
   a. Tile Installation W202: Thin-set mortar; TCA W202.
      1) Tile Type: as directed by the Owner.
      2) Thin-Set Mortar: Dry-set **OR** Latex- **OR** Medium-bed, latex-, **as directed**, portland cement mortar.
      3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
   b. Tile Installation W211: Cement mortar bed (thickset) bonded to substrate; TCA W211 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
      1) Tile Type: as directed by the Owner.
      2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
      3) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
      4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

c. Tile Installation W221: Cement mortar bed (thickset) on metal lath over waterproof membrane, **as directed**; TCA W221 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
   1) Tile Type: as directed by the Owner.
   2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
   3) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
   4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

d. Tile Installation W222: One-coat cement mortar bed (thickset) on metal lath over waterproof membrane, **as directed**; TCA W222 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
   1) Tile Type: as directed by the Owner.
   2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
   3) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
   4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

e. Tile Installation W223: Organic adhesive; TCA W223.
   1) Tile Type: as directed by the Owner.
   2) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

6. Interior Wall Installations, Wood Studs or Furring:
   a. Tile Installation W221: Cement mortar bed (thickset) over waterproof membrane, **as directed**, on solid backing; TCA W221 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
      1) Tile Type: as directed by the Owner.
      2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
      3) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
      4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
   b. Tile Installation W222: One-coat cement mortar bed (thickset) over waterproof membrane, **as directed**, on solid backing; TCA W222 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
      1) Tile Type: as directed by the Owner.
      2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
      3) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
      4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.
   c. Tile Installation W223: Organic adhesive on solid backing; TCA W223.
      1) Tile Type: as directed by the Owner.
      2) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

d. Tile Installation W231: Cement mortar bed (thickset); TCA W231 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
   1) Tile Type: as directed by the Owner.
   2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
   3) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
   4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

e. Tile Installation W243: Thin-set mortar on gypsum board; TCA W243.
   1) Tile Type: as directed by the Owner.
   2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
   3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

f. Tile Installation W244: Thin-set mortar on cementitious backer units or fiber cement underlayment over cleavage membrane, **as directed**; TCA W244.
   1) Tile Type: as directed by the Owner.
   2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
   3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

g. Tile Installation W245: Thin-set mortar **OR** Organic adhesive, **as directed**, on coated glass-mat, water-resistant gypsum backer board; TCA W245.
   1) Tile Type: as directed by the Owner.
   2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
   3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

7. Interior Wall Installations, Metal Studs or Furring:
   a. Tile Installation W221: Cement mortar bed (thickset) over waterproof membrane, **as directed**, on solid backing; TCA W221 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
      1) Tile Type: as directed by the Owner.
      2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
      3) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
      4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

   b. Tile Installation W222: One-coat cement mortar bed (thickset) over waterproof membrane, **as directed**, on solid backing; TCA W222 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
      1) Tile Type: as directed by the Owner.
      2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
      3) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
      4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

   c. Tile Installation W223: Organic adhesive on solid backing; TCA W223.
      1) Tile Type: as directed by the Owner.

2) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

d. Tile Installation W241: Cement mortar bed (thickset); TCA W241 and ANSI A108.1B.
   1) Tile Type: as directed by the Owner.
   2) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
   3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

e. Tile Installation W242: Organic adhesive on gypsum board; TCA W242.
   1) Tile Type: as directed by the Owner.
   2) Grout: Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

f. Tile Installation W243: Thin-set mortar on gypsum board; TCA W243.
   1) Tile Type: as directed by the Owner.
   2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
   3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

g. Tile Installation W244: Thin-set mortar on cementitious backer units or fiber cement underlayment over cleavage membrane, **as directed**; TCA W244.
   1) Tile Type: as directed by the Owner.
   2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
   3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

h. Tile Installation W245: Thin-set mortar **OR** Organic adhesive, **as directed**, on coated glass-mat, water-resistant gypsum backer board; TCA W245.
   1) Tile Type: as directed by the Owner.
   2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
   3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

8. Bathtub Wall Installations, Wood **OR** Metal, **as directed**, Studs or Furring:
   a. Tile Installation B413: Thin-set mortar **OR** Organic adhesive, **as directed**, on water-resistant gypsum board; TCA B413.
      1) Tile Type: as directed by the Owner.
      2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
      3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

9. Bathtub/Shower Wall Installations, Wood **OR** Metal, **as directed**, Studs or Furring:
   a. Tile Installation B411: Cement mortar bed (thickset); TCA B411 and ANSI A108.1A.
      1) Tile Type: as directed by the Owner.
      2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **s drected**, portland cement mortar.
      3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
   b. Tile Installation B412: Thin-set mortar on cementitious backer units or fiber cement underlayment; TCA B412.
      1) Tile Type: as directed by the Owner.
      2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.

3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

c. Tile Installation B419: Thin-set mortar **OR** Organic adhesive, **as directed**, on coated glass-mat, water-resistant backer board; TCA B419.
1) Tile Type: as directed by the Owner.
2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded **OR** Water-cleanable epoxy, **as directed**, grout.

10. Shower Receptor and Wall Installations, Concrete or Masonry:
a. Tile Installation B414: Cement mortar bed (thickset); TCA B414 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
1) Tile Type: as directed by the Owner.
2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
3) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
b. Tile Installation B421: Thin-set mortar on waterproof membrane; TCA B421.
1) Tile Type: as directed by the Owner.
2) Thin-Set Mortar: Latex-portland cement mortar.
3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
c. Tile Installation B422: Thin-set mortar on waterproof membrane with integrated bonding flange for bonded membranes; TCA B422.
1) Tile Type: as directed by the Owner.
2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

11. Shower Receptor and Wall Installations, Wood **OR** Metal, **as directed**, Studs or Furring:
a. Tile Installation B414: Cement mortar bed (thickset); TCA B414 and ANSI A108.1A **OR** ANSI A108.1B **OR** ANSI A108.1C, **as directed**.
1) Tile Type: as directed by the Owner.
2) Bond Coat Mortar for Wet-Set Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
3) Thin-Set Mortar for Cured-Bed Method: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
4) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
b. Tile Installation B415: Thin-set mortar on cementitious backer units or fiber cement underlayment; TCA B415.
1) Tile Type: as directed by the Owner.
2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.
3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.
c. Tile Installation B420: Thin-set mortar on coated glass-mat, water-resistant backer board; TCA B420.
1) Tile Type: as directed by the Owner.
2) Thin-Set Mortar: Dry-set **OR** Latex-, **as directed**, portland cement mortar.

3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

d. Tile Installation B421: Thin-set mortar on waterproof membrane over cementitious backer units or fiber cement underlayment; TCA B421.
   1) Tile Type: as directed by the Owner.
   2) Thin-Set Mortar: Latex-portland cement mortar.
   3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

e. Tile Installation B422: Thin-set mortar on waterproof membrane over cementitious backer units or fiber cement underlayment with integrated bonding flange for bonded membranes; TCA B422.
   1) Tile Type: as directed by the Owner.
   2) Thin-Set Mortar: Latex-portland cement mortar.
   3) Grout: Sand-portland cement **OR** Standard sanded cement **OR** Standard unsanded cement **OR** Polymer-modified sanded **OR** Polymer-modified unsanded, **as directed**, grout.

END OF SECTION 09310

SECTION 09410 - PORTLAND CEMENT TERRAZZO FLOORING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for portland cement terrazzo flooring. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Poured-in-place portland cement terrazzo flooring and base.
b. Poured-in-place rustic terrazzo flooring.
c. Precast terrazzo units.

C. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For marble chips, aggregates, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
1) Include statement that indicates cost for each product having recycled content.
b. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content.
3. Shop Drawings: Include terrazzo installation requirements. Include plans, elevations, sections, component details, and attachments to other work.
4. Samples: For each type, material, color, and pattern of terrazzo and accessory required showing the full range of color, texture, and pattern variations expected
5. Qualification data.
6. Material certificates.
7. Maintenance data.

D. Quality Assurance
1. Installer Qualifications: An installer who is a contractor member of NTMA.
2. NTMA Standards: Comply with NTMA's "Terrazzo Specifications and Design Guide" and with written recommendations for terrazzo type indicated unless more stringent requirements are specified.
3. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
1. Deliver materials to Project site in supplier's original wrappings and containers, labeled with source's or manufacturer's name, material or product brand name, and lot number if any.
2. Store materials in their original, undamaged packages and containers, inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

F. Project Conditions
1. Environmental Limitations: Maintain temperature above 50 deg F (10 deg C) for 48 hours before and during terrazzo installation.
2. Weather Limitations: Proceed with rustic terrazzo installation only when forecasted weather conditions permit work to be performed according to NTMA's written recommendations and temperatures remain above 45 deg F (7.2 deg C).
3. Field Measurements: Verify actual dimensions of construction contiguous with precast terrazzo by field measurements before fabrication.

4. Control and collect dust produced by grinding operations. Protect adjacent construction from detrimental effects of grinding operations.
   a. Provide dustproof partitions and temporary enclosures to limit dust migration and to isolate areas from noise.

1.2 PRODUCTS

A. Portland Cement Terrazzo
   1. Portland Cement Terrazzo Type: Sand cushion **OR** Structural **OR** Bonded **OR** Monolithic **OR** Installed over metal deck, **as directed**.
   2. Materials:
      a. Portland Cement: ASTM C 150, Type 1.
         1) Color for Exposed Matrix: As required by mix indicated **OR** White **OR** Gray, **as directed**.
      b. Water: Potable.
      c. Sand: ASTM C 33.
      d. Marble Chips **OR** Aggregates, **as directed**: Complying with NTMA gradation standards for mix indicated and containing no deleterious or foreign matter.
         1) Abrasion and Impact Resistance: Less than 40 percent loss per ASTM C 131 and ASTM C 535, **as directed**.
         2) 24-Hour Absorption Rate: Less than 0.75 percent.
         3) Dust Content: Less than 1.0 percent by weight.
      e. Matrix Pigments: Pure mineral or synthetic pigments, alkali resistant, durable under exposure to sunlight, and compatible with terrazzo matrix.
      f. Bonding Agent: Neat portland cement or epoxy or acrylic bonding agents formulated for use with topping indicated.
      g. Underbed Reinforcement: Galvanized welded-wire reinforcement, 2 by 2 inches (51 by 51 mm) by 0.062-inch- (1.57-mm-) diameter wire, complying with ASTM A 185 and ASTM A 82, except for minimum wire size.
      h. Isolation Membrane: Polyethylene sheeting, ASTM D 2103, Type 13300, 4 mils (0.1 mm) thick; or unperforated asphalt felt, ASTM D 226, Type I (No. 15).
   3. Mixes:
      a. Underbed (for structural portland cement terrazzo or portland cement terrazzo installed over metal deck): Structural-concrete underbed as specified in Division 03 Section "Cast-in-place Concrete".
      b. Underbed (for sand-cushion or bonded portland cement terrazzo): Comply with NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated for component proportions and mixing.
      c. Portland Cement Terrazzo (below for NTMA-formulated design mixes): Comply with NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated for matrix and marble-chip proportions and mixing.
         1) Formulated Mix Color and Pattern: As selected from NTMA standard-terrazzo plates **OR** As selected from NTMA Venetian-terrazzo plates, **as directed**.
      d. Portland Cement Terrazzo (for custom design mixes): Comply with NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated for matrix and marble-chip **OR** aggregate, **as directed**, proportions and mixing.
         1) Custom Mix Color and Pattern: Match sample **OR** Match existing, **as directed**.

B. Rustic Terrazzo
   1. Rustic Terrazzo Type: Structural **OR** Bonded **OR** Monolithic **OR** Unbonded, **as directed**.
   2. Materials:
      a. Portland Cement: ASTM C 150, Type 1.
         1) Color for Exposed Matrix: As required by mix indicated.
      b. Water: Potable.

c. Sand: ASTM C 33.
d. Marble Chips **OR** Aggregates, **as directed**: As required for mix indicated, sizes complying with NTMA gradation standards, 0.25 percent maximum 24-hour absorption rate, and containing no deleterious or foreign matter.
e. Matrix Pigments: Pure mineral or synthetic pigments, alkali resistant, durable under exposure to sunlight and weather, and compatible with matrix binder.
f. Air-Entraining Agent (for underbed of structural, bonded, or unbonded rustic terrazzo): Complying with NTMA's written recommendations and recommended by supplier for intended use.
g. Underbed Bonding Agent (for bonded rustic terrazzo): Neat portland cement.
h. Topping Bonding Agent (for monolithic rustic terrazzo): Neat portland cement, or epoxy or acrylic bonding agents formulated for use with topping indicated.
i. Isolation Membrane (for unbonded rustic terrazzo): Polyethylene sheeting, ASTM D 2103, Type 13300, 4 mils (0.1 mm) thick.

3. Mixes:
a. Underbed (for structural or unbonded rustic terrazzo): Structural-concrete underbed as specified in Division 03 Section "Cast-in-place Concrete".
b. Underbed (for bonded rustic terrazzo): Comply with NTMA's "Terrazzo Specifications and Design Guide" for component proportions and mixing.
1) Exterior Applications: Provide air-entraining agent.
c. Rustic Terrazzo (for NTMA-formulated design mixes): Comply with NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated for matrix and marble-chip proportions and mixing.
1) Formulated Mix Color and Pattern: As selected from NTMA rustic-terrazzo plates.
d. Rustic Terrazzo (for custom design mixes): Comply with NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated for matrix and marble-chip **OR** aggregate, **as directed**, proportions and mixing.
1) Custom Mix Color and Pattern: Match sample **OR** Match existing, **as directed**.

C. Strip Materials
1. Standard Divider Strips: One-piece, flat-type strips for grouting into sawed joints prepared in concrete slab or underbed.
a. Material: As indicated **OR** White-zinc alloy **OR** Brass, **as directed**.
b. Depth: As indicated **OR** 3/4 inch (19 mm) **OR** 1-1/4 inches (32 mm) **OR** 2 inches (51 mm), **as directed**.
c. Width: As indicated **OR** 0.05 inch (1.27 mm) **OR** 1/8 inch (3.2 mm) **OR** 1/4 inch (6.4 mm), **as directed**.
2. Heavy-Top Divider Strips: One-piece, flat-type strips for grouting into sawed joints prepared in concrete slab or underbed.
a. Base-Section Material: As indicated **OR** White-zinc alloy **OR** Galvanized steel, **as directed**.
b. Top-Section Material: As indicated **OR** White-zinc alloy **OR** Brass **OR** Plastic, in color selected from manufacturer's full range, **as directed**.
c. Depth: As indicated **OR** 3/4 inch (19 mm) **OR** 1-1/4 inches (32 mm) **OR** 2 inches (51 mm), **as directed**.
d. Top-Section Width: As indicated **OR** 1/8 inch (3.2 mm) **OR** 1/4 inch (6.4 mm) **OR** 1/2 inch (12.7 mm), **as directed**.
3. Heavy-Top Angle Divider Strips: One-piece, L-type angle strips with anchoring device and in depth required for topping thickness indicated.
a. Material: As indicated **OR** White-zinc alloy **OR** Brass **OR** Plastic, in color selected from manufacturer's full range, **as directed**.
b. Top-Section Width: As indicated **OR** 1/8 inch (3.2 mm) **OR** 1/4 inch (6.4 mm) **OR** 3/8 inch (9.5 mm) **OR** 1/2 inch (12.7 mm), **as directed**.
4. Control-Joint Strips: Separate, double L-type angles, positioned back to back, that match material, thickness, and color of divider strips and in depth required for topping thickness indicated.

5. Expansion-Joint Strips (for structural portland cement terrazzo or for any type of rustic terrazzo): Brass **OR** Plastic strips in color selected from manufacturer's full range, **as directed**, with removable zip-strip top for installing sealant; in width indicated **OR** minimum 1/2 inch (12.7 mm) wide, **as directed**.
6. Accessory Strips: Match divider strip width, material, and color unless otherwise indicated. Use the following types of accessory strips as required to provide a complete installation:
   a. Base-bead strips for exposed top edge of terrazzo base.
   b. Edge-bead strips for exposed edges of terrazzo.
   c. Nosings for terrazzo stair treads and landings.
7. Abrasive Strips (for terrazzo stair treads and landings): Silicon carbide or aluminum oxide, or combination of both, in epoxy-resin binder and set in channel.
   a. Width: 1/2 inch (12.7 mm).
   b. Depth: As required by terrazzo thickness.
   c. Length: 4 inches (100 mm) less than stair width **OR** As indicated, **as directed**.
   d. Color: As selected from manufacturer's full range.

D. Miscellaneous Accessories
1. Strip Adhesive: Adhesive recommended by manufacturer for this use.
   a. Use adhesives that have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Anchoring Devices:
   a. Strips: Provide mechanical anchoring devices for strip materials as required for secure attachment to substrate.
   b. Precast Terrazzo: Provide mechanical anchoring devices as recommended by fabricator for proper anchorage and support of units for conditions of installation and support.
3. Isolation and Expansion-Joint Material: Closed-cell polyethylene foam, nonabsorbent to liquid water and gas, and nonoutgassing in unruptured state; butyl rubber; rubber; or cork; in width indicated **OR** minimum 1/2 inch (12.7 mm) wide, **as directed**.
4. Portland Cement Terrazzo Cleaner: Chemically neutral cleaner with pH factor between 7 and 10 that is biodegradable, phosphate free, and recommended by cleaner manufacturer for use on terrazzo type indicated.
5. Rustic Terrazzo Cleaner: Solution of muriatic acid and water for use on terrazzo type indicated.
6. Sealer: Slip- and stain-resistant, penetrating-type sealer that is chemically neutral with pH factor between 7 and 10; does not affect color or physical properties of terrazzo; is recommended by sealer manufacturer; and complies with NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated.
   a. Rustic Terrazzo: Use solvent acrylic-type sealer.

E. Precast Terrazzo
1. Precast Terrazzo Base Units: Minimum 3/4-inch- (19-mm-) thick, reinforced portland cement terrazzo units cast in maximum lengths possible, but not less than 36 inches (900 mm).
   a. Type: As indicated **OR** Coved with minimum 3/4-inch (19-mm) radius **OR** Straight **OR** Splayed, **as directed**.
   b. Top Edge: Straight, unfinished if top edge is concealed **OR** Beveled with polished top surface **OR** Radius edge with polished top surface, **as directed**.
   c. Metal Toe Strip (for coved-toe bases): Zinc **OR** Brass, **as directed**.
   d. Outside Corner Units: With finished returned edges at outside corner.
   e. Color, Pattern, and Finish: As selected from manufacturer's full range **OR** Match sample **OR** Match adjacent poured-in-place terrazzo flooring, **as directed**.
2. Precast Terrazzo Units for Stair Treads, Thresholds, Sills**,** Benches and Planters: Comply with NTMA's written recommendations for fabricating precast terrazzo units in sizes and profiles indicated. Reinforce units as required by unit sizes, profiles, and thicknesses and as recommended by manufacturer.
   a. Stair Treads: Three-line **OR** Two-line **OR** One-line **OR** Abrasive nosing strip and two-line, **as directed**, abrasive inserts at nosings.

b. Color, Pattern, and Finish: As selected from manufacturer's full range **OR** Match sample **OR** Match adjacent poured-in-place terrazzo flooring, **as directed**.

3. Precast Terrazzo Finishing (for custom precast terrazzo components):
   a. Finish exposed-to-view edges or reveals to match face finish.
   b. Ease exposed edges to 1/8-inch (3-mm) radius.

1.3 EXECUTION

A. Preparation
1. Clean substrates to produce clean, dry, and neutral substrate for terrazzo application.
   a. Remove substances, including oil, grease, and curing compounds, that might impair bond of terrazzo system.
   b. Roughen concrete substrates before installing terrazzo system according to NTMA's written recommendations.
2. Protect other work from dust generated by grinding operations. Control dust to prevent air pollution and comply with environmental protection regulations.
   a. Erect and maintain temporary enclosures and other suitable methods to limit dust migration and to ensure adequate ambient temperatures and ventilation conditions during installation.

B. Installation, General
1. Comply with NTMA's written recommendations for terrazzo and accessory installation.
2. Installation Tolerance: Limit variation in terrazzo surface from level to 1/4 inch in 10 feet (6 mm in 3 m); noncumulative.
3. Structural Portland Cement **OR** Structural Rustic **OR** Bonded Rustic **OR** Monolithic Rustic **OR** Unbonded Rustic, **as directed**, Terrazzo: Install isolation and expansion material where terrazzo and underbed abut **OR** terrazzo abuts, **as directed**, adjacent construction and directly above substrate expansion joints.
4. Underbed (for structural portland cement terrazzo or portland cement terrazzo installed over metal deck, or for structural or unbonded rustic terrazzo): Install structural-concrete underbed according to requirements specified in Division 03 Section "Cast-in-place Concrete".
5. Underbed (for sand-cushion or bonded portland cement terrazzo or for bonded rustic terrazzo):
   a. Comply with NTMA's "Terrazzo Specifications and Design Guide" for underbed installation.
   b. For sand-cushion portland cement terrazzo only:
      1) Cover entire surface to receive terrazzo with dusting of sand.
      2) Install isolation membrane over sand, overlapping ends and edges a minimum of 3 inches (75 mm).
      3) Install welded wire reinforcement, overlapping at edges and ends at least two squares. Stop mesh a minimum of 1 inch (25 mm) short of expansion joints.
   c. Place underbed and screed to elevation indicated below finished floor elevation.
6. Strip Materials:
   a. Divider and Control-Joint Strips:
      1) Locate divider strips over each edge of steel beams and girders **OR** centered over steel beams and joists **OR** directly over control joints, breaks, and saw cuts in concrete slabs **OR** in locations indicated, **as directed**.
      2) Install control-joint strips back to back and directly above concrete-slab control joints **OR** in locations indicated, **as directed**.
      3) Install control-joint strips with 1/4-inch (6.4-mm) gap between strips, and install sealant in gap.
      4) Install strips in adhesive setting bed without voids below strips, or mechanically anchor strips as required to attach strips to substrate, as recommended by strip manufacturer.
   b. Expansion-Joint Strips (for structural portland cement terrazzo or for any type of rustic terrazzo): Form expansion joints using divider strips and install directly above concrete-slab expansion joints.

c. Accessory Strips: Install accessory strips as required to provide a complete installation.
d. Abrasive Strips: Install with surface of abrasive strip positioned 1/16 inch (1.6 mm) **OR** 1/32 inch (0.8 mm), **as directed**, higher than terrazzo surface.

7. Repair: Cut out and replace terrazzo areas that evidence lack of bond with substrate or underbed, including areas that emit a "hollow" sound if tapped. Cut out terrazzo areas in panels defined by strips and replace to match adjacent terrazzo, or repair panels according to NTMA's written recommendations, as approved by the Owner.

C. Portland Cement Terrazzo Installation
1. Pour in place, cure, and finish portland cement terrazzo according to NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated.
2. Terrazzo Topping Thickness: As indicated.
3. Finishing:
a. Seed additional marble chips **OR** aggregates, **as directed**, in matrix to uniformly distribute granular material on surface.
b. Delay fine grinding until heavy trade work is complete and construction traffic through area is restricted.
c. Fine Grinding: Grind with stones 120 grit or finer until all grout is removed from surface. Repeat rough grinding, grout coat, and fine grinding if large voids exist after initial fine grinding. Produce surface with a minimum of 70 percent aggregate exposure.

D. Rustic Terrazzo Installation
1. Pour in place, cure, and finish rustic terrazzo according to NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated.
2. Terrazzo Topping Thickness: As indicated.
3. Finishing:
a. Seed additional marble chips **OR** aggregates, **as directed**, in matrix to uniformly distribute granular material on surface.

E. Precast Terrazzo Installation
1. Install precast terrazzo units using method recommended by NTMA and manufacturer unless otherwise indicated.
2. Installation Tolerance: Set units with alignment level and true to dimensions, varying 1/8 inch (3.2 mm) maximum in length, height, or width; noncumulative.
3. Do not install units that are chipped, cracked, discolored, or improperly finished.
4. Seal joints between units with cement grout matching precast terrazzo matrix **OR** joint sealant, **as directed**.

F. Cleaning And Protection
1. Portland Cement Terrazzo and Precast Terrazzo Cleaning:
a. Remove grinding dust from installation and adjacent areas.
b. Wash surfaces with cleaner immediately after grouting precast terrazzo units and final cleaning of terrazzo flooring.
c. Wash surfaces with cleaner according to NTMA's written recommendations and manufacturer's written instructions; rinse surfaces with water and allow to dry thoroughly.
2. Rustic Terrazzo Cleaning: Clean surfaces with 1:10 solution of muriatic acid in water. Legally contain and dispose of runoff from cleaning operations. Rinse surfaces with water and allow to dry thoroughly.
3. Sealing:
a. Seal surfaces according to NTMA's written recommendations.
b. Apply sealer according to sealer manufacturer's written instructions.
4. Protection: Provide final protection and maintain conditions, in a manner acceptable to Installer, that ensure that terrazzo is without damage or deterioration at time of Substantial Completion.

END OF SECTION 09410

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Task	Specification	Specification Description
09420	09410	Portland Cement Terrazzo Flooring

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SECTION 09430 - RESINOUS MATRIX TERRAZZO FLOORING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for resinous matrix terrazzo flooring. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Thin-set epoxy-resin terrazzo flooring and base.
b. Precast terrazzo units.

C. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For marble chips, aggregates, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
1) Include statement that indicates cost for each product having recycled content.
b. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content.
3. Shop Drawings: Include terrazzo installation requirements. Include plans, elevations, sections, component details, and attachments to other work.
4. Samples: For each type, material, color, and pattern of terrazzo and accessory required showing the full range of color, texture, and pattern variations expected.
5. Installer certificates.
6. Qualification data.
7. Material certificates.
8. Maintenance data.

D. Quality Assurance
1. Installer Qualifications: A qualified installer who is acceptable to terrazzo manufacturer to install manufacturer's products.
a. Engage an installer who is certified in writing by terrazzo manufacturer as qualified to install manufacturer's products.
b. Engage an installer who is a contractor member of NTMA.
2. NTMA Standards: Comply with NTMA's "Terrazzo Specifications and Design Guide" and with written recommendations for terrazzo type indicated unless more stringent requirements are specified.
3. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
1. Deliver materials to Project site in supplier's original wrappings and containers, labeled with source's or manufacturer's name, material or product brand name, and lot number if any.
2. Store materials in their original, undamaged packages and containers, inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

F. Project Conditions
1. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting terrazzo installation.

2. Field Measurements: Verify actual dimensions of construction contiguous with precast terrazzo by field measurements before fabrication.
3. Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during terrazzo installation.
4. Close spaces to traffic during terrazzo application and for not less than 24 hours after application unless manufacturer recommends a longer period.
5. Control and collect dust produced by grinding operations. Protect adjacent construction from detrimental effects of grinding operations.
    a. Provide dustproof partitions and temporary enclosures to limit dust migration and to isolate areas from noise.

1.2 PRODUCTS

A. Epoxy-Resin Terrazzo
    1. Materials:
        a. Flexible Reinforcing Membrane: Manufacturer's resinous membrane for substrate crack preparation and reflective crack reduction.
            1) Reinforcement: Fiberglass scrim.
        b. Primer: Manufacturer's product recommended for substrate and use indicated.
        c. Epoxy-Resin Matrix: Manufacturer's standard recommended for use indicated and in color required for mix indicated.
            1) Physical Properties without Marble Chips **OR** Aggregates, **as directed**:
                a) Hardness: 60 to 85 per ASTM D 2240, Shore D.
                b) Minimum Tensile Strength: 3000 psi (20.7 MPa) per ASTM D 638 for a 2-inch (51-mm) specimen made using a "C" die per ASTM D 412.
                c) Minimum Compressive Strength: 10,000 psi (6.9 MPa) per ASTM D 695, Specimen B cylinder.
                d) Chemical Resistance: No deleterious effects by contaminants listed below after seven-day immersion at room temperature per ASTM D 1308.
                    i. Distilled water.
                    ii. Mineral water.
                    iii. Isopropanol.
                    iv. Ethanol.
                    v. 0.025 percent detergent solution.
                    vi. 1.0 percent soap solution.
                    vii. 10 percent sodium hydroxide.
                    viii. 10 percent hydrochloric acid.
                    ix. 30 percent sulfuric acid.
                    x. 5 percent acetic acid.
            2) Physical Properties with Marble Chips **OR** Aggregates, **as directed**: For resin blended with Georgia white marble, ground, grouted, and cured per requirements in NTMA's "Terrazzo Specifications and Design Guide," comply with the following:
                a) Flammability: Self-extinguishing, maximum extent of burning 0.25 inch (6.35 mm) per ASTM D 635.
                b) Thermal Coefficient of Linear Expansion: 0.0025 inch/inch per deg F (0.0025 mm/mm per 0.5556 deg C) for temperature range of minus 12 to plus 140 deg F (minus 24 to plus 60 deg C) per ASTM D 696.
        d. Marble Chips **OR** Aggregates, **as directed**: Complying with NTMA gradation standards for mix indicated and containing no deleterious or foreign matter.
            1) Abrasion and Impact Resistance: Less than 40 percent loss per ASTM C 131.
            2) 24-Hour Absorption Rate: Less than 0.75 percent.
            3) Dust Content: Less than 1.0 percent by weight.
        e. Finishing Grout: Resin based.

2. Terrazzo (for NTMA-formulated design mixes): Comply with NTMA's "Terrazzo Specifications and Design Guide" and manufacturer's written instructions for matrix and marble-chip proportions and mixing.
   a. Formulated Mix Color and Pattern: As selected by the Owner from manufacturer's full range **OR** As selected from NTMA standard-terrazzo plates **OR** As selected from NTMA thin-set terrazzo plates, **as directed**.
3. Terrazzo (for custom design mixes): Comply with NTMA's "Terrazzo Specifications and Design Guide" and manufacturer's written instructions for matrix and marble-chip **OR** aggregate, **as directed**, proportions and mixing.
   a. Custom Mix Color and Pattern: Match sample **OR** Match existing, **as directed**.

B. Strip Materials
1. Thin-Set Divider Strips: L-type angle or T-type, 1/4 inch (6.4 mm) deep.
   a. Material: White-zinc alloy **OR** Brass **OR** Aluminum **OR** Plastic, in color selected from manufacturer's full range, **as directed**.
   b. Top Width: 1/8 inch (3.2 mm) **OR** 1/4 inch (6.4 mm), **as directed**.
2. Heavy-Top Divider Strips: L-type angle in depth required for topping thickness indicated.
   a. Bottom-Section Material: Galvanized steel **OR** Matching top-section material, **as directed**.
   b. Top-Section Material: White-zinc alloy **OR** Brass **OR** Aluminum **OR** Plastic, in color selected from manufacturer's full range, **as directed**.
   c. Top-Section Width: 1/8 inch (3.2 mm) **OR** 1/4 inch (6.4 mm) **OR** 3/8 inch (9.5 mm) **OR** 1/2 inch (12.7 mm), **as directed**.
3. Control-Joint Strips: Separate, double L-type angles, positioned back to back, that match material, thickness, and color of divider strips and in depth required for topping thickness indicated.
4. Accessory Strips: Match divider strip width, material, and color unless otherwise indicated. Use the following types of accessory strips as required to provide a complete installation:
   a. Base-bead strips for exposed top edge of terrazzo base.
   b. Edge-bead strips for exposed edges of terrazzo.
   c. Nosings for terrazzo stair treads and landings.
5. Abrasive Strips (for terrazzo stair treads and landings): Silicon carbide or aluminum oxide, or combination of both, in epoxy-resin binder and set in channel.
   a. Width: 1/2 inch (12.7 mm).
   b. Depth: As required by terrazzo thickness.
   c. Length: 4 inches (100 mm) less than stair width **OR** As indicated, **as directed**.
   d. Color: As selected from manufacturer's full range.

C. Miscellaneous Accessories
1. Strip Adhesive: Epoxy-resin adhesive recommended by adhesive manufacturer for this use and acceptable to terrazzo manufacturer.
   a. Use adhesives that have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Anchoring Devices:
   a. Strips: Provide mechanical anchoring devices for strip materials as required for secure attachment to substrate.
   b. Precast Terrazzo: Provide mechanical anchoring devices as recommended by fabricator for proper anchorage and support of units for conditions of installation and support.
3. Patching and Fill Material: Terrazzo manufacturer's resinous product approved and recommended by manufacturer for application indicated.
4. Joint Compound: Terrazzo manufacturer's resinous product approved and recommended by manufacturer for application indicated.
5. Cleaner: Chemically neutral cleaner with pH factor between 7 and 10 that is biodegradable, phosphate free, and recommended by sealer manufacturer for use on terrazzo type indicated.
6. Sealer: Slip- and stain-resistant penetrating-type sealer that is chemically neutral with pH factor between 7 and 10; does not affect color or physical properties of terrazzo; is recommended by

sealer manufacturer; and complies with NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated **OR** Acrylic **OR** Urethane **OR** Chemical-resistant epoxy, **as directed**.

D. Precast Terrazzo
   1. Precast Terrazzo Units: Precast epoxy-resin terrazzo base**,** stair tread, threshold, bench, and planter units.
   2. Precast Terrazzo Base Units: 1/4 inch (6.4 mm) thick; cast in maximum lengths possible, but not less than 36 inches (900 mm); with rounded, finished top edge.
      a. Type: Coved with minimum 3/4-inch (19-mm) radius **OR** Straight **OR** Splayed **OR** As indicated, **as directed**.
      b. Height: 6 inches (152 mm) **OR** 4 inches (101 mm) **OR** As indicated, **as directed**.
      c. Outside Corner Units: With finished returned edges at outside corner.
      d. Color, Pattern, and Finish: As selected from manufacturer's full range **OR** Match sample **OR** Match adjacent poured-in-place terrazzo flooring, **as directed**.
   3. Precast Terrazzo Stair Treads: 1/2 inch (12.7 mm) thick with rounded nosing edge.
      a. Abrasive Strips: Three-line **OR** Two-line **OR** One-line **OR** Abrasive nosing strip and two-line, **as directed**, abrasive inserts at nosings.
      b. Color, Pattern, and Finish: As selected from manufacturer's full range **OR** Match sample **OR** Match adjacent poured-in-place terrazzo flooring, **as directed**.
   4. Precast Terrazzo Finishing (for custom precast terrazzo components):
      a. Finish exposed-to-view edges or reveals to match face finish.
      b. Ease exposed edges to 1/8-inch (3-mm) radius.

1.3 EXECUTION

A. Preparation
   1. Clean substrates of substances, including oil, grease, and curing compounds, that might impair terrazzo bond. Provide clean, dry, and neutral substrate for terrazzo application.
   2. Concrete Slabs:
      a. Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with terrazzo.
         1) Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
         2) Repair damaged and deteriorated concrete according to terrazzo manufacturer's written recommendations.
         3) Use patching and fill material to fill holes and depressions in substrates according to terrazzo manufacturer's written instructions.
      b. Verify that concrete substrates are visibly dry and free of moisture.
      c. Moisture Testing:
         1) Test for moisture by anhydrous calcium chloride method according to ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
         2) Test for moisture by relative humidity probe and digital meter method according to ASTM F 2170. Proceed with installation only after substrates have a maximum relative-humidity-measurement reading of 70 to 75 percent in 24 hours.
         3) Test for moisture content by method recommended in writing by terrazzo manufacturer. Proceed with installation only after substrates pass testing.
   3. Protect other work from dust generated by grinding operations. Control dust to prevent air pollution and comply with environmental protection regulations.
      a. Erect and maintain temporary enclosures and other suitable methods to limit dust migration and to ensure adequate ambient temperatures and ventilation conditions during installation.

4. Installation of terrazzo indicates acceptance of surfaces and conditions.

B. Epoxy-Resin Terrazzo Installation
   1. General:
      a. Comply with NTMA's written recommendations for terrazzo and accessory installation.
      b. Place, rough grind, grout, cure grout, fine grind, and finish terrazzo according to manufacturer's written instructions and NTMA's "Terrazzo Specifications and Design Guide."
      c. Installation Tolerance: Limit variation in terrazzo surface from level to 1/4 inch in 10 feet (6 mm in 3 m); noncumulative.
      d. Ensure that matrix components and fluids from grinding operations do not stain terrazzo by reacting with divider and control-joint strips.
      e. Delay fine grinding until heavy trade work is complete and construction traffic through area is restricted.
   2. Thickness: 1/4 inch (6.4 mm) **OR** 3/8 inch (9.5 mm) **OR** As indicated, **as directed**, nominal.
   3. Flexible Reinforcing Membrane:
      a. Prepare and prefill substrate cracks with membrane material.
      b. Install membrane to produce full substrate coverage in areas to receive terrazzo.
      c. Reinforce membrane with fiberglass scrim.
      d. Prepare membrane according to manufacturer's written instructions before applying substrate primer.
   4. Primer: Apply to terrazzo substrates according to manufacturer's written instructions.
   5. Strip Materials:
      a. Divider and Control-Joint Strips:
         1) Locate divider strips in locations indicated.
         2) Install control-joint strips back to back directly above concrete-slab control joints **OR** in locations indicated, **as directed**.
         3) Install control-joint strips with 1/4-inch (6.4-mm) gap between strips, and install sealant in gap.
         4) Install strips in adhesive setting bed without voids below strips, or mechanically anchor strips as required to attach strips to substrate, as recommended by strip manufacturer.
      b. Accessory Strips: Install accessory strips as required to provide a complete installation **OR** in locations indicated, **as directed**.
      c. Abrasive Strips: Install with surface of abrasive strip positioned 1/16 inch (1.6 mm) **OR** 1/32 inch (0.8 mm), **as directed**, higher than terrazzo surface.
   6. Fine Grinding: Grind with stones 120 grit or finer until all grout is removed from surface. Repeat rough grinding, grout coat, and fine grinding if large voids exist after initial fine grinding. Produce surface with a minimum of 70 percent aggregate exposure.
   7. Repair: Remove and replace terrazzo areas that evidence lack of bond with substrate. Cut out terrazzo areas in panels defined by strips and replace to match adjacent terrazzo, or repair panels according to NTMA's written recommendations, as approved by the Owner.

C. Precast Terrazzo Installation
   1. Install precast terrazzo units using method recommended NTMA and manufacturer unless otherwise indicated.
   2. Installation Tolerance: Set units with alignment level and true to dimensions, varying 1/8-inch (3.2-mm) maximum in length, height, or width; noncumulative.
   3. Do not install units that are chipped, cracked, discolored, or not properly finished.
   4. Seal joints between units with joint compound matching precast terrazzo matrix **OR** joint sealant, **as directed**.

D. Cleaning And Protection
   1. Cleaning:
      a. Remove grinding dust from installation and adjacent areas.

b. Wash surfaces with cleaner according to NTMA's written recommendations and manufacturer's written instructions; rinse surfaces with water and allow to dry thoroughly.

2. Sealing:
   a. Seal surfaces according to NTMA's written recommendations.
   b. Apply sealer according to sealer manufacturer's written instructions.
3. Protection: Provide final protection and maintain conditions, in a manner acceptable to Installer, that ensure that terrazzo is without damage or deterioration at time of Substantial Completion.

END OF SECTION 09430

Task	Specification	Specification Description
09490	09410	Portland Cement Terrazzo Flooring

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SECTION 09511 - ACOUSTICAL PANEL CEILINGS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for acoustical panel ceilings. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes acoustical panels and exposed suspension systems for ceilings.
2. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete at ceilings.

C. Definitions
1. AC: Articulation Class.
2. CAC: Ceiling Attenuation Class.
3. LR: Light Reflectance coefficient.
4. NRC: Noise Reduction Coefficient.

D. Submittals
1. Product Data: For each type of product indicated.
2. Coordination Drawings: Drawn to scale and coordinating acoustical panel ceiling installation with hanger attachment to building structure and ceiling mounted items:
3. Samples: For each exposed finish.
4. LEED Submittals:
   a. Product Data for Credit MR 4.1 and MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
      1) Include statement indicating costs for each product having recycled content.
   b. Product Data for Credit EQ 4.1: For sealants, including printed statement of VOC content.
5. Product test reports.
6. Research/evaluation reports.
7. Maintenance data.

E. Quality Assurance
1. Acoustical Testing Agency Qualifications: An independent testing laboratory, or an NVLAP-accredited laboratory, with the experience and capability to conduct the testing indicated. NVLAP-accredited laboratories must document accreditation, based on a "Certificate of Accreditation" and a "Scope of Accreditation" listing the test methods specified.
2. Fire-Test-Response Characteristics
   a. Fire-Resistance Characteristics: Where indicated, provide acoustical panel ceilings identical to those of assemblies tested for fire resistance per ASTM E 119 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
      1) Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.
      2) Identify materials with appropriate markings of applicable testing and inspecting agency.
   b. Surface-Burning Characteristics: Provide acoustical panels with the following surface-burning characteristics complying with ASTM E 1264 for Class A **OR** B **OR** C, **as directed**, materials as determined by testing identical products per ASTM E 84:
      1) Smoke-Developed Index: 450 or less.

3. Seismic Standard: Provide acoustical panel ceilings designed and installed to withstand the effects of earthquake motions according to the following:
   a. Standard for Ceiling Suspension Systems Requiring Seismic Restraint: Comply with ASTM E 580.
   b. CISCA's Recommendations for Acoustical Ceilings: Comply with CISCA's "Recommendations for Direct-Hung Acoustical Tile and Lay-in Panel Ceilings--Seismic Zones 0-2."
   c. CISCA's Guidelines for Systems Requiring Seismic Restraint: Comply with CISCA's "Guidelines for Seismic Restraint of Direct-Hung Suspended Ceiling Assemblies--Seismic Zones 3 & 4."
   d. UBC Standard 25-2, "Metal Suspension Systems for Acoustical Tile and for Lay-in Panel Ceilings."
   e. ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."
4. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Deliver acoustical panels, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
2. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.
3. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.2 PRODUCTS

A. Acoustical Panels, General
1. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances, unless otherwise indicated.
   a. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches (400 mm) away from test surface per ASTM E 795.
2. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.
   a. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by the Owner from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.
3. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical panels treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.
4. Antimicrobial Fungicide Treatment: Provide acoustical panels with face and back surfaces coated with antimicrobial treatment consisting of manufacturer's standard formulation with fungicide added to inhibit growth of mold and mildew and showing no mold or mildew growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

B. Acoustical Panels For Acoustical Panel Ceiling
1. Classification: Provide fire-resistance-rated, **as directed**, panels complying with ASTM E 1264 for type, form, and pattern as follows:

a. Type and Form: Type III, mineral base with painted finish; Form 1, nodular **OR** 2, water felted **OR** 4, cast or molded, **as directed**.
b. Type and Form: Type IV, mineral base with membrane-faced overlay; Form 1, nodular; with glass-fiber cloth **OR** washable vinyl-film, **as directed**, overlay.
c. Type and Form: Type IV, mineral base with membrane-faced overlay; Form 2, water felted; with vinyl overlay on face **OR** vinyl overlay on face and back **OR** vinyl overlay on face, back, and sealed edges **OR** fiberglass-fabric overlay on face, **as directed**.
d. Type and Form: Type XII, glass-fiber base with membrane-faced overlay; Form 1, plastic **OR** 2, cloth **OR** 3, other, **as directed**.
e. Type and Form: Type XX, other types; described as high-density, ceramic- and mineral-base panels with scrubbable finish, resistant to heat, moisture, and corrosive fumes.
f. Pattern: C (perforated, small holes) **OR** CD (perforated, small holes and fissured) **OR** CE (perforated, small holes and lightly textured) **OR** D (fissured) **OR** E (lightly textured) **OR** F (heavily textured) **OR** G (smooth) **OR** GH (smooth and printed) **OR** I (embossed) **OR** J (embossed-in-register) **OR** K (surface scored) **OR** Z (other patterns as described) **OR** As indicated by manufacturer's designation, **as directed**.

2. Color: White **OR** As selected from manufacturer's full range **OR** Match sample **OR** As indicated by manufacturer's designation **OR** As indicated on Drawings **OR** As indicated in a schedule, **as directed**.
3. LR: Not less than 0.65 **OR** 0.70 **OR** 0.75 **OR** 0.80 **OR** 0.85 **OR** 0.90, **as directed**.
4. NRC: Not less than 0.10 **OR** 0.35 **OR** 0.40 **OR** 0.50 **OR** 0.55 **OR** 0.60 **OR** 0.65 **OR** 0.70 **OR** 0.75 **OR** 0.80 **OR** 0.85 **OR** 0.90 **OR** 0.95 **OR** 1.00, **as directed**.
5. CAC: Not less than 20 **OR** 25 **OR** 30 **OR** 35 **OR** 40, **as directed**.
6. AC: Not less than 170 **OR** 180 **OR** 190 **OR** 200 **OR** 210, **as directed**.
7. Edge/Joint Detail: Square **OR** Reveal sized to fit flange of exposed suspension system members **OR** Flush reveal sized to fit flange of exposed suspension system members **OR** Beveled, kerfed and rabbeted long edges and square, butt-on short edges, **as directed**.
8. Thickness: 5/8 inch (15 mm) **OR** 3/4 inch (19 mm) **OR** 7/8 inch (22 mm) **OR** As indicated on Drawings **OR** As indicated in a schedule, **as directed**.
9. Thickness (For glass-fiber-based panels): 1/8 inch (3 mm) **OR** 9/16 inch (15 mm) **OR** 5/8 inch (15 mm) **OR** 7/16 inch (22 mm) **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (51 mm) **OR** 3 inches (76 mm) **OR** As indicated on Drawings **OR** As indicated in a schedule, **as directed**.
10. Modular Size: 24 by 24 inches (610 by 610 mm) **OR** 24 by 48 inches (610 by 1220 mm) **OR** 600 by 600 mm **OR** 600 by 1200 mm **OR** As indicated on Drawings **OR** As indicated in a schedule, **as directed**.
11. Antimicrobial Treatment: Broad spectrum fungicide and bactericide **OR** Fungicide, **as directed**, based.

C. Metal Suspension Systems, General
1. Recycled Content: Provide products made from steel sheet with average recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
2. Metal Suspension System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635.
3. Finishes and Colors, General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.
   a. High-Humidity Finish: Comply with ASTM C 635 requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.
4. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
   a. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing per

ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.

1) Type: Cast-in-place **OR** Postinstalled expansion **OR** Postinstalled bonded, **as directed**, anchors.
2) Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.
3) Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Group 1 Alloy 304 or 316 for bolts; Alloy 304 or 316 for anchor.
4) Corrosion Protection: Components fabricated from nickel-copper-alloy rods complying with ASTM B 164 for UNS No. N04400 alloy.

b. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing per ASTM E 1190, conducted by a qualified testing and inspecting agency.

5. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
   a. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
      OR
      Stainless-Steel Wire: ASTM A 580/A 580M, Type 304, nonmagnetic.
      OR
      Nickel-Copper-Alloy Wire: ASTM B 164, nickel-copper-alloy UNS No. N04400.
   b. Size: Select wire diameter so its stress at 3 times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch- (2.69-mm-) **OR** 0.135-inch- (3.5-mm-), **as directed**, diameter wire.
6. Hanger Rods **OR** Flat Hangers, **as directed**: Mild steel, zinc coated or protected with rust-inhibitive paint.
7. Angle Hangers: Angles with legs not less than 7/8 inch (22 mm) wide; formed with 0.04-inch- (1-mm-) thick, galvanized steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation; with bolted connections and 5/16-inch- (8-mm-) diameter bolts.
8. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.
9. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.
10. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical panels in-place.
11. Hold-Down Clips: Where indicated, provide manufacturer's standard hold-down clips spaced 24 inches (610 mm) o.c. on all cross tees.
12. Impact Clips: Where indicated, provide manufacturer's standard impact-clip system designed to absorb impact forces against acoustical panels.
13. Clean-Room Gasket System: Where indicated, provide manufacturer's standard system, including manufacturer's standard **OR** closed-cell PVC **OR** neoprene **OR** antimicrobial, **as directed**, gasket and related adhesives, tapes, seals, and retention clips, designed to seal out foreign material from and maintain positive pressure in clean room.

D. Metal Suspension System For Acoustical Panel Ceiling
1. Wide-Face, Capped, Double-Web, Fire-Rated, **as directed**, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 (Z90) coating designation, with prefinished 15/16-inch- (24-mm-) wide metal caps on flanges.
   a. Structural Classification: Intermediate-duty **OR** Heavy-duty, **as directed**, system.
   b. End Condition of Cross Runners: Override (stepped) **OR** Butt-edge, **as directed**, type.
   c. Face Design: Flat, flush.
   d. Cap Material: Steel **OR** Aluminum, **as directed**, cold-rolled sheet.
   e. Cap Finish: Painted white **OR** Painted in color as selected from manufacturer's full range **OR** Painted to match color indicated by manufacturer's designation **OR** Painted to match

color of acoustical unit **OR** Plated with metallic finish, as selected from manufacturer's full range **OR** Plated with metallic finish indicated by manufacturer's designation **OR** Natural finish for aluminum, **as directed**.

2. Narrow-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 (Z90) coating designation, with prefinished 9/16-inch- (15-mm-) wide metal caps on flanges.
   a. Structural Classification: Intermediate-duty **OR** Heavy-duty, **as directed**, system.
   b. End Condition of Cross Runners: Override (stepped) **OR** Butt-edge, **as directed**, type.
   c. Face Design: Flat, flush **OR** Flanges formed with an integral center reveal, **as directed**.
   d. Cap Material: Steel **OR** Aluminum, **as directed**, cold-rolled sheet.
   e. Cap Finish: Painted white **OR** Painted in color as selected from manufacturer's full range **OR** Painted to match color indicated by manufacturer's designation **OR** Painted to match color of acoustical unit **OR** Plated with metallic finish, as selected from manufacturer's full range **OR** Plated with metallic finish indicated by manufacturer's designation **OR** Natural finish for aluminum, **as directed**.
3. Narrow-Face, Steel-Capped, Double-Web, Fire-Rated Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 (Z90) coating designation, with prefinished, cold-rolled, 9/16-inch- (15-mm-) wide metal caps on flanges.
   a. Structural Classification: Intermediate-duty system.
   b. Face Design: Flat, flush.
   c. Cap Finish: Painted white **OR** Painted in color as selected from manufacturer's full range **OR** Painted to match color indicated by manufacturer's designation **OR** Painted to match color of acoustical unit **OR** Plated with metallic finish, as selected from manufacturer's full range **OR** Plated with metallic finish indicated by manufacturer's designation **OR** Natural finish for aluminum, **as directed**.
4. Narrow-Face, Uncapped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized, to produce structural members with 9/16-inch- (15-mm-) wide faces.
   a. Structural Classification: Intermediate-duty **OR** Heavy-duty, **as directed**, system.
   b. Face Design: With 1/8-inch- (3.2-mm-) wide, slotted, box-shaped flange **OR** With 1/4-inch- (6.35-mm-) wide, slotted, box-shaped flange **OR** Flanges formed in stepped design with a center protrusion projecting 19/64 inch (7.54 mm) below flange surfaces supporting panel faces and forming 3/16-inch- (4.76-mm-) wide reveals between edges of protrusion and those of panels, **as directed**.
   c. Face Finish: Painted white **OR** in color as selected from manufacturer's full range **OR** to match color indicated by manufacturer's designation **OR** to match color of acoustical unit, **as directed**.
   d. Reveal Finish: Painted to match flange color **OR** white **OR** black **OR** in color other than flange color as selected from manufacturer's full range of contrasting reveal colors, **as directed**.
5. Wide-Face, Capped, Double-Web, Fire-Rated, **as directed**, Hot-Dip Galvanized, G60 (Z180), Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, hot-dip galvanized according to ASTM A 653/A 653M, G60 (Z180) coating designation, with prefinished, cold-rolled, 15/16-inch- (24-mm-) wide, aluminum caps on flanges.
   a. Structural Classification: Intermediate-duty **OR** Heavy-duty, **as directed**, system.
   b. Face Design: Flat, flush.
   c. Face Finish: Painted white **OR** Painted to match color indicated by manufacturer's designation **OR** Painted to match color of acoustical unit **OR** Natural finish, **as directed**.
6. Wide-Face, Single-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet electrolytically zinc coated, with prefinished flanges of width indicated.
   a. Structural Classification: Heavy-duty system.
   b. Face Finish: Painted white **OR** black, **as directed**.

7. Wide-Face, Capped, Double-Web, Stainless-Steel Suspension System: Main and cross runners roll formed from Type 304 or 316, stainless-steel sheet, with prefinished 15/16-inch- (24-mm-) wide, stainless-steel caps on flanges.
   a. Structural Classification: Intermediate-duty system.
   b. Face Design: Flat, flush.
8. Narrow-Face, Single-Web, Extruded-Aluminum Suspension System: Main and cross runners formed from extruded aluminum to produce structural members with 9/16-inch- (15-mm-) wide faces.
   a. Structural Classification: Intermediate-duty **OR** Heavy-duty, **as directed**, system.
   b. Face Design: Screw-slot profile.
   c. Face Finish: Painted white **OR** Satin anodized per AA-M12C22A31 and AAMA 611, **as directed**.
   d. Reveal Finish: Match face finish **OR** Painted white **OR** Painted black, **as directed**.
9. Extra-Wide-Face, Double-Web **OR** Single-Web, **as directed**, Metal Suspension System: Main and cross runners formed from extruded aluminum **OR** aluminum-capped steel **OR** steel-capped steel, **as directed**, to produce structural members with 1-1/2-inch- (50-mm-) **OR** 2-inch- (50-mm-), **as directed**, wide flanges.
   a. Structural Classification: Intermediate-duty **OR** Heavy-duty, **as directed**, system.
   b. Face Design: Flat, flush.
   c. Face Finish: Painted white **OR** Satin anodized per AA-M12C22A31 and AAMA 611, **as directed**.
   d. Gasket System: Clean-room type.

E. Metal Edge Moldings And Trim
1. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners.
   a. Provide manufacturer's standard edge moldings that fit acoustical panel edge details and suspension systems indicated and that match width and configuration of exposed runners, unless otherwise indicated.
   b. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
   c. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
2. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements and the following:
   a. Aluminum Alloy: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of aluminum extrusions complying with ASTM B 221 (ASTM B 221M) for Alloy and Temper 6063-T5.
   b. Finish designations prefixed by AA comply with system established by the Aluminum Association for designating aluminum finishes.
   c. Conversion-Coated Finish: AA-M12C42 (Chemical Finish: cleaned with inhibited chemicals; acid-chromate-fluoride-phosphate conversion coating).
   d. Conversion-Coated and Factory-Primed Finish: AA-M12C42R1x (Chemical Finish: cleaned with inhibited chemicals; acid-chromate-fluoride-phosphate conversion coating; organic coating as follows):
      1) Manufacturer's standard, factory-applied prime-coat finish ready for field painting.
   e. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.

f. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; organic coating: as specified below). Apply baked enamel complying with paint manufacturer's written instructions for cleaning, conversion coating, and painting.
   1) Organic Coating: Thermosetting, primer/topcoat system with a minimum dry film thickness of 0.8 to 1.2 mils (0.02 to 0.03 mm).

F. Acoustical Sealant
1. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex sealant, with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
2. Acoustical Sealant for Concealed Joints: Manufacturer's standard nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant, with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), recommended for sealing interior concealed joints to reduce airborne sound transmission.

1.3 EXECUTION

A. Preparation
1. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

B. Installation
1. General: Install acoustical panel ceilings to comply with ASTM C 636 **OR** UBC Standard 25-2, **as directed**, and seismic design requirements indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
   a. Fire-Rated Assembly: Install fire-rated ceiling systems according to tested fire-rated design.
2. Suspend ceiling hangers from building's structural members and as follows:
   a. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
   b. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
   c. Splay hangers only where required and, if permitted with fire-resistance-rated ceilings, to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
   d. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
   e. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
   f. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both structure to which hangers are attached and type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
   g. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.

h. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
i. Do not attach hangers to steel deck tabs.
j. Do not attach hangers to steel roof deck. Attach hangers to structural members.
k. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers, unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.
l. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

3. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
4. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
   a. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
   b. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.2 mm in 3.6 m). Miter corners accurately and connect securely.
   c. Do not use exposed fasteners, including pop rivets, on moldings and trim.
5. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
6. Install acoustical panels with undamaged edges and fit accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
   a. Arrange directionally patterned acoustical panels as follows:
      1) As indicated on reflected ceiling plans.
         OR
         Install panels with pattern running in one direction parallel to long **OR** short, **as directed**, axis of space.
         OR
         Install panels in a basket-weave pattern.
   b. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension system runners and moldings.
   c. For reveal-edged panels on suspension system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
   d. For reveal-edged panels on suspension system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension system surfaces and panel faces flush with bottom face of runners.
   e. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
   f. Install hold-down clips in areas indicated, in areas required by authorities having jurisdiction, and for fire-resistance ratings; space as recommended by panel manufacturer's written instructions, unless otherwise indicated.
   g. Install clean-room gasket system in areas indicated, sealing each panel and fixture as recommended by panel manufacturer's written instructions.
   h. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

C. Field Quality Control
   1. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

2. Tests and Inspections: Testing and inspecting of completed installations of acoustical panel ceiling hangers and anchors and fasteners shall take place in successive stages, in areas of extent and using methods as follows. Do not proceed with installations of acoustical panel ceiling hangers for the next area until test results for previously completed installations of acoustical panel ceiling hangers show compliance with requirements.
   a. Extent of Each Test Area: When installation of ceiling suspension systems on each floor has reached 20 percent completion but no panels have been installed.
      1) Within each test area, testing agency will select 1 of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for 200 lbf (890 N) of tension; it will also select one of every 2 postinstalled anchors used to attach bracing wires to concrete and will test them for 440 lbf (1957 N) of tension.
      2) When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.
3. Remove and replace acoustical panel ceiling hangers and anchors and fasteners that do not pass tests and inspections and retest as specified above.

D. Cleaning
1. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 09511

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SECTION 09512 - ACOUSTICAL TILE CEILINGS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for acoustical tile ceilings. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes acoustical tiles for ceilings and the following:
   a. Concealed suspension systems.
   b. Direct attachment of tiles to substrates with adhesive.
   c. Direct attachment of tiles to substrates with staples.
2. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete at ceilings.

C. Definitions
1. AC: Articulation Class.
2. CAC: Ceiling Attenuation Class.
3. LR: Light-Reflectance coefficient.
4. NRC: Noise Reduction Coefficient.

D. Submittals
1. Product Data: For each type of product indicated.
2. Coordination Drawings: Drawn to scale and coordinating acoustical tile ceiling installation with hanger attachment to building structure and ceiling mounted items. Show size and location of initial access modules.
3. Samples: For each exposed finish.
4. LEED Submittals:
   a. Product Data for Credit MR 4.1 and MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
      1) Include statement indicating costs for each product having recycled content.
   b. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
5. Field quality-control test reports.
6. Product test reports.
7. Research/evaluation reports.
8. Maintenance data.

E. Quality Assurance
1. Acoustical Testing Agency Qualifications: An independent testing laboratory, or an NVLAP-accredited laboratory, with the experience and capability to conduct the testing indicated. NVLAP-accredited laboratories must document accreditation, based on a "Certificate of Accreditation" and a "Scope of Accreditation" listing the test methods specified.
2. Fire-Test-Response Characteristics: Provide acoustical tile ceilings that comply with the following requirements:
   a. Fire-Resistance Characteristics: Where indicated, provide acoustical tile ceilings identical to those of assemblies tested for fire resistance per ASTM E 119 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
      1) Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.

2) Identify materials with appropriate markings of applicable testing and inspecting agency.

b. Surface-Burning Characteristics: Provide acoustical tiles with the following surface-burning characteristics complying with ASTM E 1264 for Class A **OR** B **OR** C, **as directed**, materials as determined by testing identical products per ASTM E 84:

1) Smoke-Developed Index: 450 or less.

3. Seismic Standard: Provide acoustical tile ceilings designed and installed to withstand the effects of earthquake motions according to the following:
   a. Standard for Ceiling Suspension Systems Requiring Seismic Restraint: Comply with ASTM E 580.
   b. CISCA's Recommendations for Acoustical Ceilings: Comply with CISCA's "Recommendations for Direct-Hung Acoustical Tile and Lay-in Panel Ceilings--Seismic Zones 0-2."
   c. CISCA's Guidelines for Systems Requiring Seismic Restraint: Comply with CISCA's "Guidelines for Seismic Restraint of Direct-Hung Suspended Ceiling Assemblies--Seismic Zones 3 & 4."
   d. UBC Standard 25-2, "Metal Suspension Systems for Acoustical Tile and for Lay-in Panel Ceilings."
   e. ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."
4. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Deliver acoustical tiles, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
2. Before installing acoustical tiles, permit them to reach room temperature and a stabilized moisture content.
3. Handle acoustical tiles carefully to avoid chipping edges or damaging units in any way.

1.2 PRODUCTS

A. Acoustical Tiles, General
1. Acoustical Tile Standard: Provide manufacturer's standard tiles of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances, unless otherwise indicated.
   a. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches (400 mm) away from test surface per ASTM E 795.
2. Acoustical Tile Colors and Patterns: Match appearance characteristics indicated for each product type.
   a. Where appearance characteristics of acoustical tiles are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by the Owner from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.
3. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical tiles treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.
4. Antimicrobial Fungicide Treatment: Provide acoustical tiles with face and back surfaces coated with antimicrobial treatment consisting of manufacturer's standard formulation with fungicide

added to inhibit growth of mold and mildew and showing no mold or mildew growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

B. Acoustical Tiles For Acoustical Tile Ceiling
   1. Classification: Provide fire-resistance-rated, **as directed**, tiles complying with ASTM E 1264 for type, form, and pattern as follows:
      a. Type III, mineral base with painted finish; Form 1, nodular **OR** 2, water felted **OR** 4, cast or molded, **as directed**.
      b. Pattern: C (perforated, small holes) **OR** CD (perforated, small holes and fissured) **OR** CE (perforated, small holes and lightly textured) **OR** D (fissured) **OR** E (lightly textured) **OR** F (heavily textured) **OR** G (smooth) **OR** I (embossed) **OR** J (embossed-in-register) **OR** As indicated by manufacturer's designation, **as directed**.
   2. Color: White **OR** As selected from manufacturer's full range **OR** Match sample **OR** As indicated by manufacturer's designation **OR** As indicated on Drawings **OR** As indicated in a schedule, **as directed**.
   3. LR: Not less than 0.65 **OR** 0.70 **OR** 0.75 **OR** 0.80, **as directed**.
   4. NRC: Not less than 0.50 **OR** 0.55 **OR** 0.60 **OR** 0.65 **OR** 0.70, **as directed**.
   5. CAC: Not less than 20 **OR** 25 **OR** 30 **OR** 35 **OR** 40, **as directed**.
   6. AC: Not less than 170 **OR** 180 **OR** 190 **OR** 200 **OR** 210, **as directed**.
   7. Edge/Joint Detail: Square, kerfed and rabbeted, or tongue and grooved, or butt **OR** Beveled, kerfed and rabbeted, or tongue and grooved, or butt **OR** Beveled, kerfed and rabbeted long edges and square, butt on short edges, **as directed**.
   8. Thickness: 5/8 inch (15 mm) **OR** 3/4 inch (19 mm) **OR** As indicated on Drawings **OR** As indicated in a schedule, **as directed**.
   9. Modular Size: 12 by 12 inches (305 by 305 mm) **OR** 300 by 300 mm **OR** As indicated on Drawings **OR** As indicated in a schedule, **as directed**.
   10. Antimicrobial Treatment: Broad spectrum fungicide and bactericide **OR** Fungicide, **as directed**, based.

C. Metal Suspension Systems, General
   1. Recycled Content: Provide products made from steel sheet with average recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
   2. Metal Suspension System Standard: Provide manufacturer's standard metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635.
   3. Finishes and Colors, General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.
   4. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
      a. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing per ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
         1) Type: Cast-in-place **OR** Postinstalled expansion **OR** Postinstalled bonded, **as directed**, anchors.
         2) Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.
         3) Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Group 1 Alloy 304 or 316 for bolts; Alloy 304 or 316 for anchors.
      b. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without

failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing per ASTM E 1190, conducted by a qualified testing and inspecting agency.

5. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
   a. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
   b. Size: Select wire diameter so its stress at 3 times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch- (2.69-mm-) **OR** 0.135-inch- (3.5-mm-), **as directed**, diameter wire.
6. Hanger Rods **OR** Flat Hangers, **as directed**: Mild steel, zinc coated or protected with rust-inhibitive paint.
7. Angle Hangers: Angles with legs not less than 7/8 inch (22 mm) wide; formed with 0.04-inch- (1-mm-) thick, galvanized steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation; with bolted connections and 5/16-inch- (8-mm-) diameter bolts.
8. Seismic Struts: Manufacturer's standard compression struts designed to accommodate lateral forces.
9. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical tiles in-place.

D. Metal Suspension System For Acoustical Tile Ceiling
1. Direct-Hung, Double-Web, Fire-Rated, **as directed**, Suspension System: Main and cross runners roll formed from and capped with cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, G30 (Z90) coating designation.
   a. Structural Classification: Intermediate-duty **OR** Heavy-duty, **as directed**, system.
   b. Access: Upward **OR** Downward, **as directed**, and end pivoted, **OR** side pivoted, **as directed**, with initial access openings of size indicated below and located throughout ceiling within each module formed by main and cross runners, with additional access available by progressively removing remaining acoustical tiles.
2. Indirect-Hung, Fire-Rated, **as directed**, Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, G30 (Z90) coating designation.
   a. Structural Classification: Intermediate-duty **OR** Heavy-duty, **as directed**, system.
   b. Carrying Channels: Cold-rolled steel, 0.059850-inch- (1.52-mm-) minimum base (uncoated) metal thickness, not less than 3/16-inch- (4.7-mm-) wide flanges by 1-1/2-inch- (38-mm-) deep steel channels, 475 lb/1000 feet (0.707 kg/m), with rust-inhibitive paint finish **OR** hot-dip galvanized according to ASTM A 653/A 653M, G60 (Z180) coating designation, **as directed**.
   c. Access: Where access is indicated, provide special cross runners or split splines to allow for removal of acoustical units in indicated access areas. Identify access tile with manufacturer's standard unobtrusive markers for each access unit.

E. Metal Edge Moldings And Trim
1. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners.
   a. Provide manufacturer's standard edge moldings that fit acoustical tile edge details and suspension systems indicated and that match width and configuration of exposed runners, unless otherwise indicated.
   b. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
2. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements and the following:
   a. Aluminum Alloy: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability

properties of aluminum extrusions complying with ASTM B 221 (ASTM B 221M) for Alloy and Temper 6063-T5.

b. Finish designations prefixed by AA comply with system established by the Aluminum Association for designating aluminum finishes.

c. Conversion-Coated Finish: AA-M12C42 (Chemical Finish: cleaned with inhibited chemicals; acid-chromate-fluoride-phosphate conversion coating).

d. Conversion-Coated and Factory-Primed Finish: AA-M12C42R1x (Chemical Finish: cleaned with inhibited chemicals; acid-chromate-fluoride-phosphate conversion coating; organic coating as follows):

1) Manufacturer's standard factory-applied prime-coat finish ready for field painting.

e. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.

f. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; organic coating: as specified below). Apply baked enamel complying with paint manufacturer's written instructions for cleaning, conversion coating, and painting.

1) Organic Coating: Thermosetting, enamel primer/topcoat system with a minimum dry film thickness of 0.8 to 1.2 mils (0.02 to 0.03 mm).

F. Acoustical Sealant

1. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex sealant, with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
2. Acoustical Sealant for Concealed Joints: Manufacturer's standard nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant, with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), recommended for sealing interior concealed joints to reduce airborne sound transmission.

G. Miscellaneous Materials

1. Tile Adhesive: Type recommended by tile manufacturer, bearing UL label for Class 0-25 flame spread.
   a. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Staples: 5/16-inch- (8-mm-) long, divergent-point staples.

1.3 EXECUTION

A. Preparation

1. Testing Substrates: Before installing adhesively applied tiles on wet-placed substrates such as cast-in-place concrete or plaster, test and verify that moisture level is below tile manufacturer's recommended limits.
2. Measure each ceiling area and establish layout of acoustical tiles to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width tiles at borders, and comply with layout shown on reflected ceiling plans.

B. Installation, Suspended Acoustical Tile Ceilings

1. General: Install acoustical tile ceilings to comply with ASTM C 636 **OR** UBC Standard 25-2, **as directed**, and seismic design requirements indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
   a. Fire-Rated Assembly: Install fire-rated ceiling systems according to tested fire-rated design.
2. Suspend ceiling hangers from building's structural members and as follows:

a. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
b. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
OR
Splay hangers only where required and, if permitted with fire-resistance-rated ceilings, to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
c. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
d. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
OR
Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both structure to which hangers are attached and type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
e. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
f. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
g. Do not attach hangers to steel deck tabs.
h. Do not attach hangers to steel roof deck. Attach hangers to structural members.
i. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers, unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.
j. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

3. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
4. Install edge moldings and trim of type indicated at perimeter of acoustical tile ceiling area and where necessary to conceal edges of acoustical tiles.
   a. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
   b. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.2 mm in 3.6 m). Miter corners accurately and connect securely.
   c. Do not use exposed fasteners, including pop rivets, on moldings and trim.
5. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
6. Arrange directionally patterned acoustical tiles as follows:
   a. As indicated on reflected ceiling plans.
   OR
   Install tiles with pattern running in one direction parallel to long **OR** short, **as directed**, axis of space.
   OR

Install tiles in a basket-weave pattern.

7. Install acoustical tiles in coordination with suspension system and exposed moldings and trim. Place splines or suspension system flanges into kerfed edges so tile-to-tile joints are closed by double lap of material.
   a. Fit adjoining tile to form flush, tight joints. Scribe and cut tile for accurate fit at borders and around penetrations through tile.
   b. Hold tile field in compression by inserting leaf-type, spring-steel spacers between tile and moldings, spaced 12 inches (305 mm) o.c.
   c. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

C. Installation, Directly Attached Acoustical Tile Ceilings
   1. Adhesive Installation: Install acoustical tile by bonding to substrate, using amount of adhesive and procedure recommended in writing by tile manufacturer and as follows:
      a. Remove loose dust from backs of tiles by brushing and prime them with a thin coat of adhesive.
      b. Install splines in joints between tiles; maintain level of bottom surface of tiles to a tolerance of 1/8 inch in 12 feet (3 mm in 3.6 m) and not exceeding 1/4 inch (6.35 mm) cumulatively.
      c. Maintain tight butt joints, aligned in both directions and coordinated with ceiling fixtures.
   2. Stapled Installation: Fasten acoustical tile to substrate using a minimum of two staples per tile that are installed in flanges of tile and as follows:
      a. Form double-lapped joint between tiles by securely pressing tile tongues into corresponding tile grooves.
      b. Maintain level of bottom surface of tiles to a tolerance of 1/8 inch in 12 feet (3 mm in 3.6 m) and not exceeding 1/4 inch (6.35 mm) cumulatively. Shim tile or correct substrate as required to maintain tolerance.
      c. Maintain tight butt joints, aligned in both directions and coordinated with ceiling fixtures.
   3. Install edge moldings and trim of type indicated at perimeter of acoustical tile ceiling area and where necessary to conceal edges of acoustical units.
   4. Arrange directionally patterned acoustical tiles as follows:
      a. As indicated on reflected ceiling plans.
         OR
         Install tiles with pattern running in one direction parallel to long axis of space.
         OR
         Install tiles with pattern running in one direction parallel to short axis of space.
         OR
         Install tiles in a basket-weave pattern.

D. Field Quality Control
   1. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
   2. Tests and Inspections: Testing and inspecting of completed installations of acoustical tile ceiling hangers and anchors and fasteners shall take place in successive stages, in areas of extent and using methods as follows. Do not proceed with installations of acoustical tile ceiling hangers for the next area until test results for previously completed installations of acoustical tile ceiling hangers show compliance with requirements.
      a. Extent of Each Test Area: When installation of ceiling suspension systems on each floor has reached 20 percent completion but no tiles have been installed.
         1) Within each test area, testing agency will select 1 of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for 200 lbf (890 N) of tension; it will also select one of every 2 postinstalled anchors used to attach bracing wires to concrete and will test them for 440 lbf (1957 N) of tension.
         2) When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.

3. Remove and replace acoustical tile ceiling hangers and anchors and fasteners that do not pass tests and inspections and retest as specified above.

E. Cleaning
1. Clean exposed surfaces of acoustical tile ceilings, including trim and edge moldings. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace tiles and other ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 09512

SECTION 09513 - ACOUSTICAL METAL PAN CEILINGS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for acoustical metal pan ceilings. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes clip-in, lay-in, snap-in, and torsion-spring acoustical metal pans and the following suspension system for ceilings:
   a. Direct hung, exposed tee and slot-bolt grid.
   b. Direct-hung and Indirect-hung, concealed grid designed to support metal pans.
2. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete at ceilings.

C. Definitions
1. CAC: Ceiling Attenuation Class.
2. LR: Light Reflectance coefficient.
3. NRC: Noise Reduction Coefficient.

D. Performance Requirements
1. Structural Performance: Exterior snap-in metal pan ceilings shall withstand exterior exposure and the effects of gravity loads and the following loads and stresses without showing permanent deformation of ceiling system components including pans and suspension system; noise or metal fatigue caused by vibration, deflection, and displacement of ceiling units; or permanent damage to fasteners and anchors.
   a. Wind Load: Uniform pressure of 20 lbf/sq. ft. (960 Pa) **OR** of 30 lbf/sq. ft. (1436 Pa) **OR** as indicated on Drawings, **as directed**, acting inward or outward.
2. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   a. Temperature Change (Range): 100 deg F (55 deg C).

E. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
   a. Product Data for Credit MR 4.1 and MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
      1) Include statement indicating costs for each product having recycled content.
   b. Product Data for Credit EQ 4.1: For sealants, including printed statement of VOC content.
3. Samples: For each exposed finish.
4. Performance Data: For installed products indicated to comply with design loads and other criteria, include structural analysis and other analytical data signed and sealed by the qualified professional engineer responsible for their preparation.
5. Coordination Drawings: Drawn to scale and coordinating and showing the following:
   a. Ceiling suspension members.
   b. Method of attaching hangers to building structure.
   c. Ceiling-mounted items.
   d. Ceiling perimeter and penetrations through the ceiling; and trim and moldings.
6. Product test reports.

7. Evaluation reports.
8. Field quality-control reports.
9. Maintenance data.

F. Quality Assurance
1. Acoustical Testing Agency Qualifications: An independent testing laboratory or an NVLAP-accredited laboratory, with the experience and capability to conduct the testing indicated. NVLAP-accredited laboratories must document accreditation, based on a "Certificate of Accreditation" and a "Scope of Accreditation" listing the test methods specified.
2. Surface-Burning Characteristics: Complying with ASTM E 1264 for Class A materials as determined by testing identical products according to ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
3. Seismic Standard: Provide acoustical metal pan ceilings designed and installed to withstand the effects of earthquake motions according to the following:
   a. Standard for Ceiling Suspension Systems Requiring Seismic Restraint: Comply with ASTM E 580.
   b. CISCA's Recommendations for Acoustical Ceilings: Comply with CISCA's "Recommendations for Direct-Hung Acoustical Tile and Lay-in Panel Ceilings - Seismic Zones 0-2."
   c. CISCA's Guidelines for Systems Requiring Seismic Restraint: Comply with CISCA's "Guidelines for Seismic Restraint of Direct-Hung Suspended Ceiling Assemblies - Seismic Zones 3 & 4."
   d. UBC Standard 25-2, "Metal Suspension Systems for Acoustical Tile and for Lay-in Panel Ceilings."
   e. SEI/ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."
4. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver acoustical metal pans, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
2. Handle acoustical metal pans, suspension system components, and accessories carefully to avoid damaging units and finishes in any way.

1.2 PRODUCTS

A. Acoustical Metal Ceiling Pans
1. Acoustical Metal Pan Standard: Provide manufacturer's standard acoustical metal pans of configuration indicated that comply with ASTM E 1264 classifications as designated by types, acoustical ratings, and light reflectances unless otherwise indicated.
   a. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches (400 mm) away from test surface per ASTM E 795.
2. Sheet Metal Characteristics: For metal components exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, roughness, stains, or discolorations.
   a. Aluminum Sheet: Roll-formed aluminum sheet, complying with ASTM B 209 (ASTM B 209M); alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
   b. Steel Sheet: Commercial-quality, cold-rolled, carbon-steel sheet; stretcher leveled; with protective coating complying with ASTM C 635.

1) Recycled Content: Provide products made from steel sheet with average recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
2) Painted Finishes: Electrolytic zinc-coated steel complying with ASTM A 591/A 591M, 40Z (12G) coating, surface treatment as recommended by finish manufacturer for type of use and finish indicated.
3) Chemical/Mechanical Finishes: Uncoated steel sheet complying with ASTM A 1008/A 1008M with luster or bright finish as required by finisher for applying electroplating or other metallic-finishing processes.

c. Stainless-Steel Sheet: Complying with ASTM A 240/A 240M, Type 304 **OR** Type 430, **as directed**.

3. Sound-Absorbent Fabric Layer: Provide fabric layer, sized to fit concealed surface of pan, and consisting of black, nonwoven, nonflammable, sound-absorbent material with surface-burning characteristics for flame-spread index of 25 or less and smoke-developed index of 50 or less, as determined by testing per ASTM E 84.
   a. Bond fabric layer to panels in the factory with manufacturer's standard nonflammable adhesive.
4. Sound-Absorbent Pads: Provide width and length to completely fill concealed surface of pan, with surface-burning characteristics for flame-spread index of 25 or less and smoke-developed index of 50 or less, as determined by testing per ASTM E 84, and to comply with the following requirements:
   a. Plastic Sheet-Wrapped Mineral-Fiber Insulation: Pads consisting of nonrigid, PVC plastic sheet encapsulating unfaced mineral-fiber insulation complying with ASTM C 553, Type I, II, or III, and as follows:
      1) Mineral-Fiber Type and Thickness: Glass fiber; 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 3 inches (76 mm), **as directed**.
      2) Mineral-Fiber Density: 3/4 lb/cu. ft. (12 kg/cu. m) **OR** 1 lb/cu. ft. (16 kg/cu. m) **OR** 1-1/2 lb/cu. ft. (24 kg/cu. m), **as directed**.
      3) Plastic Sheet Thickness and Color: Not less than 0.003 inch (0.076 mm); clear **OR** flat black **OR** white, **as directed**.
   b. Unwrapped, Glass-Fiber Insulation: Black coated, unfaced, complying with ASTM C 553, Type I, II, or III; not less than 1-lb/cu. ft. (16-kg/cu. m) density; treated to be nondusting; and as follows:
      1) Thickness: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm), **as directed**.
   c. Spacer Grids: Provide manufacturer's standard aluminum **OR** galvanized-steel, **as directed**, grid units that provide an air cushion between metal pans and insulation pads and that act to improve sound absorption.
   d. Sound Attenuation Panels: Provide manufacturer's standard aluminum **OR** galvanized-steel, **as directed**, unperforated metal backing unit that acts as a sound-attenuating pan to reduce the travel of sound through ceiling plenum into adjoining rooms.
      1) Sound-Absorbent Pads: Provide secondary sound-absorbent pads, same as specified for primary pads, for placement over sound attenuation pan to reduce plenum sound.

B. Aluminum Pans For Acoustical Metal Pan Ceiling
   1. Classification: Units complying with ASTM E 1264 for Type VII, perforated aluminum facing (pan) with mineral- or glass-fiber-base backing **OR** Type XX, other types described as perforated aluminum facing (pan) units with sound-absorbent fabric backing **OR** Type XX, other types described as unperforated aluminum facing (pan) units, **as directed**.
      a. Pattern: Pattern A (perforated, regularly spaced large holes), arranged in diagonal **OR** parallel, **as directed**, alignment to pan edge with uniform perforations of dimension, holes per square foot or inch, and percent open area as indicated by product designation **OR** selected from manufacturer's full range, **as directed**.
      OR

Pattern: Pattern C (perforated, small holes) regularly spaced, with uniform perforations of dimension, holes per square foot or inch, and percent open area as specified by product designation **OR** selected from manufacturer's full range, **as directed**.

2. Pan Fabrication: Manufacturer's standard units of size, profile, and edge treatment indicated, formed from metal indicated and finished to comply with requirements indicated.
   a. Lay-in Pans: Formed to set in exposed suspension grid.
   b. Clip-in Pans: Designed to clip-in and be securely retained in exposed suspension grid by formed edges or accessory clips.
   c. Snap-in Pans: Designed with dimples or continuous beads on flanges for snap-in, secure engagement with concealed suspension system.
   d. Torsion-Spring-Hinged Pans: Designed to be securely retained in preslotted exposed suspension grid by torsion springs.
3. Pan Thickness: Not less than 0.020 inch (0.5 mm) **OR** 0.025 inch (0.6 mm) **OR** 0.032 inch (0.8 mm) **OR** 0.040 inch (1.0 mm), **as directed**.
4. Pan Edge Detail: Square **OR** Beveled **OR** Reveal **OR** Manufacturer's standard edge detail, **as directed**.
   OR
   Pan Joint Detail: Butt **OR** Wide reveal, not less than 15/16 inch (24 mm) wide **OR** Narrow reveal, not greater than 9/16 inch (15 mm) wide **OR** Flush narrow reveal, not greater than 9/16 inch (15 mm) wide, **as directed**.
5. Pan Size: 12 by 12 inches (305 by 305 mm) **OR** 12 by 24 inches (305 by 610 mm) **OR** 12 by 36 inches (305 by 915 mm) **OR** 24 by 24 inches (610 by 610 mm) **OR** 24 by 48 inches (610 by 1220 mm) **OR** 24 by 60 inches (610 by 1525 mm) **OR** 30 by 30 inches (760 by 760 mm) **OR** 30 by 60 inches (760 by 1525 mm) **OR** As indicated on Drawings, **as directed**.
6. Scoring: Score pans at intervals to appear as 12-by-12-inch (305-by-305-mm) ceiling units.
7. Pan Face Finish: Mill **OR** Lacquered mill **OR** Clear anodized **OR** Clear mirror-anodized **OR** Painted white **OR** Painted to match color indicated by product designation **OR** Painted to match sample **OR** Painted in color selected from manufacturer's full range **OR** Bright-reflective metallic finish selected from manufacturer's full range, **as directed**.
8. LR: Not less than 0.70 **OR** 0.75, **as directed**.
9. NRC: Not less than 0.60 **OR** 0.65 **OR** 0.70 **OR** 0.75 **OR** 0.80 **OR** 0.85 **OR** 0.90 **OR** 0.95, **as directed**.
10. CAC: Not less than 35 **OR** 40 **OR** 45, **as directed**.

C. Steel Pans For Acoustical Metal Pan Ceiling
   1. Classification: Units complying with ASTM E 1264 for Type V, perforated steel facing (pan) with mineral- or glass-fiber-base backing **OR** Type XX, other types described as perforated steel facing (pan) units with sound-absorbent fabric backing **OR** Type XX, other types described as unperforated steel facing (pan) units, **as directed**.
      a. Pattern: Pattern A (perforated, regularly spaced large holes), arranged in diagonal **OR** parallel, **as directed**, alignment to pan edge with uniform perforations of dimension, holes per square foot or inch, and percent open area as indicated by product designation **OR** selected from manufacturer's full range, **as directed**.
         OR
         Pattern: Pattern C (perforated, small holes) regularly spaced, with uniform perforations of dimension, holes per square foot or inch, and percent open area as specified by product designation **OR** selected from manufacturer's full range, **as directed**.
   2. Pan Fabrication: Manufacturer's standard units of size, profile, and edge treatment indicated, formed from metal indicated and finished to comply with requirements indicated.
      a. Lay-in Pans: Formed to set in exposed suspension grid.
      b. Clip-in Pans: Designed to clip-in and be securely retained in exposed suspension grid by formed edges or accessory clips.
      c. Snap-in Pans: Designed with dimples or continuous beads on flanges for snap-in, secure engagement with concealed suspension system.

d. Torsion-Spring-Hinged Pans: Designed to be securely retained in preslotted exposed suspension grid by torsion springs.

3. Pan Thickness: Not less than 0.010-inch (0.25-mm) **OR** 0.020-inch (0.5-mm) **OR** 0.024-inch (0.6-mm) **OR** 0.030-inch (0.75-mm) **OR** 0.036-inch (0.9-mm), **as directed**, nominal thickness.
4. Pan Edge Detail: Square **OR** Beveled **OR** Reveal **OR** Manufacturer's standard edge detail, **as directed**.
   OR
   Pan Joint Detail: Butt **OR** Wide reveal, not less than 15/16 inch (24 mm) wide **OR** Narrow reveal, not greater than 9/16 inch (15 mm) wide **OR** Flush narrow reveal, not greater than 9/16 inch (15 mm) wide, **as directed**.
5. Pan Size: 12 by 12 inches (305 by 305 mm) **OR** 12 by 24 inches (305 by 610 mm) **OR** 12 by 36 inches (305 by 915 mm) **OR** 24 by 24 inches (610 by 610 mm) **OR** 24 by 48 inches (610 by 1220 mm) **OR** 24 by 60 inches (610 by 1525 mm) **OR** 30 by 30 inches (760 by 760 mm) **OR** 30 by 60 inches (760 by 1525 mm) **OR** As indicated on Drawings, **as directed**.
6. Scoring: Score pans at intervals to appear as 12-by-12-inch (305-by-305-mm) ceiling units.
7. Pan Face Finish: Painted white **OR** Painted to match color indicated by product designation **OR** Painted to match sample **OR** Painted in color selected from manufacturer's full range **OR** Plated with metallic finish, as selected from manufacturer's full range **OR** Bright-reflective metallic finish selected from manufacturer's full range, **as directed**.
8. LR: Not less than 0.70 **OR** 0.75, **as directed**.
9. NRC: Not less than 0.60 **OR** 0.65 **OR** 0.70 **OR** 0.75 **OR** 0.80 **OR** 0.85 **OR** 0.90 **OR** 0.95, **as directed**.
10. CAC: Not less than 35 **OR** 40 **OR** 45, **as directed**.

D. Stainless-Steel Pans For Acoustical Metal Pan Ceiling

1. Classification: Units complying with ASTM E 1264 for Type VI, perforated stainless-steel facing (pan) with mineral- or glass-fiber-base backing **OR** Type XX, other types described as perforated stainless-steel facing (pan) units with sound-absorbent fabric backing **OR** Type XX, other types described as unperforated stainless-steel facing (pan) units, **as directed**.
   a. Pattern: Pattern A (perforated, regularly spaced large holes), arranged in parallel alignment to pan edge with uniform perforations of 0.109-inch (2.8-mm) diameter, 1800 holes/sq. ft. or inch, and 11.8 percent open area.
2. Pan Fabrication: Manufacturer's standard units of size, profile, and edge treatment indicated, formed from metal indicated and finished to comply with requirements indicated.
   a. Lay-in Pans: Formed to set in exposed suspension grid.
   b. Clip-in Pans: Designed to clip-in and be securely retained in exposed suspension grid by formed edges or accessory clips.
   c. Snap-in Pans: Designed with dimples or continuous beads on flanges for snap-in, secure engagement with concealed suspension system.
   d. Torsion-Spring-Hinged Pans: Designed to be securely retained in preslotted exposed suspension grid by torsion springs.
3. Pan Thickness: Not less than 0.019 inch (0.5 mm) **OR** 0.025 inch (0.65 mm) **OR** 0.030 inch (0.76 mm), **as directed**.
4. Pan Edge Detail: Square **OR** Beveled **OR** Reveal **OR** Manufacturer's standard edge detail, **as directed**.
   OR
   Pan Joint Detail: Butt **OR** Wide reveal, not less than 15/16 inch (24 mm) wide **OR** Narrow reveal, not greater than 9/16 inch (15 mm) wide **OR** Flush narrow reveal, not greater than 9/16 inch (15 mm) wide, **as directed**.
5. Pan Size: 12 by 12 inches (305 by 305 mm) **OR** 12 by 24 inches (305 by 610 mm) **OR** 12 by 36 inches (305 by 915 mm) **OR** 24 by 24 inches (610 by 610 mm) **OR** 24 by 48 inches (610 by 1220 mm) **OR** 30 by 30 inches (760 by 760 mm) **OR** As indicated on Drawings, **as directed**.
6. Scoring: Score pans at intervals to appear as 12-by-12-inch (305-by-305-mm) ceiling units.
7. Pan Face Finish: Brushed, directional polish **OR** Satin, directional polish **OR** Mirrorlike reflective, nondirectional polish, **as directed**.

8. NRC: Not less than 0.60 **OR** 0.65 **OR** 0.70 **OR** 0.75 **OR** 0.80 **OR** 0.85 **OR** 0.90 **OR** 0.95, **as directed**.
9. CAC: Not less than 35 **OR** 40 **OR** 45, **as directed**.

E. Metal Suspension Systems
1. Recycled Content: Provide products made from steel sheet with average recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
2. Metal Suspension System Standard: Provide manufacturer's standard metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable ASTM C 635 requirements.
3. Suspension Systems: Provide systems complete with carriers, runners, splice sections, connector clips, alignment clips, leveling clips, hangers, molding, trim, retention clips, load-resisting struts, and other suspension components required to support ceiling units and other ceiling-supported construction.
4. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
   a. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing per ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
      1) Type: Cast-in-place **OR** Postinstalled expansion **OR** Postinstalled bonded, **as directed**, anchors.
      2) Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.
      3) Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Group 1 Alloy 304 or 316 for bolts; Alloy 304 or 316 for anchor.
      4) Corrosion Protection: Components fabricated from nickel-copper-alloy rods complying with ASTM B 164 for UNS No. N04400 alloy.
   b. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing per ASTM E 1190, conducted by a qualified testing and inspecting agency.
5. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
   a. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
   b. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304, nonmagnetic.
   c. Nickel-Copper-Alloy Wire: ASTM B 164, nickel-copper-alloy UNS No. N04400.
   d. Size: Select wire diameter so its stress at 3 times the hanger design load indicated in ASTM C 635, Table 1, Direct Hung will be less than yield stress of wire, but provide not less than 0.106-inch- (2.69-mm-) **OR** 0.135-inch- (3.5-mm-), **as directed**, diameter wire.
6. Hanger Rods **OR** Flat Hangers, **as directed**: Mild steel, zinc coated or protected with rust-inhibitive paint.
7. Angle Hangers: Angles with legs not less than 7/8 inch (22 mm) wide; formed with 0.04-inch- (1.0-mm-) thick, galvanized-steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation; with bolted connections and 5/16-inch- (8-mm-) diameter bolts.
8. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.
9. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.
10. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical metal pans in place.
11. Hold-Down Clips: Manufacturer's standard hold-down clips spaced to secure acoustical metal pans in place to molding and trim at perimeter **OR** at each pan, **as directed**.

12. Exposed Metal Edge Moldings and Trim: Provide exposed members as indicated or as required to comply with seismic requirements of authorities having jurisdiction, to conceal edges of and penetrations through ceiling, to conceal edges of pans and runners, for fixture trim and adapters, for fasciae at changes in ceiling height, and for other conditions; of metal and finish matching acoustical metal pan ceiling units, unless otherwise indicated.
    a. For Circular Penetrations of Ceiling: Fabricate edge moldings to diameter required to fit penetration exactly.

F. Direct-Hung, Standard-Grid, Metal Suspension System For Acoustical Metal Pan Ceiling
1. Suspension System: For clip-in **OR** lay-in **OR** torsion-spring, **as directed**, pans.
2. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytic zinc-coated or hot-dip galvanized according to ASTM A 653/A 653M, G30 (Z90) coating designation, with prefinished, cold-rolled, 15/16-inch- (24-mm-) wide sheet metal caps on flanges.
    a. Structural Classification: Intermediate-duty **OR** Heavy-duty, **as directed**, system.
    b. End Condition of Cross Runners: Override (stepped) **OR** Butt-edge, **as directed**, type.
    c. Face Design: Flat, flush.
    d. Cap Material: Steel **OR** Aluminum, **as directed**, cold-rolled sheet.
    e. Cap Finish: Painted white **OR** Painted in color as selected from manufacturer's full range **OR** Painted to match color indicated by manufacturer's designation **OR** Painted to match color of metal pan **OR** Plated with metallic finish, as selected from manufacturer's full range **OR** Plated with metallic finish indicated by manufacturer's designation **OR** Natural finish for aluminum, **as directed**.
3. Narrow-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytic zinc-coated or hot-dip galvanized according to ASTM A 653/653M, G30 (Z90) coating designation, with prefinished, cold-rolled, 9/16-inch- (15-mm-) wide sheet metal caps on flanges.
    a. Structural Classification: Intermediate-duty **OR** Heavy-duty, **as directed**, system.
    b. End Condition of Cross Runners: Override (stepped) **OR** Butt-edge, **as directed**, type.
    c. Face Design: Flat, flush **OR** Flanges formed with an integral center reveal, **as directed**.
    d. Cap Material: Steel **OR** Aluminum, **as directed**, cold-rolled sheet.
    e. Cap Finish: Painted white **OR** Painted in color as selected from manufacturer's full range **OR** Painted to match color indicated by manufacturer's designation **OR** Painted to match color of metal pan **OR** Plated with metallic finish, as selected from manufacturer's full range **OR** Plated with metallic finish indicated by manufacturer's designation **OR** Natural finish for aluminum, **as directed**.
4. Narrow-Face, Uncapped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytic zinc-coated or hot-dip galvanized, to produce structural members with 9/16-inch- (15-mm-) wide faces.
    a. Structural Classification: Intermediate-duty **OR** Heavy-duty, **as directed**, system.
    b. Face Design: With 1/8-inch- (3.2-mm-) wide, slotted, box-shaped flange **OR** With 1/4-inch- (6.35-mm-) wide, slotted, box-shaped flange, **as directed**.
    c. Face Finish: Painted white **OR** in color as selected from manufacturer's full range **OR** to match color indicated by manufacturer's designation **OR** to match color of metal pan, **as directed**.
5. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, hot-dip galvanized according to ASTM A 653/A 653M, G60 (Z180) coating designation, with prefinished, cold-rolled, 15/16-inch- (24-mm-) wide aluminum caps on flanges.
    a. Structural Classification: Intermediate-duty **OR** Heavy-duty, **as directed**, system.
    b. Face Design: Flat, flush.
    c. Face Finish: Painted white **OR** Painted to match color indicated by manufacturer's designation **OR** Painted to match color of acoustical unit **OR** Natural finish, **as directed**.
6. Wide-Face, Capped, Double-Web, Stainless-Steel Suspension System: Main and cross runners roll formed from and capped with Type 304 or 316 stainless-steel sheet, with prefinished, cold-rolled, 15/16-inch- (24-mm-) wide stainless-steel caps on flanges.

a. Structural Classification: Intermediate-duty system.
b. Face Design: Flat, flush.

7. Suspension System for Torsion-Spring Metal Pans: Provide runners with factory-cut slots fabricated to accept torsion-spring attachment.

G. Metal Suspension System For Acoustical Snap-In Metal Pan Ceiling

1. Indirect-Hung, Snap-Tee **OR** Bar, **as directed**, System: Designed to support metal pans that snap into main runners, consisting of main runners connected to carrying channels that are attached by hangers to building structure, and complying with the following requirements:
   a. Main Runners: Formed from the following metal:
      1) Aluminum Sheet: Alloy and temper recommended by aluminum producer and finisher for type of use indicated and manufacturer's standard finish, complying with ASTM B 209 (ASTM B 209M).
      2) Electrolytic Zinc-Coated Steel Sheet: ASTM A 591/A 591M, with not less than 80Z (24G) zinc coating.
      3) Hot-Dip Galvanized Steel: ASTM A 653/A 653M, not less than G60 (Z180) zinc coating.
      4) Stainless-Steel Sheet: ASTM A 666, Type 302 or 304, stretcher leveled, with cold-rolled mill finish.
      5) Metal Sheet: Metal as standard with ceiling system manufacturer with factory-applied protective finish complying with ASTM C 635.
   b. Carrying Channels: Same member and metal as indicated for main runners.
      OR
      Carrying Channels: Cold-rolled steel, not less than 0.060-inch (1.5-mm) nominal thickness of base (uncoated) metal and 7/16-inch- (11-mm-) wide flanges, protected with rust-inhibitive paint **OR** hot-dip galvanized according to ASTM A 653/A 653M, G60 (Z180) coating designation, **as directed**, and as follows:
      1) Depth and Weight: 1-1/2 inches and 475 lb/1000 feet (38 mm and 215 kg/305 m) **OR** 2 inches and 590 lb/1000 feet (51 mm and 268 kg/305 m), **as directed**.
   c. Exterior Bracing Channels and Angles: Cold-rolled steel, hot-dip galvanized to comply with ASTM A 653/A 653M, G60 (Z180) coating designation; size and profile as required to withstand wind load.
2. Direct-Hung, Snap-Tee **OR** Bar, **as directed**, System: Designed to support metal pans that snap into main runners, consisting of main runners supported by hangers attached directly to building structure, and complying with the following requirements:
   a. Hangers: Angles or channels, as standard with ceiling system manufacturer, formed from same metal as main runners.
   b. Main Runners: Rolled aluminum sheet; alloy and temper recommended by aluminum producer and finisher for type of use indicated and manufacturer's standard finish, complying with ASTM B 209 (ASTM B 209M).
3. Access Panels: For access at locations indicated, provide acoustical snap-in metal pan ceiling units, accessible by key or tool **OR** two access knobs; place one access knob at each end of panel near corners, **as directed**.
   a. Access Key or Tool: Provide manufacturer' standard key or tool for opening access panels; one **OR** two, **as directed**.

H. Acoustical Sealant

1. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex sealant, with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
2. Acoustical Sealant for Concealed Joints: Manufacturer's standard nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant, with a VOC content of 250 g/L or

less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), recommended for sealing interior concealed joints to reduce airborne sound transmission.

I. General Finish Requirements
   1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
      a. High-Humidity Finish: Comply with ASTM C 635 requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.
   2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
   3. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

J. Aluminum Finishes
   1. Mill Finish: AA-M10C10 (Mechanical Finish: as fabricated, unspecified; Chemical Finish: chemically cleaned).
   2. Lacquered Mill Finish: AA-M10C10R1x (Mechanical Finish: as fabricated, unspecified; Chemical Finish: chemically cleaned; Organic Coating: as specified below).
      a. Organic Coating: Manufacturer's standard clear organic coating.
   3. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
   4. Clear Mirror Anodic Finish: AA-M21C12A212, 0.005 mm or thicker.
   5. Color-Coated Finish: Manufacturer's standard powder-coat, **as directed**, baked paint complying with coating manufacturer's written instructions for surface preparation, pretreatment, application, baking, and minimum dry film thickness.
   6. Bright-Reflective Finish: Manufacturer's standard chemical/mechanical bright-reflective metallic finish complying with finish manufacturer's written instructions for surface preparation, pretreatment, process, protective coating, and minimum thickness to produce a finish uniform in appearance and free of blisters, pits, roughness, nodules, burning, cracks, unfinished areas, and other visible defects.

K. Galvanized-Steel Sheet Finishes
   1. Color-Coated Finish: Manufacturer's standard powder-coat, **as directed**, baked paint complying with coating manufacturer's written instructions for surface preparation, pretreatment, application, baking, and minimum dry film thickness.

L. Steel Sheet Finishes
   1. Electroplated Finish: Electroplating process complying with finish manufacturer's written instructions for surface preparation, pretreatment, process, and minimum thickness to produce a coating uniform in appearance and free of blisters, pits, roughness, nodules, burning, cracks, unplated areas, and other visible defects.
   2. Bright-Reflective Finish: Manufacturer's standard chemical/mechanical bright-reflective metallic finish complying with finish manufacturer's written instructions for surface preparation, pretreatment, process, protective coating, and minimum thickness to produce a finish uniform in appearance and free of blisters, pits, roughness, nodules, burning, cracks, unfinished areas, and other visible defects.

M. Stainless-Steel Finishes
   1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
   2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
      a. Run grain of directional finishes with long dimension of each piece.
      b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

1.3 EXECUTION

A. Preparation
1. Measure each ceiling area and establish layout of acoustical metal pans to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width pans at borders, and comply with layout shown on reflected ceiling plans and Coordination Drawings.

B. Installation
1. Install acoustical metal pan ceilings to comply with ASTM C 636 **OR** UBC Standard 25-2, **as directed**, and seismic requirements indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
2. Suspend ceiling hangers from building's structural members and as follows:
   a. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
   b. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
   c. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
   d. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
      OR
      Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both structure to which hangers are attached and type of hanger involved.
   e. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
   f. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
   g. Do not attach hangers to steel deck tabs.
   h. Do not attach hangers to steel roof deck. Attach hangers to structural members.
   i. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.
   j. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
3. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
4. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical metal pans.
   a. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
   b. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.2 mm in 3.6 m). Miter corners accurately and connect securely.
   c. Do not use exposed fasteners, including pop rivets, on moldings and trim.
5. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

6. Cut acoustical metal pan units for accurate fit at borders and at interruptions and penetrations by other work through ceilings. Stiffen edges of cut units as required to eliminate evidence of buckling or variations in flatness exceeding referenced standards for stretcher-leveled metal sheet.
7. Install acoustical metal pans in coordination with suspension system and exposed moldings and trim.
   a. For lay-in square-edge pans, install pans with edges fully hidden from view by flanges of suspension system runners and moldings.
   b. For lay-in reveal-edge pans on suspension system runners, install pans with bottom of reveal in firm contact with top surface of runner flanges.
   c. For lay-in reveal-edge pans on suspension system members with box-shaped flanges, install pans with reveal surfaces in firm contact with suspension system surfaces and panel faces flush with bottom face of runners.
   d. For clip-in **OR** torsion-spring-hinged, **as directed**, pans, position pans according to manufacturer's written instructions.
   e. For snap-in pans, fit adjoining units to form flush, tight joints.
   f. Align joints in adjacent courses to form uniform, straight joints parallel to room axis in both directions unless otherwise indicated.
   g. Fit adjoining units to form flush, tight joints.
   h. Install directionally patterned or textured metal pans in directions indicated.
   i. Install sound-absorbent fabric layers in perforated metal pans.
   j. Install sound-absorbent pads in perforated metal pans over metal spacer grids, **as directed**.
8. Install sound attenuation panels in areas indicated by reflected ceiling plans or room finish schedules. Lay panels directly on ceiling system and close major openings to form complete coverage in required areas. Lay second sound-absorbent pads on sound attenuation panels.
9. Install hold-down clips where indicated.

C. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Tests and Inspections: Testing and inspecting of completed installations of acoustical panel ceiling hangers and anchors and fasteners shall take place in successive stages, in areas of extent and using methods as follows. Do not proceed with installations of acoustical panel ceiling hangers for the next area until test results for previously completed installations of acoustical panel ceiling hangers show compliance with requirements.
   a. Extent of Each Test Area: When installation of ceiling suspension systems on each floor has reached 20 percent completion but no panels have been installed.
      1) Within each test area, testing agency will select 1 of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for 200 lbf (890 N) of tension; it will also select one of every 2 postinstalled anchors used to attach bracing wires to concrete and will test them for 440 lbf (1957 N) of tension.
      2) When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.
3. Acoustical panel ceiling hangers and anchors and fasteners will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.

D. Cleaning
1. Clean exposed surfaces of acoustical metal pan ceilings, including trim and edge moldings after removing strippable, temporary protective covering, if any. Comply with manufacturer's written instructions for stripping of temporary protective covering, cleaning, and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage, including dented and bent units.

END OF SECTION 09513

SECTION 09620 - FLUID-APPLIED ATHLETIC FLOORING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for fluid-applied sports flooring. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes polyurethane flooring that is fluid applied directly on substrates or over base mats.

C. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Show installation details for flooring including layout, colors, widths, and dimensions of game lines and markers and locations of athletic equipment floor inserts.
3. Samples: For each color, gloss, and texture of flooring required, 12 inches (305 mm) square, applied to a rigid backing. Include sample sets showing the game-line paint and marker paint colors applied to the flooring.
4. Qualification Data: For Installer.
5. Maintenance Data: For fluid-applied sports flooring to include in maintenance manuals.

D. Quality Assurance
1. Installer Qualifications: An installer (applicator) who is approved, trained, or certified by fluid-applied sports flooring manufacturer.
2. Game Lines and Markers: Comply with requirements of National Collegiate Athletic Association (NCAA) **OR** National Federation of State High School Associations, **as directed,** for sports activities indicated.

E. Project Conditions
1. Environmental Limitations: Comply with flooring manufacturer's written instructions for substrate temperature, ambient temperature, humidity, ventilation, and other conditions affecting flooring application.
   a. Do not apply flooring until spaces are enclosed and weatherproof; wet work in spaces is complete and dry; and overhead work, including installing mechanical systems, lighting, and athletic equipment, is complete.
2. Conditioning Period: Begins not less than seven days before flooring application, is continuous through application, and continues not less than three days after application.
   a. During conditioning period, maintain an ambient temperature between 65 and 75 deg F (18 and 24 deg C) and not more than 50 percent relative humidity in spaces to receive flooring.
   b. After conditioning period, maintain relative humidity and ambient temperature planned for building occupants.

1.2 PRODUCTS

A. Fluid-Applied Sports Flooring
1. Direct-Applied Flooring:
   a. Primer: Manufacturer's primer recommended for substrate indicated.
   b. Body Coat(s): Two-component, self-leveling, pigmented, polyurethane containing no rubber fillers and no mercury.
   c. Topcoat (Finish Coat): Manufacturer's standard pigmented polyurethane.

1) Color: As selected from manufacturer's full range.
2) Surface Texture: Smooth.

2. Flooring Applied over Base Mats:
   a. Resilient Base Mat: Manufacturer's standard base mats of granulated recycled rubber in polyurethane binder.
      1) Thickness: 5/32 inch (4 mm) **OR** 1/4 inch (6 mm) **OR** 9/32 inch (7 mm) **OR** 11/32 inch (9 mm) **OR** 15/32 inch (12 mm), **as directed**.
   b. Base-Mat Adhesive: Manufacturer's standard two-component polyurethane.
   c. Base-Mat Sealer: Manufacturer's standard two-component polyurethane compound formulated for sealing base mat.
   d. Body Coat(s): Two-component, self-leveling, pigmented, polyurethane containing no rubber fillers and no mercury.
   e. Topcoat (Finish Coat): Manufacturer's standard pigmented polyurethane.
      1) Color: As selected from manufacturer's full range.
      2) Surface Texture: Smooth.

B. Accessories
1. Game-Line and Marker Paint: Manufacturer's standard two-component polyurethane.
   a. Colors: As selected **OR** As required to comply with game-line and marker requirements of sports association indicated, **as directed**.

1.3 EXECUTION

A. Preparation
1. Concrete Substrates: Prepare and clean substrates according to manufacturer's written instructions.
   a. Remove laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants that might impair flooring bond. Remove contaminants using mechanical means.
   b. Treat nonmoving substrate cracks and control joints to prevent cracks from telegraphing (reflecting) through flooring according to manufacturer's written recommendations.
   c. Protect substrate voids and joints to prevent flooring resins from flowing into or leaking through them.
2. Protect walls, floor openings, athletic equipment inserts, electrical openings, door frames, and other obstructions during installation. Cover floor and wall areas at mixing stations.

B. Application
1. General: Mix and apply flooring components according to manufacturer's written instructions.
   a. At substrate expansion, isolation, and other moving joints, install continuous joint of same width through flooring.
2. Direct-Applied Flooring:
   a. Apply primer over prepared substrate at manufacturer's recommended spreading rate.
   b. Apply body coat(s) and topcoat to produce a uniform, level surface and finish.
3. Flooring Applied over Base Mats:
   a. Adhesively apply resilient base mats to substrate according to manufacturer's written instructions.
      1) Base mats must not be in compression. Leave gap of width recommended in writing by manufacturer at butted base-mat sheets, walls, floor openings, athletic equipment inserts, electrical openings, door frames, and other obstructions.
      2) Roll base mats to set them into adhesive and eliminate air pockets.
      3) Repair ridges at seams, loose areas, and air pockets according to manufacturer's written instructions.
   b. Apply seal coat to base mats before applying body coat(s).
   c. Smooth ridges and high spots in seal coat before applying elastomeric resin.

d. Apply elastomeric resin and topcoat to produce a uniform surface and finish.

C. Game Lines And Markers
1. Mask flooring surfaces at game lines and markers, and apply paint to produce sharp edges.
a. Where game lines cross, break minor game line at intersection; do not overlap lines.
b. Apply game lines and markers in widths and colors according to requirements indicated on Drawings **OR** sports association indicated, **as directed**.

D. Protection
1. Protect fluid-applied sports flooring during remainder of construction period to allow it to cure and to ensure that flooring and finish are without damage or deterioration at the time of Substantial Completion.

END OF SECTION 09620

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SECTION 09620a - TACTILE/DETECTABLE WARNING TILE

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for tactile/detectable warning tile. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product data for each specified product.
2. Shop drawings, showing detailed plans of tile profile, fastener locations, and installation methods
3. Two (2) tile samples, minimum size 6" x 8" of the kind proposed for use.
4. Material Test Reports: Submit test reports from qualified independent testing laboratory indicating that materials proposed for use are in compliance with requirements and meet the properties indicated. All test reports shall be conducted on a cast-in-place tactile panel system as certified by a qualified independent testing laboratory.
5. Maintenance Instructions: Submit copies of manufacturer's specified maintenance practices for each type of tactile tile and accessory as required.

C. Quality Control
1. Americans with Disabilities Act (ADA): Provide tactile warning surfaces, which comply with the detectable warnings on walking surfaces, section of the Americans with Disabilities Act (Title 49 CFR TRANSPORTATION, PART 37.9 STANDARDS FOR ACCESSIBLE TRANSPORTATION FACILITIES, Appendix A, Section 4.29.2 DETECTABLE WARNINGS ON WALKING SURFACES.
2. California Code of Regulations (CCR): Provide only approved DSAAC detectable warning products as provided in the California Code of Regulations (CCR). Title 24, Part 1, Articles 2, 3 and 4 and Part 2, Section 205 definition of "Detectable Warning". Section 1127B.5 for "Curb Ramps" and Section 1133B.8.5 for "Detectable Warnings at Hazardous Vehicle Area's".
3. Performance: Tiles shall meet or exceed the following criteria:
   a. Water Absorption: 0.35% maximum, when tested in accordance with ASTM D570.
   b. Slip Resistance: 0.90 minimum combined wet/ dry static coefficient of friction on top of domes and field area, when tested in accordance with ASTM C1028.
   c. Compressive Strength: 18,000 psi minimum, when tested in accordance with ASTM D695.
   d. Tensile Strength: 10,000 psi minimum, when tested in accordance with ASTM D638.
   e. Flexural Strength: 24,000 psi minimum, when tested in accordance with ASTM C293.
   f. Gardner Impact: 450 inch-pounds per inch minimum, when tested in accordance with Geometry "GE" of ASTM D5420.
   g. Chemical Stain Resistance: No reaction to 1% hydrochloric acid, urine, calcium chloride, stamp pad ink, gum and red aerosol paint, when tested in accordance with ASTM D543.
   h. Wear Depth: 0.03" maximum, after 1000 abrasion cycles of 40 grit Norton Metallite sandpaper, when tested in accordance with ASTM D2486-Modified.
   i. Flame Spread: 25 maximum, when tested in accordance with ASTM E84.
   j. Accelerated Weathering: No deterioration, fading or chalking for 2000 hours, when tested in accordance with ASTM D2565.
4. Tactile warning tiles embedded in or adhered to concrete shall meet or exceed the following performance criteria:
   a. Accelerated Aging and Freeze Thaw of Adhesive System: No cracking, delamination, warping, checking, blistering, color change, loosening, etc. when tested in accordance with ASTM D1037.
   b. Salt and Spray Performance: No deterioration after 100 hours of exposure, when tested in accordance with ASTM B117.

D. Delivery, Storage And Handling
   1. Tiles shall be suitably packaged or crated to prevent damage in shipment or handling. Finished surfaces shall be protected by sturdy wrappings, and tile type shall be identified by part number.
   2. Tiles shall be delivered to location at building site for storage prior to installation.

E. Warranty
   1. Installed tiles shall be warranted for a minimum of five (5) years against failure of adhesives, fasteners and sealants.

1.2 PRODUCT

A. Materials
   1. Vitrified Polymer Composite (VPC) tiles shall be an epoxy polymer composition with an ultra violet stabilized coating employing aluminum oxide particles in the truncated domes. The tile shall incorporate an in-line dome pattern of truncated domes. For wheelchair safety the field area shall consist of a non-slip surface with a minimum of 40 - 90º raised points 0.045" high, per square inch.
   2. Color: Safety Yellow, (Federal Color # 33538) colorfast, UV stabilized coating. Color shall be homogeneous throughout the tile.

B. Cast-In-Place Tactile Tile
   1. Tile shall be minimum 1-3/8" thick, with minimum 3/8" thick face and ribs designed for after-pour embedment in concrete.

C. Surface Applied Detectable Warning Surface Tile
   1. The tile shall have with countersunk fastening holes and perimeter beveled edges.
   2. Accessories:
      a. Fasteners: Color matched, corrosion resistant, flat head drive anchor, 1/4" diameter x 1-3/4" long.
      b. Adhesive: Urethane elastomeric adhesive.
      c. Sealants: Epoxy two component sealant.

D. Modular Paver Tactile Tile
   1. Pre-cast with a 1-3/8" thick reinforced epoxy polymer concrete core.
      a. Polymer Concrete and/or epoxy resin properties shall meet or exceed the following criteria:

Tensile Strength of Resin:	greater than 7,000psi; ASTM D638
Modulus of Elasticity of Resin:	greater than 4,000psi; ASTM D638
Bond Strength of Polymeric Concrete:	greater than 8,000psi; ASTM C551

   2. Accessories:
      a. Adhesive: Urethane elastomeric adhesive.
      b. Backer Rod: ASTM C 1330, Type C (closed-cell material with a surface skin) **OR** Type O (open-cell material) **OR** Type B (bicellular material with a surface skin), **as directed**, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance

E. Surface Applied Detectable Guidance Tiles
   1. Accessories:
      a. Adhesive: Heavy-duty polyurethane elastomeric adhesive.
      b. Sealants: Heavy-duty polyurethane elastomeric sealant.

F. Surface Applied Detectable Directional Bar Tiles
   1. Accessories:
      a. Fasteners: Stainless steel low profile expansion anchors, 3/16" diameter by 2" long.

b. Adhesive: Heavy-duty polyurethane elastomeric adhesive.
c. Sealants: Heavy-duty polyurethane elastomeric sealant.

1.3 EXECUTION

A. Installation
1. Installation shall be in strict compliance with manufacturer's printed instructions.

END OF SECTION 09620a

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SECTION 09620b - RESILIENT FLOOR TILE

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for resilient floor tile. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Solid vinyl floor tile.
b. Rubber floor tile.
c. Vinyl composition floor tile.
d. Resilient terrazzo floor tile.

C. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
a. Product Data for Credit EQ 4.1: For adhesives, sealants and chemical-bonding compounds, including printed statement of VOC content.
3. Shop Drawings: For each type of floor tile. Include floor tile layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
a. Show details of special patterns.
4. Samples: Full-size units of each color and pattern of floor tile required.
5. Seam Samples: For seamless-installation technique indicated and for each flooring product, color, and pattern required; with seam running lengthwise and in center of 6-by-9-inch (150-by-230-mm) Sample applied to a rigid backing and prepared by Installer for this Project.
6. Maintenance data.

D. Quality Assurance
1. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
a. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

E. Delivery, Storage, And Handling
1. Store floor tile and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C). Store floor tiles on flat surfaces.

F. Project Conditions
1. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 95 deg F (35 deg C), in spaces to receive floor tile during the following time periods:
a. 48 hours before installation.
b. During installation.
c. 48 hours after installation.
2. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).
3. Close spaces to traffic during floor tile installation.
4. Close spaces to traffic for 48 hours after floor tile installation.
5. Install floor tile after other finishing operations, including painting, have been completed.

1.2 PRODUCTS

A. Solid Vinyl Floor Tile
1. Tile Standard: ASTM F 1700.
a. Class: As indicated by product designations **OR** Class I, monolithic vinyl tile **OR** Class II, surface-decorated vinyl tile **OR** Class III, printed film vinyl tile, **as directed**.
b. Type: Type A, smooth surface **OR** Type B, embossed surface, **as directed**.
2. Thickness: 0.080 inch (2.0 mm) **OR** 0.100 inch (2.5 mm) **OR** 0.120 inch (3.0 mm) **OR** 0.125 inch (3.2 mm), **as directed**.
3. Size: 12 by 12 inches (305 by 305 mm) **OR** 18 by 18 inches (457 by 457 mm) **OR** 24 by 24 inches (610 by 610 mm) **OR** 36 by 36 inches (914 by 914 mm) **OR** 3 by 36 inches (76 by 914 mm), **as directed**.
4. Seaming Method: Heat welded **OR** Chemically bonded **OR** Standard, **as directed**.
5. Colors and Patterns: As selected from full range of industry colors.

B. Rubber Floor Tile
1. Tile Standard: ASTM F 1344, Class I-A, homogeneous rubber tile, solid color **OR** Class I-B, homogeneous rubber tile, through mottled **OR** Class II-A, laminated rubber tile, solid-color wear layer **OR** Class II-B, laminated rubber tile, mottled wear layer, **as directed**.
2. Hardness: Not less than 85 as required by ASTM F 1344, measured using Shore, Type A durometer per ASTM D 2240 **OR** Manufacturer's standard hardness, **as directed**.
3. Wearing Surface: Smooth **OR** Textured **OR** Molded pattern, **as directed**.
a. Molded-Pattern Figure: Raised discs **OR** Raised squares, **as directed**.
4. Thickness: 0.125 inch (3.2 mm).
5. Size: 12 by 12 inches (305 by 305 mm) **OR** 24 by 24 inches (610 by 610 mm), **as directed**.
6. Seaming Method: Heat welded **OR** Chemically bonded **OR** Standard, **as directed**.
7. Colors and Patterns: As selected from full range of industry colors.

C. Vinyl Composition Floor Tile
1. Tile Standard: ASTM F 1066, Class 1, solid-color tile **OR** Class 2, through-pattern tile **OR** Class 3, surface-pattern tile, **as directed**.
2. Wearing Surface: Smooth **OR** Embossed, **as directed**.
3. Thickness: 0.125 inch (3.2 mm).
4. Size: 12 by 12 inches (305 by 305 mm).
5. Colors and Patterns: As selected from full range of industry colors.

D. Resilient Terrazzo Floor Tile
1. Resilient Terrazzo Floor Tile: Marble or granite chips embedded in flexible, thermoset-polyester-resin matrix; electrically nonconductive and chemical, oil, and corrosion resistive, with smooth wearing surface and manufacturer's standard factory-applied, protective urethane coating.
2. Thickness: 1/8 inch (3.0 mm) **OR** 3/16 inch (4.8 mm), **as directed**.
3. Size: 12 by 12 inches (305 by 305 mm).
4. Performance Characteristics:
a. Compressive Strength: 2900 to 5000 psi (20 to 34.5 MPa), ASTM C 109/C 109M or ASTM D 695.
b. Abrasion Resistance: Maximum 0.0196 cubic centimeters volume loss, ASTM F 510, Taber abrader, S-39 wheels, at 500 cycles with 1000-gram load.
c. Static Load Limit: 0.0007-inch (0.0177-mm) maximum indentation, ASTM F 970 at 125 lb (57 kg).
d. Resin Matrix Hardness: Not less than 78, as measured using Shore, Type D durometer per ASTM D 2240.
5. Colors and Patterns: As selected from full range of industry colors.

E. Installation Materials

1. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
2. Adhesives: Water-resistant type recommended by manufacturer to suit floor tile and substrate conditions indicated.
   a. Use adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
      1) VCT and Asphalt Tile Adhesives: Not more than 50 g/L.
      2) Rubber Floor Adhesives: Not more than 60 g/L.
3. Seamless-Installation Accessories:
   a. Heat-Welding Bead: Manufacturer's solid-strand product for heat welding seams.
      1) Color: As selected from manufacturer's full range to contrast with floor tile **OR** Match floor tile, **as directed**.
   b. Chemical-Bonding Compound: Manufacturer's product for chemically bonding seams.
      1) Use chemical-bonding compound that has a VOC content of 350 **OR** 510, **as directed**, g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
4. Floor Polish: Provide protective liquid floor polish products as recommended by manufacturer.
5. Joint Sealant for Resilient Terrazzo Floor Tile: Silicone sealant of type and grade as recommended in writing by manufacturer to suit resilient terrazzo floor tile.
   a. Use sealant that has a VOC content of not more than 250 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   b. Joint-Sealant Color: White **OR** As selected from manufacturer's full range to match floor tile **OR** Match floor tile, **as directed**.
6. Sealers and Finish Coats for Resilient Terrazzo Floor Tile: Premium-type products as recommended by manufacturer for resilient terrazzo floor tile.

1.3 EXECUTION

A. Preparation
   1. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
   2. Concrete Substrates: Prepare according to ASTM F 710.
      a. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
      b. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
      c. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
      d. Moisture Testing: Perform tests recommended by manufacturer and as follows. Proceed with installation only after substrates pass testing.
         1) Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
         2) Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75% relative humidity level measurement.
   3. Access Flooring Panels: Remove protective film of oil or other coating using method recommended by access flooring manufacturer.
   4. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.
   5. Do not install floor tiles until they are same temperature as space where they are to be installed.
      a. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.

6. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

B. Floor Tile Installation
1. Comply with manufacturer's written instructions for installing floor tile.
2. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
   a. Lay tiles square with room axis **OR** at a 45-degree angle with room axis **OR** in pattern indicated, **as directed**.
3. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.
   a. Lay tiles with grain running in one direction **OR** with grain direction alternating in adjacent tiles (basket-weave pattern) **OR** in pattern of colors and sizes indicated, **as directed**.
4. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
5. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
6. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent, nonstaining marking device.
7. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in finished floor areas. Maintain overall continuity of color and pattern between pieces of tile installed on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.
8. Adhere floor tiles to flooring substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
9. Seamless Installation:
   a. Heat-Welded Seams: Comply with ASTM F 1516. Rout joints and heat weld with welding bead to permanently fuse sections into a seamless floor covering. Prepare, weld, and finish seams to produce surfaces flush with adjoining floor covering surfaces.
   b. Chemically Bonded Seams: Bond seams with chemical-bonding compound to permanently fuse sections into a seamless floor covering. Prepare seams and apply compound to produce tightly fitted seams without gaps, overlays, or excess bonding compound on floor covering surfaces.

C. Cleaning And Protection
1. Comply with manufacturer's written instructions for cleaning and protection of floor tile.
2. Perform the following operations immediately after completing floor tile installation:
   a. Remove adhesive and other blemishes from exposed surfaces.
   b. Sweep and vacuum surfaces thoroughly.
   c. Damp-mop surfaces to remove marks and soil.
3. Protect floor tile products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
4. Floor Polish: Remove soil, visible adhesive, and surface blemishes from floor tile surfaces before applying liquid floor polish.
   a. Apply one **OR** two **OR** three, **as directed**, coat(s).
5. Joint Sealant: Apply sealant to resilient terrazzo floor tile perimeter and around columns, at door frames, and at other joints and penetrations.
6. Sealers and Finish Coats: Remove soil, visible adhesive, and surface blemishes from resilient terrazzo floor tile surfaces before applying liquid cleaners, sealers, and finish products.
   a. Sealer: Apply two base coats of liquid sealer.
   b. Finish: Apply two **OR** three, **as directed**, coats of liquid floor finish.

7. Cover floor tile until Substantial Completion.

END OF SECTION 09620b

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SECTION 09620c - RESINOUS FLOORING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for resinous flooring. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Decorative resinous flooring systems.
b. Industrial resinous flooring systems.
c. High-performance resinous flooring systems.

C. Submittals
1. Product Data: For each type of product indicated. Include manufacturer's technical data, application instructions, and recommendations for each resinous flooring component required.
2. LEED Submittal:
a. Product Data for Credit EQ 4.2: For resinous flooring systems, documentation including printed statement of VOC content and chemical components.
3. Samples: For each resinous flooring system required, 6 inches (150 mm) square, applied to a rigid backing by Installer for this Project.
4. Product Schedule: For resinous flooring. Use same designations indicated on Drawings.
5. Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.
6. Material Certificates: For each resinous flooring component, from manufacturer.
7. Material Test Reports: For each resinous flooring system.
8. Maintenance Data: For resinous flooring to include in maintenance manuals.

D. Quality Assurance
1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of flooring systems required for this Project.
a. Engage an installer who is certified in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.
2. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, from single source from single manufacturer. Provide secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from source recommended by manufacturer of primary materials.
3. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
1. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.

F. Project Conditions
1. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring application.
2. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring application.

3. Close spaces to traffic during resinous flooring application and for not less than 24 hours after application unless manufacturer recommends a longer period.

1.2 PRODUCTS

A. Materials
1. VOC Content of Resinous Flooring: Provide resinous flooring systems, for use inside the weatherproofing system, that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
a. Resinous Flooring: 100 g/L.

B. Decorative Resinous Flooring
1. Resinous Flooring: Abrasion-, impact- and chemical-resistant, decorative-aggregate-filled, epoxy-resin-based, monolithic floor surfacing designed to produce a seamless floor and integral cove base, **as directed**.
2. System Characteristics:
a. Color and Pattern: As selected from manufacturer's full range **OR** As indicated by product designation, **as directed**.
b. Wearing Surface: Textured for slip resistance **OR** Orange-peel texture **OR** Smooth **OR** Manufacturer's standard wearing surface, **as directed**.
c. Overall System Thickness: 1/16 inch (1.6 mm) **OR** 1/8 inch (3.2 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/4 inch (6.4 mm), **as directed**.
d. Federal Agency Approvals: USDA **OR** FDA, **as directed**, approved for food-processing environments.
3. Body Coats:
a. Resin: Epoxy.
b. Formulation Description: 100 percent solids **OR** High solids **OR** Water based, **as directed**.
c. Application Method: Self-leveling slurry with broadcast aggregates **OR** Self-leveling slurry **OR** Troweled or screeded, **as directed**.
1) Thickness of Coats: 1/16 inch (1.6 mm) **OR** 1/8 inch (3.2 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/4 inch (6.4 mm), **as directed**.
2) Number of Coats: One **OR** Two, **as directed**.
d. Aggregates: Manufacturer's standard **OR** Colored quartz (ceramic-coated silica) **OR** Vinyl flakes **OR** Granite **OR** Natural silica, **as directed**.
4. Topcoat: Sealing or finish coats.
a. Resin: Epoxy **OR** Urethane **OR** Vinyl ester, **as directed**.
b. Formulation Description: 100 percent solids **OR** High solids **OR** Water based, **as directed**.
c. Type: Clear **OR** Pigmented, **as directed**.
d. Finish: Matte **OR** Gloss, **as directed**.
e. Number of Coats: One **OR** Two, **as directed**.
5. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:
a. Compressive Strength: per ASTM C 579.
b. Tensile Strength: per ASTM C 307.
c. Flexural Modulus of Elasticity: per ASTM C 580.
d. Water Absorption: per ASTM C 413.
e. Coefficient of Thermal Expansion: per ASTM C 531.
f. Indentation: per MIL-D-3134.
g. Impact Resistance: No chipping, cracking, or delamination and not more than 1/16-inch (1.6-mm) permanent indentation per MIL-D-3134.
h. Resistance to Elevated Temperature: No slip or flow of more than 1/16 inch (1.6 mm) per MIL-D-3134.
i. Abrasion Resistance: maximum weight loss per ASTM D 4060.
j. Flammability: Self-extinguishing per ASTM D 635.

k. Critical Radiant Flux: 0.45 W/sq. cm **OR** 0.22 W/sq. cm, **as directed**, or greater per NFPA 253.
l. Hardness: Shore D per ASTM D 2240.
m. Bond Strength: 100 percent concrete failure per ACI 503R.

6. System Chemical Resistance: Test specimens of cured resinous flooring system are unaffected when tested according to ASTM D 1308 for 50 percent immersion **OR** ASTM D 543, Procedure A, for immersion **OR** ASTM C 267 for immersion, **as directed**, in reagents **as directed** for no fewer than seven days:

C. Industrial Resinous Flooring
1. Resinous Flooring: Abrasion-, impact- and chemical-resistant, industrial-aggregate-filled, resin-based, monolithic floor surfacing designed to produce a seamless floor and integral cove base, **as directed**.
2. System Characteristics:
a. Color and Pattern: As selected from manufacturer's full range **OR** As indicated by product designation, **as directed**.
b. Wearing Surface: Textured for slip resistance **OR** Orange-peel texture **OR** Smooth **OR** Manufacturer's standard wearing surface, **as directed**.
c. Overall System Thickness: 1/16 inch (1.6 mm) **OR** 1/8 inch (3.2 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/4 inch (6.4 mm), **as directed**.
d. Federal Agency Approvals: USDA **OR** FDA, **as directed**, approved for food-processing environments.
3. Body Coats:
a. Resin: Epoxy **OR** Urethane **OR** Vinyl ester, **as directed**.
b. Formulation Description: 100 percent solids **OR** High solids **OR** Water based, **as directed**.
c. Application Method: Self-leveling slurry with broadcast aggregates **OR** Self-leveling slurry **OR** Troweled or screeded, **as directed**.
1) Thickness of Coats: 1/16 inch (1.6 mm) **OR** 1/8 inch (3.2 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/4 inch (6.4 mm), **as directed**.
2) Number of Coats: One **OR** Two, **as directed**.
d. Aggregates: Manufacturer's standard **OR** Colored quartz (ceramic-coated silica) **OR** Vinyl flakes **OR** Granite **OR** Natural silica, **as directed**.
4. Topcoat: Sealing or finish coats.
a. Resin: Epoxy **OR** Urethane **OR** Vinyl ester, **as directed**.
b. Formulation Description: 100 percent solids **OR** High solids **OR** Water based, **as directed**.
c. Type: Clear **OR** Pigmented, **as directed**.
d. Finish: Matte **OR** Gloss, **as directed**.
e. Number of Coats: One **OR** Two, **as directed**.
5. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:
a. Compressive Strength: per ASTM C 579.
b. Tensile Strength: per ASTM C 307.
c. Flexural Modulus of Elasticity: per ASTM C 580.
d. Water Absorption: per ASTM C 413.
e. Coefficient of Thermal Expansion: per ASTM C 531.
f. Indentation: percent maximum per MIL-D-3134.
g. Impact Resistance: No chipping, cracking, or delamination and not more than 1/16-inch (1.6-mm) permanent indentation per MIL-D-3134.
h. Resistance to Elevated Temperature: No slip or flow of more than 1/16 inch (1.6 mm) per MIL-D-3134.
i. Abrasion Resistance: maximum weight loss per ASTM D 4060.
j. Flammability: Self-extinguishing per ASTM D 635.
k. Critical Radiant Flux: 0.45 W/sq. cm **OR** 0.22 W/sq. cm, **as directed**, or greater per NFPA 253.
l. Hardness: Shore D per ASTM D 2240.
m. Bond Strength: 100 percent concrete failure per ACI 503R.

6. System Chemical Resistance: Test specimens of cured resinous flooring system are unaffected when tested according to ASTM D 1308 for 50 percent immersion **OR** ASTM D 543, Procedure A, for immersion **OR** ASTM C 267 for immersion, **as directed**, in reagents **as directed** for no fewer than seven days:

D. High-Performance Resinous Flooring
   1. Resinous Flooring: Abrasion-, impact- and chemical-resistant, high-performance-aggregate-filled, resin-based, monolithic floor surfacing designed to produce a seamless floor and integral cove base, **as directed**.
   2. System Characteristics:
      a. Color and Pattern: As selected from manufacturer's full range **OR** As indicated by product designation, **as directed**.
      b. Wearing Surface: Textured for slip resistance **OR** Orange-peel texture **OR** Smooth **OR** Manufacturer's standard wearing surface, **as directed**.
      c. Overall System Thickness: 1/16 inch (1.6 mm) **OR** 1/8 inch (3.2 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/4 inch (6.4 mm), **as directed**.
      d. Federal Agency Approvals: USDA **OR** FDA, **as directed**, approved for food-processing environments.
   3. Body Coats:
      a. Resin: Epoxy **OR** Epoxy novolac **OR** Urethane **OR** Vinyl ester **OR** Methyl methacrylate, **as directed**.
      b. Formulation Description: 100 percent solids **OR** High solids **OR** Water based, **as directed**.
      c. Application Method: Self-leveling slurry with broadcast aggregates **OR** Self-leveling slurry **OR** Troweled or screeded, **as directed**.
         1) Thickness of Coats: 1/16 inch (1.6 mm) **OR** 1/8 inch (3.2 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/4 inch (6.4 mm), **as directed**.
         2) Number of Coats: One **OR** Two, **as directed**.
      d. Aggregates: Manufacturer's standard **OR** Colored quartz (ceramic-coated silica) **OR** Vinyl flakes **OR** Granite **OR** Natural silica, **as directed**.
   4. Topcoat: Sealing or finish coats.
      a. Resin: Epoxy **OR** Epoxy novolac **OR** Urethane **OR** Vinyl ester **OR** Methyl methacrylate, **as directed**.
      b. Formulation Description: 100 percent solids **OR** High solids **OR** Water based, **as directed**.
      c. Type: Clear **OR** Pigmented, **as directed**.
      d. Finish: Matte **OR** Gloss, **as directed**.
      e. Number of Coats: One **OR** Two, **as directed**.
   5. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:
      a. Compressive Strength: per ASTM C 579.
      b. Tensile Strength: per ASTM C 307.
      c. Flexural Modulus of Elasticity: per ASTM C 580.
      d. Water Absorption: per ASTM C 413.
      e. Coefficient of Thermal Expansion: per ASTM C 531.
      f. Indentation: percent maximum per MIL-D-3134.
      g. Impact Resistance: No chipping, cracking, or delamination and not more than 1/16-inch (1.6-mm) permanent indentation per MIL-D-3134.
      h. Resistance to Elevated Temperature: No slip or flow of more than 1/16 inch (1.6 mm) per MIL-D-3134.
      i. Abrasion Resistancemaximum weight loss per ASTM D 4060.
      j. Flammability: Self-extinguishing per ASTM D 635.
      k. Critical Radiant Flux: 0.45 W/sq. cm **OR** 0.22 W/sq. cm, **as directed**, or greater per NFPA 253.
      l. Hardness: Shore D per ASTM D 2240.
      m. Bond Strength: 100 percent concrete failure per ACI 503R.

6. System Chemical Resistance: Test specimens of cured resinous flooring system are unaffected when tested according to ASTM D 1308 for 50 percent immersion **OR** ASTM D 543, Procedure A, for immersion **OR** ASTM C 267 for immersion, **as directed**, in reagents **as directed** for no fewer than seven days:

E. Accessories
1. Primer: Type recommended by manufacturer for substrate and body coats indicated.
   a. Formulation Description: 100 percent solids **OR** High solids **OR** Water based, **as directed**.
2. Waterproofing Membrane: Type recommended by manufacturer for substrate and primer and body coats indicated.
   a. Formulation Description: 100 percent solids **OR** High solids, **as directed**.
3. Reinforcing Membrane: Flexible resin formulation that is recommended by manufacturer for substrate and primer and body coats indicated and that prevents substrate cracks from reflecting through resinous flooring.
   a. Formulation Description: 100 percent solids **OR** High solids, **as directed**.
      1) Provide fiberglass scrim embedded in reinforcing membrane.
4. Patching and Fill Material: Resinous product of or approved by resinous flooring manufacturer and recommended by manufacturer for application indicated.

1.3 EXECUTION

A. Preparation
1. General: Prepare and clean substrates according to resinous flooring manufacturer's written instructions for substrate indicated. Provide clean, dry substrate for resinous flooring application.
2. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring.
   a. Roughen concrete substrates as follows:
      1) Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
      OR
      Comply with ASTM C 811 requirements unless manufacturer's written instructions are more stringent.
   b. Repair damaged and deteriorated concrete according to resinous flooring manufacturer's written instructions.
   c. Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer's written instructions.
      1) Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with application of resinous flooring only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) of slab area in 24 hours.
      2) Perform plastic sheet test, ASTM D 4263. Proceed with application only after testing indicates absence of moisture in substrates.
      3) Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
   d. Alkalinity and Adhesion Testing: Verify that concrete substrates have pH within acceptable range. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.
3. Resinous Materials: Mix components and prepare materials according to resinous flooring manufacturer's written instructions.
4. Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.
5. Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written instructions.

B. Application
1. General: Apply components of resinous flooring system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.
   a. Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.
   b. Cure resinous flooring components according to manufacturer's written instructions. Prevent contamination during application and curing processes.
   c. At substrate expansion and isolation joints, comply with resinous flooring manufacturer's written instructions.
2. Apply primer over prepared substrate at manufacturer's recommended spreading rate.
3. Apply waterproofing membrane, where indicated, in manufacturer's recommended thickness.
   a. Apply waterproofing membrane to integral cove base substrates.
4. Apply reinforcing membrane to substrate cracks **OR** entire substrate surface, **as directed**.
5. Integral Cove Base: Apply cove base mix to wall surfaces before applying flooring. Apply according to manufacturer's written instructions and details including those for taping, mixing, priming, troweling, sanding, and topcoating of cove base. Round internal and external corners.
   a. Integral Cove Base: 4 inches (100 mm) high.
6. Apply self-leveling slurry body coats in thickness indicated for flooring system.
   a. Broadcast aggregates at rate recommended by manufacturer and, after resin is cured, remove excess aggregates to provide surface texture indicated.
7. Apply troweled or screeded body coats in thickness indicated for flooring system. Hand or power trowel and grout to fill voids. When cured, remove trowel marks and roughness using method recommended by manufacturer.
8. Apply grout coat, of type recommended by resinous flooring manufacturer, to fill voids in surface of final body coat and to produce wearing surface indicated.
9. Apply topcoats in number indicated for flooring system and at spreading rates recommended in writing by manufacturer.

C. Field Quality Control
1. Core Sampling: At the direction of Owner and at locations designated by Owner, take one core sample per 1000 sq. ft. (92.9 sq. m) of resinous flooring, or portion of, to verify thickness. For each sample that fails to comply with requirements, take two additional samples. Repair damage caused by coring and correct deficiencies.
2. Material Sampling: Owner may at any time and any number of times during resinous flooring application require material samples for testing for compliance with requirements.
   a. Contractor will engage an independent testing agency to take samples of materials being used. Material samples will be taken, identified, sealed, and certified in presence of Contractor.
   b. Testing agency will test samples for compliance with requirements, using applicable referenced testing procedures or, if not referenced, using testing procedures listed in manufacturer's product data.
   c. If test results show applied materials do not comply with specified requirements, pay for testing, remove noncomplying materials, prepare surfaces coated with unacceptable materials, and reapply flooring materials to comply with requirements.

D. Protection
1. Protect resinous flooring from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer.

END OF SECTION 09620c

SECTION 09640 - WOOD FLOORING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for wood flooring. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes factory- and field-finished wood flooring.

C. Submittals
1. Product Data: For each type of product indicated.
2. Samples: For each exposed finish.
3. LEED Submittals:
   a. Product Data for Credit EQ 4.1: For wood flooring installation adhesives, including printed statement of VOC content.
   b. Product Data for Credit EQ 4.2: For field-applied finishes for wood flooring, including printed statement of VOC content.
   c. Product Data for Credit EQ 4.4: For composite wood products, documentation indicating that the bonding agent contains no urea formaldehyde.
   d. Certificates for Credit MR 7: Chain-of-custody certificates certifying that wood flooring complies with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
      1) Include statement indicating costs for each certified wood product.

D. Quality Assurance
1. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
2. Forest Certification: Provide wood flooring produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
3. Hardwood Flooring: Comply with NOFMA's "Official Flooring Grading Rules" for species, grade, and cut.
   a. Certification: Provide flooring that carries NOFMA grade stamp on each bundle or piece.
4. Maple Flooring: Comply with applicable MFMA grading rules for species, grade, and cut.
   a. Certification: Provide flooring that carries MFMA mark on each bundle or piece.
5. Softwood Flooring: Comply with WCLIB No. 17 grading rules for species, grade, and cut.

E. Delivery, Storage, And Handling
1. Deliver wood flooring materials in unopened cartons or bundles.
2. Protect wood flooring from exposure to moisture. Do not deliver wood flooring until after concrete, masonry, plaster, ceramic tile, and similar wet work is complete and dry.
3. Store wood flooring materials in a dry, warm, ventilated, weathertight location.

F. Project Conditions
1. Conditioning period begins not less than seven days before wood flooring installation, is continuous through installation, and continues not less than seven days after wood flooring installation.
   a. Environmental Conditioning: Maintain an ambient temperature between 65 and 75 deg F (18 and 24 deg C) and relative humidity planned for building occupants in spaces to receive wood flooring during the conditioning period.

b. Wood Flooring Conditioning: Move wood flooring into spaces where it will be installed, no later than the beginning of the conditioning period.
   1) Do not install flooring until it adjusts to relative humidity of, and is at same temperature as, space where it is to be installed.
   2) Open sealed packages to allow wood flooring to acclimatize immediately on moving flooring into spaces in which it will be installed.

2. After conditioning period, maintain relative humidity and ambient temperature planned for building occupants.
3. Install factory-finished wood flooring after other finishing operations, including painting, have been completed.

1.2 PRODUCTS

A. Field-Finished Wood Flooring
1. Solid-Wood, Strip and Plank Flooring: Kiln dried to 6 to 9 percent maximum moisture content, tongue and groove and end matched, and with backs channeled (kerfed) for stress relief.
   a. Species and Grade: Select red oak **OR** No. 1 Common red oak **OR** No. 2 Common red oak **OR** MFMA-RL First Grade hard maple **OR** MFMA-RL Second and Better Grade hard maple **OR** C & BTR - Flooring Douglas fir **OR** D - Flooring Douglas fir, **as directed**.
   b. Cut: Plain sawn **OR** Quarter/rift sawn **OR** Edge grain **OR** Vertical grain, **as directed**.
   c. Thickness: 3/4 inch (19 mm) **OR** 25/32 inch (20 mm), **as directed**.
   d. Face Width: 2-1/4 inches (57 mm) **OR** 3-1/8 inches (79 mm) **OR** 5-1/8 inches (130 mm), **as directed**.
   e. Lengths: Random-length strips complying with applicable grading rules **OR** Lengths required to form pattern indicated, **as directed**.
   f. Preservative Treatment: Clear, penetrating, water-repellent wood preservative that protects against mold, mildew, staining, and decay fungi; complying with MFMA's written recommendations and applied by immersion.
   g. Simulated Wood Pegs: Contrasting wood pegs at ends of plank flooring pieces.
2. Solid-Wood Parquet Flooring: Kiln dried to 6 to 9 percent maximum moisture content.
   a. Species: Red oak **OR** White oak **OR** Ash **OR** Maple **OR** Black cherry, **as directed**.
   b. Thickness: 5/16 inch (8 mm) **OR** 11/16 inch (17 mm) **OR** 1/4 inch (6 mm), **as directed**.
3. Engineered-Wood, Strip and Plank Flooring: HPVA EF, except bonding agent contains no urea formaldehyde.
   a. Species: Red oak **OR** White oak **OR** Ash **OR** Beech **OR** Maple **OR** Black cherry, **as directed**.
   b. Thickness: 1/2 inch (13 mm) **OR** 3/8 inch (9.5 mm), **as directed**.
   c. Construction: Five **OR** Three, **as directed**, ply.
   d. Width: 2-1/4 inches (57 mm) **OR** 3 inches (76 mm), **as directed**.
   e. Length: Manufacturer's standard.
4. Urethane Finish System: Complete solvent-based, oil-modified **OR** water-based, **as directed**, system of compatible components that is recommended by finish manufacturer for application indicated.
   a. VOC Content: When calculated according to 40 CFR 59, Subpart D (EPA Method 24), as follows:
      1) Finish Coats and Floor Sealers: Not more than 350 g/L.
      2) Stains: Not more than 250 g/L.
   b. Finish Coats: Formulated for multicoat application on wood flooring.
   c. Stain: Penetrating and nonfading type.
      1) Color: Match sample **OR** As selected from manufacturer's full range, **as directed**.
   d. Floor Sealer: Pliable, penetrating type.
5. Wood Filler: Compatible with finish system components and recommended by filler and finish manufacturers for use indicated. If required to match approved Samples, provide pigmented filler.

B. Factory-Finished Wood Flooring
   1. Solid-Wood, Strip and Plank Flooring: Kiln dried to 6 to 9 percent maximum moisture content; tongue and groove and end matched; and with backs channeled (kerfed) for stress relief.
      a. Species: Red oak **OR** White oak **OR** Ash **OR** Birch **OR** Maple **OR** Black cherry **OR** Hickory **OR** Walnut, **as directed**.
      b. Cut: Plain sawn **OR** Quarter/rift sawn **OR** Edge grain **OR** Vertical grain, **as directed**.
      c. Thickness: 3/4 inch (19 mm) **OR** 25/32 inch (20 mm), **as directed**.
      d. Face Width: 2-1/4 inches (57 mm) **OR** 3-1/8 inches (79 mm) **OR** 5-1/8 inches (130 mm), **as directed**.
      e. Lengths: Random-length strips complying with applicable grading rules **OR** Lengths required to form pattern indicated, **as directed**.
      f. Edge Style: Square **OR** Beveled (eased), **as directed**.
      g. Finish: UV urethane system.
         1) Color: As selected from manufacturer's full range, **as directed**.
   2. Solid-Wood Parquet Flooring: Kiln dried to 6 to 9 percent maximum moisture content.
      a. Species: Red oak.
      b. Thickness: 5/16 inch (8 mm) **OR** 11/16 inch (17 mm) **OR** 1/4 inch (6 mm), **as directed**.
      c. Finish: UV urethane **OR** Acrylic impregnated, **as directed**.
         1) Color: As selected from manufacturer's full range.
   3. Engineered-Wood, Strip and Plank Flooring: HPVA EF, except bonding agent contains no urea formaldehyde.
      a. Species: Red oak **OR** White oak **OR** Ash **OR** Beech **OR** Birch **OR** Maple **OR** Black cherry **OR** Hickory **OR** Walnut, **as directed**.
      b. Thickness: 1/2 inch (13 mm) **OR** 3/8 inch (9.5 mm), **as directed**.
      c. Construction: Five **OR** Three, **as directed**, ply.
      d. Width: 2-1/4 inches (57 mm) **OR** 3 inches (76 mm), **as directed**.
      e. Length: Manufacturer's standard.
      f. Edge Style: Square **OR** Beveled (eased), **as directed**.
      g. Finish: UV urethane **OR** Acrylic impregnated, **as directed**.
         1) Color: As selected in manufacturer's full range.
   4. Engineered-Wood Parquet Flooring: HPVA EF, except bonding agent contains no urea formaldehyde.
      a. Species: Red oak **OR** Ash **OR** Beech **OR** Maple **OR** Walnut, **as directed**.
      b. Thickness: 3/8 inch (9.5 mm) **OR** 1/2 inch (13 mm), **as directed**.
      c. Construction: Five **OR** Three, **as directed**, ply.
      d. Finish: UV urethane.
         1) Color: As selected from manufacturer's full range.

C. Accessory Materials
   1. Wood Sleepers and Subfloor: As specified in Division 06 Section "Rough Carpentry".
   2. Wood Underlayment: As specified in Division 06 Section "Rough Carpentry".
   3. Vapor Retarder: ASTM D 4397, polyethylene sheet not less than 6.0 mils (0.15 mm) **OR** 8.0 mils (0.2 mm), **as directed**, thick.
   4. Asphalt-Saturated Felt: ASTM D 4869, Type II.
   5. Wood Flooring Adhesive: Mastic recommended by flooring and adhesive manufacturers for application indicated.
      a. Use adhesives that have a VOC content of not more than 100 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   6. Trowelable Leveling and Patching Compound: Latex-modified, hydraulic-cement-based formulation approved by wood flooring manufacturer.
   7. Fasteners: As recommended by manufacturer, but not less than that recommended in NWFA's "Installation Guidelines: Wood Flooring."
   8. Cork Expansion Strip: Composition cork strip.
   9. Feature Strips: 2-inch- (51-mm-) wide, square-edged walnut strips furnished in lengths as long as practical and in thickness to match wood flooring.

10. Metal Feature Strips: 1/8-by-1/8-inch (3-by-3-mm) solid-brass strip, designed for inlaying into routed reveal in wood flooring surface.
11. Trim: In same species and grade as wood flooring, unless otherwise indicated.
    a. Base: 5/8 inch (16 mm) thick by 4 inches (100 mm) high.
    b. Base Shoe Molding: 1/2 by 3/4 inch (13 by 19 mm).
    c. Threshold: Tapered on each side and routed at bottom of one side to accommodate wood flooring.
    d. Reducer Strip: 2 inches (51 mm) wide, tapered on 1 side, and in thickness matching wood flooring.
12. Wood air vents and grilles of same species and grade as wood flooring and in sizes indicated on Drawings.

1.3 EXECUTION

A. Preparation
1. Grind high spots and fill low spots on concrete substrates to produce a maximum 1/8-inch (3-mm) deviation in any direction when checked with a 10-foot (3-m) straight edge.
    a. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, and depressions in substrates.
2. Remove coatings, including curing compounds, and other substances on substrates that are incompatible with installation adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
3. Broom or vacuum clean substrates to be covered immediately before product installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Installation
1. Comply with flooring manufacturer's written installation instructions, but not less than applicable recommendations in NWFA's "Installation Guidelines: Wood Flooring."
2. Wood Sleepers and Subfloor: Install according to requirements in Division 06 Section "Rough Carpentry".
3. Wood Underlayment: Install according to requirements in Division 06 Section "Rough Carpentry".
4. Provide expansion space at walls and other obstructions and terminations of flooring as indicated on Drawings **OR** of not less than 3/4 inch (19 mm), **as directed**.
5. Asphalt-Saturated Felt: Where strip or plank flooring is nailed to solid-wood subfloor, install flooring over a layer of asphalt-saturated felt.
6. Vapor Retarder:
    a. Wood Flooring Nailed to Sleepers over Concrete: Install flooring over a layer of polyethylene sheet with edges overlapped over sleepers and turned up behind baseboards.
    b. Wood Flooring Installed Directly on Concrete: Install a layer of polyethylene sheet according to flooring manufacturer's written instructions.
7. Solid-Wood, Strip and Plank Flooring: Blind nail or staple flooring to substrate.
    a. For flooring of face width more than 3 inches (75 mm), do the following:
        1) Install countersunk screws at each end of each piece in addition to blind nailing. Cover screw heads with wood plugs glued flush with flooring.
        2) Install no fewer than 2 countersunk nails at each end of each piece, spaced not more than 16 inches (406 mm) along length of each piece, in addition to blind nailing. Fill holes with matching wood filler.
8. Solid-Wood Parquet Flooring: Set in adhesive.
9. Engineered-Wood Flooring: Set in adhesive **OR** Nail or staple **OR** Install floating floor, **as directed**.
10. Wood Trim: Nail baseboard to wall and nail shoe molding or other trim to baseboard; do not nail to flooring.

C. Field Finishing
   1. Machine-sand flooring to remove offsets, ridges, cups, and sanding-machine marks that would be noticeable after finishing. Vacuum and tack with a clean cloth immediately before applying finish.
      a. Comply with applicable recommendations in NWFA's "Installation Guidelines: Wood Flooring."
   2. Fill open-grained hardwood.
   3. Fill and repair wood flooring seams and defects.
   4. Apply floor-finish materials in number of coats recommended by finish manufacturer for application indicated, but not less than one coat of floor sealer and three finish coats.
      a. Apply stains to achieve an even color distribution matching approved Samples.
      b. For water-based finishes, use finishing methods recommended by finish manufacturer to minimize grain raise.
   5. Cover wood flooring before finishing.
   6. Do not cover wood flooring after finishing until finish reaches full cure, and not before seven days after applying last finish coat.

D. Protection
   1. Protect installed wood flooring during remainder of construction period with covering of heavy kraft paper or other suitable material. Do not use plastic sheet or film that might cause condensation.
      a. Do not move heavy and sharp objects directly over kraft-paper-covered wood flooring. Protect flooring with plywood or hardboard panels to prevent damage from storing or moving objects over flooring.

END OF SECTION 09640

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SECTION 09640a - WOOD SPORTS-FLOOR ASSEMBLIES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for wood sports-floor assemblies. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes wood sports-floor assemblies.

C. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Show installation details including location and layout of each type of floor assembly and accessory. Include the following:
   a. Expansion provisions and trim details.
   b. Layout, colors, widths, and dimensions of game lines and markers.
   c. Locations of floor inserts for athletic equipment installed through flooring assembly.
3. Samples: For each exposed finish.
4. LEED Submittals:
   a. Product Data for Credit EQ 4.1: For wood sports-floor assembly installation adhesives, including printed statement of VOC content.
   b. Product Data for Credit EQ 4.2: For field-applied finishes and game-line and marker paints, including printed statement of VOC content.
   c. Certificates for Credit MR 7: Chain-of-custody certificates certifying that wood flooring complies with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
      1) Include statement indicating costs for each certified wood product.
5. Maintenance data.

D. Quality Assurance
1. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
2. Installer Responsibilities: Include installation and field finishing of sports-floor assembly components and accessories, and application of game lines and markers.
3. Forest Certification: Provide wood components produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
4. Maple Flooring: Comply with MFMA grading rules for species, grade, and cut.
   a. Certification: Provide flooring that carries MFMA mark on each bundle or piece.

E. Delivery, Storage, And Handling
1. Deliver assembly materials in unopened cartons or bundles.
2. Protect wood from exposure to moisture. Do not deliver wood components until after concrete, masonry, plaster, ceramic tile, and similar wet work is complete and dry.
3. Store wood components in a dry, warm, well-ventilated, weathertight location and in a horizontal position.

F. Project Conditions
1. Conditioning period begins not less than seven days before sports-floor assembly installation, is continuous through installation, and continues not less than seven days after sports-floor installation.

a. Environmental Conditioning: Maintain an ambient temperature between 65 and 75 deg F (18 and 24 deg C) and relative humidity planned for building occupants, but not less than 35 percent or more than 50 percent, in spaces to receive sports-floor assemblies during the conditioning period.
b. Wood Conditioning: Move wood components into spaces where they will be installed, no later than beginning of the conditioning period.
   1) Do not install sports-floor assemblies until wood components adjust to relative humidity of, and are at same temperature as, spaces where they are to be installed.
   2) Open sealed packages to allow wood components to acclimatize immediately on moving wood components into spaces in which they will be installed.
c. After conditioning period, maintain relative humidity and ambient temperature planned for building occupants.
d. Install sports-floor assemblies after other finishing operations, including painting, have been completed.

1.2 PRODUCTS

A. Wood Flooring
1. Strip Flooring: Northern hard maple (Acer saccharum), kiln dried, random length, tongue and groove, and end matched.
   a. Grade: MFMA-RL First **OR** Second and Better **OR** Third and Better, **as directed**.
      1) Exception: For areas under stacked portion of telescoping bleachers that are normally concealed from view, provide Third and Better Grade.
   b. Cut: Edge **OR** Flat, **as directed**.
   c. Thickness: 25/32 inch (20 mm) **OR** 33/32 inch (26 mm), **as directed**.
   d. Face Width: 2-1/4 inches (57 mm) **OR** 1-1/2 inches (38 mm), **as directed**.
   e. Backs: Channeled (kerfed) for stress relief.
   f. Preservative Treatment: Clear, penetrating, water-repellent wood preservative that protects against mold, mildew, staining, and decay fungi; complying with MFMA's written recommendations and applied by immersion.
2. Parquet Flooring: Northern hard maple (Acer saccharum), kiln dried, edge grain, and square edge.
   a. Grade: MFMA-PQ Second and Better **OR** Third and Better, **as directed**.
   b. Thickness: Not less than 5/16 inch (8 mm) **OR** 3/8 inch (10 mm) **OR** 7/16 inch (11 mm) **OR** 1/2 inch (13 mm) **OR** 11/16 inch (17 mm), **as directed**.
   c. Picket Dimensions:
      1) Width: 7/8 inch (22 mm) or 1-1/8 inches (29 mm) **OR** 7/8 inch (22 mm) **OR** 1-1/8 inches (29 mm), **as directed**.
      2) Length: 6 inches (152 mm) **OR** 9 inches (229 mm), **as directed**.
   d. Preservative Treatment: Clear, penetrating, water-repellent wood preservative that protects against mold, mildew, staining, and decay fungi; complying with MFMA's written recommendations and applied by immersion.

B. Subfloor System
1. Board Underlayment: Nominal 1-by-6-inch (25-by-150-mm) graded boards; of SPIB No. 2 Southern pine, WCLIB Construction grade (any species), or WWPA No. 3 (any species), dried to 15 percent moisture content.
   a. Preservative Treatment: Clear, penetrating, water-repellent wood preservative that protects against mold, mildew, staining, and decay fungi; complying with MFMA's written recommendations and applied by immersion.
2. Plywood Underlayment: APA rated, C-D Plugged, exterior glue, tongue and groove, 15/32 inch (12 mm) **OR** 23/32 inch (18 mm), **as directed**, thick.
3. Wood Sleepers: Standard grade; 48 inches (1200 mm) long; kiln-dried Eastern hemlock, fir, pine, or spruce.

a. Preservative Treatment: Clear, penetrating, water-repellent wood preservative that protects against mold, mildew, staining, and decay fungi; complying with MFMA's written recommendations and applied by immersion.
b. Size: Nominal 2 by 3 inches (50 by 75 mm) **OR** 2 by 4 inches (50 by 100 mm), **as directed**.
c. Sleeper Anchors: Manufacturer's standard, but not less than steel drive pins recommended by anchor manufacturer to achieve minimum 900-lbf (4000-N) pullout strength.
d. Sleeper Shims: In size and type recommended in writing by flooring manufacturer for application indicated.
e. Asphalt Primer: ASTM D 41.
f. Asphalt Mastic: ASTM D 312, Type I, cold-applied dead-level asphalt or Type III, hot-applied steep asphalt, as recommended in writing by manufacturer.

4. Channels: Manufacturer's standard as indicated by product designation above.
   a. Channel Anchors: Manufacturer's standard but not less than modified steel drive pins recommended by anchor manufacturer to achieve minimum 900-lbf (4000-N) pullout strength.
   b. Clips: Manufacturer's standard as indicated by product designation above.
5. Resilient Pads: With air voids for resiliency and installed at manufacturer's standard spacing for product designation indicated above.
   a. Material: PVC **OR** Rubber **OR** Neoprene, **as directed**.
   b. Thickness: 3/8 inch (10 mm) **OR** 7/16 inch (11 mm) **OR** 5/8 inch (16 mm) **OR** 3/4 inch (19 mm), **as directed**.
6. Resilient Underlayment: Asphalt-impregnated, termiticide-treated resilient fiberboard **OR** Flexible, multicellular, closed-cell, expanded polyethylene-foam sheet; 1/2 inch (13 mm) thick; nominal 2-lb/cu. ft. (32-kg/cu. m) density, **as directed**.

C. Accessories
1. Vapor Retarder: ASTM D 4397, polyethylene sheet not less than 6 mils (0.15 mm) thick.
2. Resilient Wall Base: Molded, vented, rubber or vinyl cove base; 4 by 3 by 48 inches (100 by 75 by 1200 mm); with premolded outside corners.
   a. Color: Black **OR** Brown, **as directed**.
3. Wood Wall Base: Nominal 1-by-3-inch (25-by-75-mm) wood base **OR** Built-up wood base as indicated on Drawings, **as directed**, matching species, grade, and cut of wood flooring.
4. Thresholds: As specified in Division 08 Section "Door Hardware".
5. Fasteners: Type and size recommended by manufacturer, but not less than those recommended by MFMA for application indicated.
6. Trowelable Leveling and Patching Compound: Latex-modified, hydraulic-cement-based formulation approved by sports-floor manufacturer.
7. Adhesives: Manufacturer's standard for application indicated.
   a. Concrete Primers: Manufacturer's standard for application indicated.
   b. Use adhesive and primer, if any, that have a VOC content of 100 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
8. Floor-Finish System: System of compatible components recommended in writing by flooring manufacturer and MFMA approved.
   a. Type: MFMA Group 3, Gymnasium Type (Surface) Finishes; urethane-oil type **OR** Group 5, Water Based Finishes; polyurethane, **as directed**.
   b. Floor-Sealer Formulation: Pliable, penetrating type.
   c. Finish-Coat Formulation: Formulated for gloss finish and multicoat application.
   d. Game-Line and Marker Paint: Industrial enamel compatible with finish coats and recommended in writing by manufacturers of finish coats, and paint for this use.
   e. VOC content: Provide products that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
      1) Floor Sealers and Finish Coats: VOC content of not more than 350 g/L.
      2) Game-Line and Marker Paint: VOC content of not more than 150 g/L.

1.3 EXECUTION

A. Preparation
1. Grind high spots and fill low spots on concrete substrates to produce a maximum 1/8-inch (3-mm) deviation in any direction when checked with a 10-foot (3-m) straight edge.
   a. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, and depressions in substrates.
2. Remove coatings including curing compounds and other substances on substrates that are incompatible with installation adhesives and that contain soap, wax, oil, or silicone; use mechanical methods recommended by manufacturer. Do not use solvents.
3. Broom and vacuum clean substrates to be covered immediately before product installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Installation
1. General: Comply with sports-floor assembly manufacturer's written instructions, but not less than written recommendations of MFMA applicable to flooring type indicated.
2. Pattern: Lay flooring parallel with long dimension of space to be floored, unless otherwise indicated.
3. Expansion Spaces: Provide as indicated, but not less than that required by manufacturer's written instructions and MFMA's written recommendations at walls and other obstructions, and at interruptions and terminations of flooring.
   a. Cover expansion spaces with base molding, trim, and saddles, as indicated on Drawings.
4. Vapor Retarder: Install with joints lapped a minimum of 6 inches (150 mm) and sealed.
5. Underlayment: Install perpendicular to direction of flooring, staggering end joints in adjacent rows.
6. Sleepers:
   a. Install perpendicular to direction of flooring, staggering end joints a minimum of 24 inches (610 mm).
   b. Space at spacing recommended by manufacturer for system components indicated **OR** 12 inches (305 mm) o.c. **OR** 9 inches (229 mm) o.c. **OR** 8 inches (203 mm) o.c., **as directed**.
   c. Shim and level sleepers and install anchors at spacing recommended by manufacturer, but not less than 30 inches (760 mm) o.c.
   d. Anchor predrilled sleepers through resilient pads.
7. Channels: Anchor channels to substrate according to manufacturer's written instructions.
   a. Install wood strip flooring across channels.
   b. Insert steel clip at each intersection of a flooring strip with a channel.
8. Strip Flooring: Mechanically fasten perpendicular to supports.
9. Parquet Flooring: Adhere to substrates according to manufacturer's written instructions.
10. Installation Tolerances: 1/8 inch in 10 feet (3 mm in 3 m) of variance from level.

C. Sanding And Finishing
1. Follow applicable recommendations in MFMA's "Industry Recommendations for Sanding, Sealing, Court Lining, Finishing, and Resurfacing of Maple Gym Floors."
2. Allow installed flooring to acclimate to ambient conditions for at least 10 days before sanding.
3. Machine sand with coarse, medium, and fine grades of sandpaper to achieve a level, smooth, uniform surface without ridges or cups. Remove sanding dust by tack or vacuum.
4. Finish: Apply seal and finish coats of finish system according to finish manufacturer's written instructions. Provide not less than four coats total and not less than two finish coats.
   a. Water-Based Finishes: Use finishing methods recommended by finish manufacturer to reduce grain raise and sidebonding effect.
   b. Game Lines and Markers: Apply game-line and marker paint between final seal coat and first finish coat according to paint manufacturer's written instructions.
      1) Mask flooring at game lines and markers, and apply paint to produce lines and markers with sharp edges.

2) Where game lines cross, break minor game line at intersection; do not overlap lines.
3) Apply game lines and markers in widths and colors according to requirements indicated on Drawings.
4) Apply finish coats after game-line and marker paint is fully cured.

D. Protection
1. Protect sports floors during remainder of construction period to allow finish to cure and to ensure that flooring and finish are without damage or deterioration at time of Substantial Completion.
a. Do not cover sports floors after finishing until finish reaches full cure, and not before seven days after applying last finish coat.
b. Do not move heavy and sharp objects directly over sports floors. Protect fully cured floor finishes and surfaces with plywood or hardboard panels to prevent damage from storing or moving objects over sports floors.

END OF SECTION 09640a

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SECTION 09650 - CORK FLOORING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for cork flooring. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Cork floor tile.
b. Engineered cork floor tile.
c. Cork rubber floor tile.
d. Cork floating floor system.

C. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
a. Product Data for Credit MR 6.0: For cork flooring, including printed statement of costs for each rapidly renewable material.
b. Product Data for Credit EQ 4.1: For adhesive, including printed statement of VOC content.
c. Product Data for Credit EQ 4.2: For field-applied sealer and finish coatings, including printed statement of VOC content.
d. Product Data for Credit EQ 4.4: For cork flooring and MDF, including printed statement indicating that the bonding agent and adhesive contain no urea-formaldehyde resins.
3. Shop Drawings: For each type of cork flooring. Include cork flooring layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
4. Samples: Full-size units of each shade and finish **OR** shade, pattern, and finish **OR** color and pattern, **as directed**, of cork flooring required.
5. Maintenance Data: For each type of cork flooring to include in maintenance manuals.

D. Quality Assurance
1. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
a. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm **OR** Class II, not less than 0.22 W/sq. cm, **as directed**.
2. Product Certificates: For cork floating floor system, from manufacturer, certifying that MDF core contains no urea-formaldehyde resins.

E. Delivery, Storage, And Handling
1. Store cork flooring and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C). Store cork flooring on flat surfaces.

F. Project Conditions
1. Maintain ambient temperatures within range recommended by manufacturer, but not less than 65 deg F (18 deg C) or more than 75 deg F (24 deg C) where relative humidity is between 45 and 65 percent, in spaces to receive cork flooring during the following time periods:
a. 72 hours before installation.
b. During installation.
c. 72 hours after installation.

2. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 65 deg F (18 deg C) or more than 75 deg F (24 deg C).
3. Close spaces to traffic during cork flooring installation.
4. Close spaces to traffic for 72 hours after cork flooring installation.
5. Install cork flooring after other finishing operations, including painting, have been completed.

1.2 PRODUCTS

A. Cork Floor Tile
1. Cork Floor Tile: Composed of 100 percent natural cork bark and recycled cork granules and set in a natural or synthetic, flexible resin matrix; homogeneous and uniform in composition throughout the tile thickness.
2. Provide cork floor tile made with adhesives and binders that do not contain urea-formaldehyde resins.
3. Minimum Density: 30 lb/cu. ft. (480 kg/cu. m) **OR** 34 lb/cu. ft. (544 kg/cu. m) **OR** 37 lb/cu. ft. (592 kg/cu. m), **as directed**.
4. Thickness: Nominal 0.180 inch (4.8 mm) **OR** Nominal 0.312 inch (8.0 mm), **as directed**.
5. Size: 12 by 12 inches (305 by 305 mm) **OR** 12 by 24 inches (305 by 610 mm) **OR** 24 by 24 inches (610 by 610 mm), **as directed**.
6. Shade: Light **OR** Medium **OR** Dark **OR** As indicated by manufacturer's designations **OR** Match sample, **as directed**.
7. Finish: Sanded or unfinished **OR** Waxed **OR** Polyurethane **OR** Polyurethane containing UV inhibitors **OR** Acrylic **OR** As indicated by manufacturer's designations **OR** Match sample, **as directed**.

B. Engineered Cork Floor Tile
1. Engineered Cork Floor Tile: Composed of 100 percent natural cork bark and recycled cork granules with laminated, patterned cork veneers and set in a natural or synthetic, flexible resin matrix; homogeneous and uniform in composition throughout the tile thickness.
2. Provide cork floor tile made with adhesives and binders that do not contain urea-formaldehyde resins.
3. Minimum Density: 30 lb/cu. ft. (480 kg/cu. m) **OR** 34 lb/cu. ft. (544 kg/cu. m) **OR** 37 lb/cu. ft. (592 kg/cu. m), **as directed**.
4. Thickness: Nominal 0.180 inch (4.8 mm) **OR** Nominal 0.312 inch (8.0 mm), **as directed**.
5. Size: 12 by 12 inches (305 by 305 mm) **OR** 12 by 24 inches (305 by 610 mm) **OR** 24 by 24 inches (610 by 610 mm), **as directed**.
6. Shade: Light **OR** Medium **OR** Dark **OR** As indicated by manufacturer's designations **OR** Match sample, **as directed**.
7. Pattern: As indicated by manufacturer's designations **OR** Match sample, **as directed**.
8. Finish: Sanded or unfinished **OR** Waxed **OR** Polyurethane **OR** Polyurethane containing UV inhibitors **OR** Acrylic **OR** As indicated by manufacturer's designations **OR** Match sample, **as directed**.

C. Cork Rubber Floor Tile
1. Cork Rubber Floor Tile: Composed of 70 percent natural cork granules and 30 percent rubber granules combined with fade-resistant pigments; homogeneous and uniform in composition throughout the tile thickness.
2. Provide cork rubber floor tile made with adhesives and binders that do not contain urea-formaldehyde resins.
3. Physical Characteristics:
   a. Minimum Density: 78 lb/cu. ft. (1249 kg/cu. m).
   b. Minimum Tensile Strength: 700 psi (4.8 MPa).
4. Thickness: Nominal 0.125 inch (3.2 mm).
5. Size: 18 by 18 inches (450 by 450 mm).

6. Texture: Lightly textured wear surface.
7. Colors and Patterns: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from full range of industry colors, **as directed**.

D. Cork Floating Floor System
1. Cork Floating Floor System: Laminated planks made of two cork layers, top and bottom, sandwiched around an MDF core and containing no urea-formaldehyde resins.
2. Plank Density:
   a. Cork Top Layer: 28 lb/cu. ft. (448 kg/cu. m) **OR** Manufacturer's standard density, **as directed**.
   b. Interlocking MDF Core: 45 lb/cu. ft. (720 kg/cu. m) **OR** Manufacturer's standard density, **as directed**.
   c. Cork Underlayment Layer: 13 lb/cu. ft. (208 kg/cu. m) **OR** Manufacturer's standard density, **as directed**.
3. Plank Thickness: Nominal 0.450-inch (11.4-mm) overall thickness made up as follows:
   a. Cork Top Layer: Nominal 0.125 inch (3.2 mm) **OR** Manufacturer's standard dimension, **as directed**.
   b. Interlocking MDF Core: Nominal 0.250 inch (6.3 mm) **OR** Manufacturer's standard dimension, **as directed**.
   c. Cork Underlayment Layer: Nominal 0.078 inch (2.0 mm) **OR** Manufacturer's standard dimension, **as directed**.
4. Plank Size: 18 by 18 inches (450 by 450 mm) **OR** 36 by 12 inches (900 by 305 mm), **as directed**.
5. Plank Edge: Tongue-and-groove type **OR** Manufacturer's standard interlock, **as directed**.
6. Shade: Light **OR** Medium **OR** Dark **OR** As indicated by manufacturer's designations **OR** Match sample, **as directed**.
7. Pattern: As indicated by manufacturer's designations **OR** Match sample, **as directed**.
8. Finish: Sanded or unfinished **OR** Waxed **OR** Polyurethane **OR** Polyurethane containing UV inhibitors **OR** Acrylic **OR** As indicated by manufacturer's designations **OR** Match sample, **as directed**.

E. Installation Materials
1. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement-based or blended hydraulic-cement-based formulation provided or approved by cork flooring manufacturer for applications indicated.
2. Vapor Retarder: ASTM D 4397, polyethylene sheet not less than 6.0 mils (0.15 mm) **OR** 8.0 mils (0.2 mm), **as directed**, thick.
3. Adhesive: Water-resistant products as recommended by manufacturer to suit cork flooring and substrate conditions indicated.
   a. Use adhesives that have a VOC content of not more than 50 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. Field-Applied Finishes
1. Cork Sealer: Product as recommended by cork flooring manufacturer.
   a. Use sealers that have a VOC content of not more than 350 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Paste Wax: Products as recommended by cork flooring manufacturer.
3. Finish Coatings: Products containing UV inhibitors as recommended by cork flooring manufacturer.
   a. Use finish coatings that have a VOC content of not more than 350 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
4. Cork Rubber Tile Sealer: Product as recommended by cork rubber floor tile manufacturer.
   a. Use sealers that have a VOC content of not more than 350 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1.3 EXECUTION

A. Preparation
1. Prepare substrates according to cork flooring manufacturer's written instructions to ensure adhesion of cork flooring.
2. Concrete Substrates: Prepare according to ASTM F 710.
   a. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
   b. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
   c. Alkalinity and Adhesion Testing: Perform tests recommended by cork flooring manufacturer. Proceed with installation only after substrates pass testing.
   d. Moisture Testing: Perform tests recommended by cork flooring manufacturer and as follows. Proceed with installation only after substrates pass testing.
      1) Perform anhydrous calcium chloride test according to ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
      2) Perform relative humidity test using in situ probes according to ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
3. Access Flooring Panels: Remove protective film of oil or other coating using method recommended by access flooring manufacturer.
4. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.
5. Do not install cork flooring until materials are same temperature as space where they are to be installed.
   a. Move cork flooring products and installation materials into spaces where they will be installed at least 72 hours in advance of installation.
6. Immediately before installation, sweep and vacuum clean substrates to be covered by cork flooring products.

B. Floor Tile Installation
1. Comply with cork flooring manufacturer's written instructions for installing cork flooring.
2. Mix floor tiles from each carton together to ensure uniform distribution of shade.
3. Discard broken, cracked, chipped, or deformed floor tiles.
4. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
5. Lay floor tiles square with room axis **OR** at a 45-degree angle with room axis **OR** in ashlar or staggered joint pattern **OR** in pattern indicated, **as directed**.
6. Apply adhesive to substrate and set floor tiles in adhesive.
7. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
8. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
9. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent, nonstaining marking device.
10. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in finished floor areas. Maintain overall continuity of shade and finish **OR** shade, pattern, and finish **OR** color and pattern, **as directed**, between pieces of tile installed on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.

C. Cork Floating Floor System Installation

1. Comply with manufacturer's written instructions for installing cork floating floor system.
2. Install continuous vapor retarder over substrate, taping side and end laps.
3. Mix floor planks from several cartons to ensure uniform distribution of shade.
4. Discard broken, cracked, chipped, or deformed floor planks.
5. Do not attach floor planks to substrate.
6. Tightly interlock and adhere plank edges with adhesive. Remove excess adhesive from top surface of planks.
7. Lay floor planks in pattern indicated.
8. Use spacers to keep planks from shifting as subsequent rows are added. Remove spacers after installing cork floating floor system.
9. Maintain expansion space at walls and other obstructions and terminations of flooring as indicated on Drawings **OR** of not less than 3/8 inch (9.5 mm), **as directed**.
10. Extend floor planks into toe spaces, door reveals, closets, and similar openings. Extend floor planks to center of door openings.
11. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor planks as marked on substrates. Use chalk or other nonpermanent, nonstaining marking device.

D. Field-Applied Finishes
1. Apply finishes according to cork flooring manufacturer's written instructions.
2. Cork Sealer: Apply one **OR** two, **as directed**, coat(s).
3. Paste Wax: Apply one **OR** two **OR** three, **as directed**, coat(s).
4. Finish Coatings: Apply two **OR** three, **as directed**, coat(s).
5. Cork Rubber Tile Sealer: Apply one **OR** two, **as directed**, coat(s).

E. Cleaning And Protection
1. Comply with manufacturer's written instructions for cleaning and protecting cork flooring.
2. Remove adhesive and other blemishes from exposed surfaces.
3. Sweep and vacuum surfaces thoroughly.
4. Damp-mop surfaces to remove marks and soil.
5. Protect cork flooring products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
6. Cover cork flooring until Substantial Completion.

END OF SECTION 09650

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SECTION 09650a - RESILIENT SHEET FLOORING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for resilient sheet floor flooring. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Vinyl sheet floor covering, with and without backing.
b. Rubber sheet floor covering, with and without backing.

C. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
a. Product Data for Credit EQ 4.1: For adhesives and chemical-bonding compounds, including printed statement of VOC content.
3. Shop Drawings: For each type of floor covering. Include floor covering layouts, locations of seams, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
a. Show details of special patterns.
4. Samples: In manufacturer's standard size, but not less than 6-by-9-inch (150-by-230-mm) sections of each different color and pattern of floor covering required.
a. For heat-welding bead, manufacturer's standard-size Samples, but not less than 9 inches (230 mm) long, of each color required.
5. Seam Samples: For seamless-installation technique indicated and for each floor covering product, color, and pattern required; with seam running lengthwise and in center of 6-by-9-inch (150-by-230-mm) Sample applied to a rigid backing and prepared by Installer for this Project.
6. Maintenance data.

D. Quality Assurance
1. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
a. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

E. Delivery, Storage, And Handling
1. Store floor coverings and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C). Store rolls upright.

F. Project Conditions
1. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 85 deg F (29 deg C), in spaces to receive floor coverings during the following time periods:
a. 48 hours before installation.
b. During installation.
c. 48 hours after installation.
2. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).
3. Close spaces to traffic during floor covering installation.
4. Close spaces to traffic for 48 hours after floor covering installation.
5. Install floor coverings after other finishing operations, including painting, have been completed.

1.2 PRODUCTS

A. Vinyl Sheet Floor Covering
1. Unbacked Vinyl Sheet Floor Covering: ASTM F 1913, 0.080 inch (2.0 mm) thick.
2. Vinyl Sheet Floor Covering with Backing: ASTM F 1303.
   a. Type (Binder Content): Type I, minimum binder content of 90 percent **OR** Type II, minimum binder content of 34 percent, **as directed**.
   b. Wear-Layer Thickness: Grade 1.
   c. Overall Thickness: As standard with manufacturer.
   d. Interlayer Material: Foamed plastic **OR** None, **as directed**.
   e. Backing Class: Class A (fibrous) **OR** Class B (nonfoamed plastic) **OR** Class C (foamed plastic), **as directed**.
3. Wearing Surface: Smooth **OR** Embossed **OR** Smooth with embedded abrasives **OR** Embossed with embedded abrasives, **as directed**.
4. Sheet Width: As standard with manufacturer **OR** 4.9 feet (1.5 m) **OR** 6 feet (1.8 m) **OR** 6.5 feet (1.98 m) **OR** 6.6 feet (2.0 m) **OR** 9 feet (2.7 m) **OR** 12 feet (3.6 m), **as directed**.
5. Seaming Method: Heat welded **OR** Chemically bonded **OR** Standard, **as directed**.
6. Colors and Patterns: As selected from full range of industry colors.

B. Rubber Sheet Floor Covering
1. Unbacked Rubber Sheet Floor Covering: ASTM F 1859.
   a. Type: Type I (homogeneous rubber sheet) **OR** Type II (layered rubber sheet), **as directed**.
   b. Thickness: As standard with manufacturer.
2. Rubber Sheet Floor Covering with Backing: ASTM F 1860.
   a. Type: Type I, homogeneous rubber sheet with backing **OR** Type II, layered rubber sheet with backing, **as directed**.
   b. Wear-Layer Thickness: As standard with manufacturer.
   c. Overall Thickness: As standard with manufacturer.
   d. Interlayer Material: As standard with manufacturer **OR** None, **as directed**.
   e. Backing Type: Fibrous) **OR** Foamed rubber, **as directed**.
3. Hardness: Not less than required by ASTM F 1859 **OR** Not less than required by ASTM F 1860 **OR** Manufacturer's standard hardness, measured using Shore, Type A durometer per ASTM D 2240, **as directed**.
4. Wearing Surface: Smooth **OR** Textured **OR** Molded pattern, **as directed**.
   a. Molded-Pattern Figure: Raised discs **OR** Raised squares, **as directed**.
5. Sheet Width: As standard with manufacturer **OR** 4.9 feet (1.5 m) **OR** 6 feet (1.8 m) **OR** 6.5 feet (1.98 m) **OR** 6.6 feet (2.0 m) **OR** 9 feet (2.7 m) **OR** 12 feet (3.6 m), **as directed**.
6. Seaming Method: Heat welded **OR** Chemically bonded **OR** Standard, **as directed**.
7. Colors and Patterns: As selected from full range of industry colors.

C. Installation Materials
1. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
2. Adhesives: Water-resistant type recommended by manufacturer to suit floor covering and substrate conditions indicated.
   a. Use adhesives that have a VOC content of not more than 50 g/L **OR** 60 g/L, **as directed**, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Seamless-Installation Accessories:
   a. Heat-Welding Bead: Manufacturer's solid-strand product for heat welding seams.
      1) Color: As selected from manufacturer's full range to contrast with floor covering **OR** Match floor covering, **as directed**.
   b. Chemical-Bonding Compound: Manufacturer's product for chemically bonding seams.

1) VOC Content: Not more than 510 g/L. when calculated according to 40 CFR 59, Subpart D (EPA method 24).

4. Integral-Flash-Cove-Base Accessories:
   a. Cove Strip: 1-inch (25-mm) radius provided or approved by manufacturer.
   b. Cap Strip: Square metal, vinyl, or rubber cap **OR** Tapered vinyl cap, **as directed**, provided or approved by manufacturer.
   c. Corners: Metal inside and outside corners and end stops provided or approved by manufacturer.
5. Floor Polish: Provide protective liquid floor polish products as recommended by manufacturer.

1.3 EXECUTION

A. Preparation
1. Prepare substrates according to manufacturer's written instructions to ensure adhesion of floor coverings.
2. Concrete Substrates: Prepare according to ASTM F 710.
   a. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
   b. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
   c. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
   d. Moisture Testing: Perform tests recommended by manufacturer and as follows. Proceed with installation only after substrates pass testing.
      1) Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
      2) Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
3. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.
4. Do not install floor coverings until they are same temperature as space where they are to be installed.
   a. Move floor coverings and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
5. Sweep and vacuum clean substrates to be covered by floor coverings immediately before installation.

B. Floor Covering Installation
1. Comply with manufacturer's written instructions for installing floor coverings.
2. Unroll floor coverings and allow them to stabilize before cutting and fitting.
3. Lay out floor coverings as follows:
   a. Maintain uniformity of floor covering direction.
   b. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least 6 inches (152 mm) away from parallel joints in floor covering substrates.
   c. Match edges of floor coverings for color shading at seams.
   d. Avoid cross seams.
4. Scribe and cut floor coverings to butt neatly and tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, and door frames.
5. Extend floor coverings into toe spaces, door reveals, closets, and similar openings.
6. Maintain reference markers, holes, or openings that are in place or marked for future cutting by repeating on floor coverings as marked on substrates. Use chalk or other nonpermanent marking device.

7. Install floor coverings on covers for telephone and electrical ducts and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of floor coverings installed on covers and adjoining floor covering. Tightly adhere floor covering edges to substrates that abut covers and to cover perimeters.
8. Adhere floor coverings to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
9. Seamless Installation:
    a. Heat-Welded Seams: Comply with ASTM F 1516. Rout joints and use welding bead to permanently fuse sections into a seamless floor covering. Prepare, weld, and finish seams to produce surfaces flush with adjoining floor covering surfaces.
    b. Chemically-Bonded Seams: Bond seams with chemical-bonding compound to permanently fuse sections into a seamless floor covering. Prepare seams and apply compound to produce tightly-fitted seams without gaps, overlays, or excess bonding compound on floor covering surfaces.
10. Integral-Flash-Cove Base: Cove floor coverings 6 inches (152 mm) **OR** dimension indicated, **as directed**, up vertical surfaces. Support floor coverings at horizontal and vertical junction by cove strip. Butt at top against cap strip.
    a. Install metal corners at inside and outside corners.

C. Cleaning And Protection
1. Comply with manufacturer's written instructions for cleaning and protection of floor coverings.
2. Perform the following operations immediately after completing floor covering installation:
    a. Remove adhesive and other blemishes from floor covering surfaces.
    b. Sweep and vacuum floor coverings thoroughly.
    c. Damp-mop floor coverings to remove marks and soil.
3. Protect floor coverings from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
4. Floor Polish: Remove soil, visible adhesive, and surface blemishes from floor covering before applying liquid floor polish.
    a. Apply one **OR** two **OR** three, **as directed**, coat(s).
5. Cover floor coverings until Substantial Completion.

END OF SECTION 09650a

SECTION 09650b - RESILIENT WALL BASE AND ACCESSORIES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for resilient wall base and accessories. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Resilient base.
b. Resilient stair accessories.
c. Resilient molding accessories.

C. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
a. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content.
3. Samples: For each type of product indicated, in manufacturer's standard-size Samples but not less than 12 inches (300 mm) long, of each resilient product color, texture, and pattern required.

D. Quality Assurance
1. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
a. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

E. Delivery, Storage, And Handling
1. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C).

F. Project Conditions
1. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 95 deg F (35 deg C), in spaces to receive resilient products during the following time periods:
a. 48 hours before installation.
b. During installation.
c. 48 hours after installation.
2. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).
3. Install resilient products after other finishing operations, including painting, have been completed.

1.2 PRODUCTS

A. Resilient Base
1. Resilient Base Standard: ASTM F 1861.
a. Material Requirement: Type TV (vinyl, thermoplastic) **OR** Type TS (rubber, vulcanized thermoset) **OR** Type TP (rubber, thermoplastic), **as directed**.
b. Manufacturing Method: Group I (solid, homogeneous) **OR** Group II (layered), **as directed**.

c. Style: Cove (base with toe) **OR** Straight (flat or toeless) **OR** Butt to (fit-to-floor), **as directed**.

2. Minimum Thickness: 0.125 inch (3.2 mm) **OR** 0.080 inch (2.0 mm), **as directed**.
3. Height: 2-1/2 inches (64 mm) **OR** 4 inches (102 mm) **OR** 6 inches (152 mm) **OR** As indicated on Drawings, **as directed**.
4. Lengths: Cut lengths, 48 inches (1219 mm) long **OR** Coils in manufacturer's standard length, **as directed**.
5. Outside Corners: Job formed **OR** Preformed, **as directed**.
6. Inside Corners: Job formed **OR** Preformed, **as directed**.
7. Finish: Satin **OR** Matte **OR** Low luster **OR** As selected from manufacturer's full range, **as directed**.
8. Colors and Patterns: As selected from full range of industry colors.

B. Resilient Stair Accessories
1. Resilient Stair Treads Standard: ASTM F 2169.
   a. Material Requirement: Type TV (vinyl, thermoplastic) **OR** Type TS (rubber, vulcanized thermoset) **OR** Type TP (rubber, thermoplastic), **as directed**.
   b. Surface Design:
      1) Class 1, Smooth (flat).
      2) Class 2, Pattern: Raised-disc design **OR** Raised-square design **OR** Raised-chevron design **OR** Raised-diamond design **OR** Raised-rib design **OR** Raised-rib design with abrasive strips, **as directed**.
   c. Manufacturing Method: Group 1, tread with embedded abrasive strips **OR** Group 2, tread with contrasting color for the visually impaired, **as directed**.
2. Nosing Style: Square, adjustable to cover angles between 60 and 90 degrees **OR** Square **OR** Round, **as directed**.
3. Nosing Height: 1-1/2 inches (38 mm) **OR** 2 inches (51 mm) **OR** 2-3/16 inches (56 mm), **as directed**.
4. Thickness: 1/4 inch (6 mm) and tapered to back edge.
5. Size: Lengths and depths to fit each stair tread in one piece **OR** one piece or, for treads exceeding maximum lengths manufactured, in equal-length units, **as directed**.
6. Risers: Smooth, flat, coved-toe, 7 inches (178 mm) high by length matching treads **OR** toeless, height and length to cover risers, **as directed**; produced by same manufacturer as treads and recommended by manufacturer for installation with treads.
   a. Thickness: 0.125 inch (3.2 mm) **OR** 0.080 inch (2.0 mm), **as directed**.
7. Stringers: Of same thickness as risers, height and length after cutting to fit risers and treads and to cover stair stringers; produced by same manufacturer as treads and recommended by manufacturer for installation with treads.
8. Colors and Patterns: As selected from full range of industry colors.

C. Resilient Molding Accessory
1. Description: Cap for cove carpet **OR** Cap for cove resilient floor covering **OR** Carpet bar for tackless installations **OR** Carpet edge for glue-down applications **OR** Nosing for carpet **OR** Nosing for resilient floor covering **OR** Reducer strip for resilient floor covering **OR** Joiner for tile and carpet **OR** Transition strips, **as directed**.
2. Material: Vinyl **OR** Rubber, **as directed**.
3. Profile and Dimensions: As indicated.
4. Colors and Patterns: As selected from full range of industry colors.

D. Installation Materials
1. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
2. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.

a. Use adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
   1) Cove Base Adhesives: Not more than 50 g/L.
   2) Rubber Floor Adhesives: Not more than 60 g/L.

3. Stair-Tread-Nose Filler: Two-part epoxy compound recommended by resilient tread manufacturer to fill nosing substrates that do not conform to tread contours.
4. Metal Edge Strips: Extruded aluminum with mill finish of width shown, of height required to protect exposed edges of tiles, and in maximum available lengths to minimize running joints.
5. Floor Polish: Provide protective liquid floor polish products as recommended by resilient stair tread manufacturer.

1.3 EXECUTION

A. Preparation
1. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
2. Concrete Substrates for Resilient Stair Treads and Accessories: Prepare according to ASTM F 710.
   a. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
   b. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
   c. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer.
   d. Moisture Testing: Perform tests recommended by manufacturer and as follows. Proceed with installation only after substrates pass testing.
      1) Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
      2) Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have maximum 75 percent relative humidity level measurement.
3. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.
4. Do not install resilient products until they are same temperature as the space where they are to be installed.
   a. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
5. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

B. Resilient Base Installation
1. Comply with manufacturer's written instructions for installing resilient base.
2. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
3. Install resilient base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.
4. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
5. Do not stretch resilient base during installation.
6. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
7. Preformed Corners: Install preformed corners before installing straight pieces.
8. Job-Formed Corners:
   a. Outside Corners: Use straight pieces of maximum lengths possible. Form without producing discoloration (whitening) at bends.

b. Inside Corners: Use straight pieces of maximum lengths possible.

C. Resilient Accessory Installation
1. Comply with manufacturer's written instructions for installing resilient accessories.
2. Resilient Stair Accessories:
   a. Use stair-tread-nose filler to fill nosing substrates that do not conform to tread contours.
   b. Tightly adhere to substrates throughout length of each piece.
   c. For treads installed as separate, equal-length units, install to produce a flush joint between units.
3. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of carpet **OR** resilient floor covering, **as directed**, that would otherwise be exposed.

D. Cleaning And Protection
1. Comply with manufacturer's written instructions for cleaning and protection of resilient products.
2. Perform the following operations immediately after completing resilient product installation:
   a. Remove adhesive and other blemishes from exposed surfaces.
   b. Sweep and vacuum surfaces thoroughly.
   c. Damp-mop surfaces to remove marks and soil.
3. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
4. Floor Polish: Remove soil, visible adhesive, and surface blemishes from resilient stair treads before applying liquid floor polish.
   a. Apply one **OR** two **OR** three, **as directed**, coat(s).
5. Cover resilient products until Substantial Completion.

END OF SECTION 09650b

SECTION 09650c - LINOLEUM FLOOR COVERINGS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for linoleum floor coverings. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Linoleum floor tile **OR** sheet flooring, **as directed**.

C. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
a. Product Data for Credit MR 6.0: For linoleum flooring, including printed statement of costs for each rapidly renewable material.
b. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content.
3. Shop Drawings: For each type of floor covering. Include floor covering layouts, locations of seams, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
4. Samples for Verification: In manufacturer's standard size, but not less than 6-by-9-inch (152-by-230-mm) sections of each color and pattern of floor covering required.
a. Heat-Welding Bead: Include manufacturer's standard-size Samples, but not less than 9 inches (230 mm) long, of each color required.
5. Heat-Welded Seam Samples: For each floor covering product and welding bead color and pattern combination required; with seam running lengthwise and in center of 6-by-9-inch (152-by-230-mm) Sample applied to rigid backing and prepared by Installer for this Project.
6. Maintenance data.

D. Quality Assurance
1. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
a. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

E. Delivery, Storage, And Handling
1. Store floor coverings and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 65 deg F (18 deg C) or more than 90 deg F (32 deg C).
a. Floor Tile: Store on flat surfaces.
b. Sheet Flooring: Store rolls upright.

F. Project Conditions
1. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 95 deg F (35 deg C), in spaces to receive floor coverings during the following time periods:
a. 72 hours before installation.
b. During installation.
c. 72 hours after installation.
2. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).
3. Close spaces to traffic during floor covering installation.

4. Close spaces to traffic for 72 hours after floor covering installation.
5. Install floor coverings after other finishing operations, including painting, have been completed.

1.2 PRODUCTS

A. Linoleum Floor Covering
1. Floor Tile: ASTM F 2195, Type I, linoleum floor tile with fibrous backing **OR** Type II, linoleum floor tile with special backing **OR** Type III, linoleum floor tile without backing, **as directed**.
   a. Nominal Floor Tile Size: Manufacturer's standard **OR** 12 by 12 inches (300 by 300 mm) **OR** 18 by 18 inches (460 by 460 mm) **OR** 20 by 20 inches (500 by 500 mm) **OR** 24 by 24 inches (600 by 600 mm), **as directed**.
2. Sheet Flooring: ASTM F 2034, Type I, linoleum sheet with backing **OR** Type III, linoleum sheet with special backing, **as directed**.
   a. Roll Size: In manufacturer's standard length by not less than 78 inches (1980 mm) wide.
3. Seaming Method: Standard **OR** Heat welded, **as directed**.
4. Thickness: 0.08 inch (2.0 mm) **OR** 0.10 inch (2.5 mm) **OR** 0.13 inch (3.2 mm) **OR** 0.16 inch (4.0 mm) **OR** 0.18 inch (4.5 mm), **as directed**.
5. Colors and Patterns: As selected from full range of industry colors.

B. Installation Materials
1. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
2. Adhesives: Water-resistant type recommended by manufacturer to suit products and substrate conditions indicated.
   a. Use adhesives that have a VOC content of not more than 50 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Heat-Welding Bead: Solid-strand product of linoleum floor covering manufacturer.
   a. As selected from manufacturer's full range to contrast with linoleum floor covering **OR** Match linoleum floor covering, **as directed**.
4. Integral-Flash-Cove-Base Accessories:
   a. Cove Strip: 1-inch (25.4-mm) radius provided or approved by manufacturer.
   b. Cove-Base Cap Strip: Square metal, vinyl, or rubber cap provided or approved by manufacturer.
5. Floor Polish: Provide protective liquid floor polish products as recommended by manufacturer.

1.3 EXECUTION

A. Preparation
1. Prepare substrates according to manufacturer's written instructions to ensure adhesion of floor coverings.
2. Concrete Substrates: Prepare according to ASTM F 710.
   a. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
   b. Remove substrate coatings and other substances that are incompatible with floor covering adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
   c. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
   d. Moisture Testing: Perform tests recommended by manufacturer and as follows. Proceed with installation only after substrates pass testing.
      1) Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.

2) Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have maximum 75 percent relative humidity level measurement.

3. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.
4. Do not install floor coverings until they are same temperature as space where they are to be installed.
   a. Move floor coverings and installation materials into spaces where they will be installed at least 72 hours in advance of installation.
5. Sweep and vacuum clean substrates to be covered by floor coverings immediately before installation.

B. Installation, General
1. Comply with manufacturer's written instructions for installing floor coverings.
2. Scribe and cut floor coverings to butt neatly and tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings.
3. Extend floor coverings into toe spaces, door reveals, closets, and similar openings.
4. Maintain reference markers, holes, or openings that are in place or marked for future cutting by repeating on floor coverings as marked on subfloor. Use chalk or other nonpermanent marking device.
5. Install floor coverings on covers for telephone and electrical ducts and similar items in finished floor areas. Maintain overall continuity of color and pattern between pieces of floor covering installed on covers and adjoining floor covering. Tightly adhere floor covering edges to substrates that abut covers and to cover perimeters.
6. Adhere floor coverings to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
7. Heat-Welded Seams: Comply with ASTM F 1516. Rout joints and use welding bead to permanently fuse sections into a seamless floor covering. Prepare, weld, and finish seams to produce surfaces flush with adjoining floor covering surfaces.

C. Linoleum Floor Tile Installation
1. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so floor tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
   a. Lay floor tiles square with room axis **OR** at a 45-degree angle with room axis **OR** in pattern indicated, **as directed**.
2. Match floor tiles for color and pattern by selecting tiles from cartons in same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed floor tiles.
   a. Lay floor tiles with grain running in one direction **OR** with grain direction alternating in adjacent floor tiles (basket-weave pattern) **OR** in pattern of colors and sizes indicated, **as directed**.

D. Linoleum Sheet Flooring Installation
1. Unroll sheet floorings and allow them to stabilize before cutting and fitting.
2. Lay out sheet floorings as follows:
   a. Maintain uniformity of floor covering direction.
   b. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least 6 inches (152 mm) away from parallel joints in floor covering substrates.
   c. Match edges of floor coverings for color shading at seams.
   d. Avoid cross seams.
   e. Eliminate deformations that result from hanging method used during drying process (stove bar marks).

3. Integral-Flash-Cove Base: Cove linoleum floor covering 6 inches (152 mm) **OR** dimension indicated, **as directed**, up vertical surfaces. Support floor covering at horizontal and vertical junction with cove strip. Butt at top against cap strip.

E. Cleaning And Protection
1. Comply with manufacturer's written instructions for cleaning and protection of floor coverings.
2. Perform the following operations immediately after completing floor covering installation:
   a. Remove adhesive and other blemishes from exposed surfaces.
   b. Sweep and vacuum surfaces thoroughly.
   c. Damp-mop surfaces to remove marks and soil.
3. Protect floor coverings from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
4. Floor Polish: Remove soil, visible adhesive, and surface blemishes from floor coverings before applying liquid floor polish.
   a. Apply two **OR** three, **as directed**, coat(s).
5. After allowing drying room film (yellow film caused by linseed oil oxidation) to disappear, cover floor coverings until Substantial Completion.

END OF SECTION 09650c

Task	Specification	Specification Description
09650	01352	No Specification Required
09650	09620b	Resilient Floor Tile
09650	09620c	Resinous Flooring

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SECTION 09660 - STATIC-CONTROL RESILIENT FLOOR COVERINGS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for static-control resilient floor coverings. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Static-dissipative, solid vinyl floor tile, rubber floor tile, vinyl composition floor tile, vinyl sheet floor covering, and rubber sheet floor covering.
b. Conductive, solid vinyl floor tile, rubber floor tile, vinyl sheet floor covering, and rubber sheet floor covering.

C. Performance Requirements
1. Static-Dissipative Properties: Provide floor coverings with static-control properties indicated as determined by testing identical products per test method indicated by an independent testing and inspecting agency.
a. Electrical Resistance: Test per ASTM F 150 with 100-V applied voltage **OR** ESD-STM-7.1, **as directed**.
1) Average greater than 1 megohm and less than or equal to 1000 megohms when test specimens are tested surface to ground.
2) Average no less than 1 megohm and less than or equal to 1000 megohms when installed floor coverings are tested surface to ground.
b. Static Generation: Less than 300 V when tested per AATCC-134 at 20 percent relative humidity with conductive footwear.
c. Static Decay: 5000 to 0 V in less than 0.25 seconds when tested per FED-STD-101C/4046.1.
2. Conductive Properties: Provide floor coverings with static-control properties indicated as determined by testing identical products per test method indicated by an independent testing and inspecting agency.
a. Electrical Resistance: Test per ASTM F 150 with 500-V applied voltage **OR** ESD-STM-7.1 **OR** NFPA 99, Annex E **OR** UL 779, **as directed**.
1) Average greater than 25,000 ohms and less than 1 megohm when test specimens and installed floor coverings are tested surface to surface (point to point).
2) Average no less than 25,000 ohms with no single measurement less than 10,000 ohms when installed floor coverings are tested surface to ground.
b. Static Generation: Less than 100 V when tested per AATCC-134 at 20 percent relative humidity with conductive footwear.
c. Static Decay: 5000 to 0 V in less than 0.03 **OR** 0.01, **as directed**, seconds when tested per FED-STD-101C/4046.1.

D. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:
a. Product Data for Credit EQ 4.1: For static-control adhesive and chemical-bonding compound, including printed statement of VOC content.
3. Shop Drawings: For each type of floor covering. Include floor covering layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
4. Samples: For each type of floor covering indicated and of size indicated below:
a. Floor Tile: Full-size **OR** 6-by-9-inch (150-by-230-mm), **as directed**, units.

b. Sheet Floor Covering: 6-by-9-inch (150-by-230-mm) sections of floor covering.
c. Heat-Welding Bead: Include manufacturer's standard-size Samples, but not less than 9 inches (230 mm) long, of each color required.

5. Seam Samples: For seamless-installation technique indicated and for each floor covering product, color, and pattern required; with seam running lengthwise and in center of 6-by-9-inch (152-by-230-mm) Sample applied to a rigid backing and prepared by Installer for this Project.
6. Product test reports.
7. Field quality-control reports.
8. Maintenance data.

E. Quality Assurance
1. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
a. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.
2. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Store floor coverings and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C).
a. Floor Tile: Store on flat surfaces.
b. Sheet Floor Covering: Store rolls upright.

G. Project Conditions
1. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 85 deg F (29 deg C), in spaces to receive floor coverings during the following time periods:
a. 48 hours before installation.
b. During installation.
c. 48 hours after installation.
2. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).
3. Close spaces to traffic during floor covering installation.
4. Close spaces to traffic for 48 hours after floor covering installation.
5. Install floor coverings after other finishing operations, including painting, have been completed.

1.2 PRODUCTS

A. Static-Dissipative Resilient Floor Coverings
1. Static-Dissipative, Solid Vinyl Floor Tile: ASTM F 1700, Class I (monolithic), Type A (smooth surface).
a. Thickness: In manufacturer's standard thickness, but not less than 0.08 inch (2.0 mm).
b. Size: 12 by 12 inches (305 by 305 mm) **OR** 24 by 24 inches (610 by 610 mm) **OR** 36 by 36 inches (914 by 914 mm), **as directed**.
c. Seaming Method: Heat welded **OR** Chemically bonded **OR** Standard, **as directed**.
d. Colors and Patterns: As selected from full range of industry colors.
2. Static-Dissipative Rubber Floor Tile: ASTM F 1344; except in manufacturer's standard hardness when tested per ASTM D 2240 using Shore, Type A durometer.
a. Raised-Disc Floor Tile: Class I-A (homogenous rubber, solid color):
1) Size: 39.4 by 39.4 inches (1000 by 1000 mm).
2) Seaming Method: Chemically bonded **OR** Standard, **as directed**.
3) Colors and Patterns: As selected from full range of industry colors.
b. Hammered-Surface Textured Floor Tile: Class I-B (homogenous rubber, through-mottled pattern).

1) Thickness: Not less than 0.09 inch (2.2 mm) **OR** 0.14 inch (3.5 mm), **as directed**.
2) Size: 19.7 by 19.7 inches (500 by 500 mm); not less than 0.09 inch (2.2 mm) **OR** 39.4 by 39.4 inches (1000 by 1000 mm); not less than 0.14 inch (3.5 mm), **as directed**.
3) Seaming Method: Chemically bonded **OR** Standard, **as directed**.
4) Colors and Patterns: As selected from full range of industry colors.

c. [Smooth] [Textured]-Surface Floor Tile: Class I-B (homogenous rubber, through-mottled pattern).
1) Thickness: Not less than 0.08 inch (2.0 mm) **OR** 0.14 inch (3.5 mm), **as directed**.
2) Size: 24 by 24 inches (610 by 610 mm) **OR** 39.4 by 39.4 inches (1000 by 1000 mm), **as directed**.
3) Seaming Method: Heat welded **OR** Standard, **as directed**.
4) Colors and Patterns: As selected from full range of industry colors.

3. Static-Dissipative, Recycled Rubber Floor Tile: Manufactured from postconsumer rubber.
a. Thickness: Not less than 0.16 inch (4.0 mm) **OR** 0.75 inch (19 mm), **as directed**.
b. Size: 18 by 18 inches (450 by 450 mm) **OR** 36 by 36 inches (914 by 914 mm), **as directed**.
c. Colors and Patterns: As selected from full range of industry colors.

4. Static-Dissipative, Vinyl Composition Floor Tile: ASTM F 1066 (vinyl composition floor tile, nonasbestos formulated), Class 2 (through-pattern tile).
a. Thickness: Not less than 0.125 inch (3.2 mm).
b. Size: 12 by 12 inches (305 by 305 mm).
c. Colors and Patterns: As selected from full range of industry colors.

5. Static-Dissipative, Vinyl Sheet Floor Covering: ASTM F 1913 (unbacked) or ASTM F 1303, Type II, Grade I, Class B (nonfoamed plastic backing).
a. Thickness: Not less than 0.08 inch (2.0 mm).
b. Size: Manufacturer's standard roll width and length.
c. Seaming Method: Heat welded **OR** Standard, **as directed**.
d. Colors and Patterns: As selected from full range of industry colors.

6. Static-Dissipative, Rubber Sheet Floor Covering: ASTM F 1859, Type I (homogenous).
a. Wear Surface: Smooth **OR** Slightly textured, **as directed**.
b. Thickness: Not less than 0.08 inch (2.0 mm) **OR** 0.14 inch (3.5 mm), **as directed**.
c. Size: Manufacturer's standard roll width and length.
d. Seaming Method: Heat welded **OR** Standard, **as directed**.
e. Colors and Patterns: As selected from full range of industry colors.

B. Conductive Resilient Floor Coverings

1. Conductive, Solid Vinyl Floor Tile: ASTM F 1700, Class I (monolithic), Type A (smooth surface).
a. Thickness: In manufacturer's standard thickness, but not less than 0.08 inch (2.0 mm).
b. Size: 12 by 12 inches (305 by 305 mm) **OR** 24 by 24 inches (610 by 610 mm) **OR** 36 by 36 inches (914 by 914 mm), **as directed**.
c. Seaming Method: Heat welded **OR** Chemically bonded **OR** Standard, **as directed**.
d. Colors and Patterns: As selected from full range of industry colors.

2. Conductive Rubber Floor Tile: ASTM F 1344, Class II-B (laminated rubber, mottled wear layer).
a. Wear Surface: Smooth.
b. Thickness: 0.10-inch (2.5-mm).
c. Size: 24 by 24 inches (610 by 610 mm).
d. Seaming Method: Heat welded **OR** Standard, **as directed**.
e. Colors and Patterns: As selected from full range of industry colors.

3. Conductive, Vinyl Sheet Floor Covering: ASTM F 1303, Type II, Grade I, Class B (nonfoamed plastic backing).
a. Thickness: Manufacturer's standard thickness, but not less than 0.08 inch (2.0 mm).
b. Size: Manufacturer's standard roll width and length.
c. Seaming Method: Heat welded **OR** Standard, **as directed**.
d. Colors and Patterns: As selected from full range of industry colors.

4. Conductive, Rubber Sheet Floor Covering: ASTM F 1344, Class II-B (laminated rubber, mottled wear layer).
   a. Wear Surface: Smooth.
   b. Thickness: Manufacturer's standard thickness, but not less than 0.10-inch (2.5-mm).
   c. Size: Manufacturer's standard roll width and length.
   d. Seaming Method: Heat welded **OR** Standard, **as directed**.
   e. Colors and Patterns: As selected from full range of industry colors.

C. Installation Materials
1. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
2. Static-Control Adhesive: Provided or approved by manufacturer; type that maintains electrical continuity of floor covering system to ground connection.
3. Use adhesives that comply with the following limits for VOC content when calculated according to 40 CFR, Subpart D (EPA Method 24):
   a. VCT and Asphalt Tile Adhesives: Not more than 50 g/L.
   b. Rubber Floor Adhesives: Not more than 60 g/L.
4. Grounding Strips: Provided or approved by manufacturer; type and size that maintains electrical continuity of floor covering system to ground connection.
5. Seamless-Installation Accessories:
   a. Heat-Welding Bead: Solid-strand product of manufacturer for heat welding seams.
      1) Color: As selected from manufacturer's full range to contrast with floor covering **OR** Match floor covering, **as directed**.
   b. Chemical-Bonding Compound: Product of manufacturer for chemically bonding seams.
      1) Use chemical-bonding compound that has a VOC content of 350 **OR** 510, **as directed**, g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Integral-Flash-Cove Base Accessories:
   a. Cove Strip: 1-inch (25-mm) radius support strip provided or approved by manufacturer.
   b. Cap Strip: Square metal, vinyl, or rubber cap **OR** Tapered vinyl cap, **as directed**, provided or approved by manufacturer.
   c. Corners: Metal inside and outside corners and end stops provided or approved by floor covering manufacturer.
7. Maintenance Floor Tiles: Special floor tiles inscribed "Conductive floor. Do not wax."
8. Floor Polish: Provide protective, static-control liquid floor polish products as recommended by floor covering manufacturer.

1.3 EXECUTION

A. Preparation
1. Prepare substrates according to manufacturer's written instructions[and with oversight by manufacturer's representative] to ensure adhesion of floor coverings and electrical continuity of floor covering systems.
2. Concrete Substrates: Prepare according to ASTM F 710.
   a. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
   b. Remove substrate coatings and other substances that are incompatible with floor covering adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
   c. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
   d. Moisture Testing: Perform tests recommended by manufacturer and as follows. Proceed with installation only after substrates pass testing.

1) Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
2) Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have maximum 75 percent relative humidity level measurement.

3. Access Flooring Panels: Remove protective film of oil or other coating using method recommended by access flooring manufacturer.
4. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.
5. Do not install floor coverings until they are same temperature as space where they are to be installed.
   a. Move floor coverings and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
6. Sweep and vacuum clean substrates to be covered by floor coverings immediately before installation.

B. Installation, General
1. Install static-control resilient floor covering according to manufacturer's written instructions and with oversight by manufacturer's representative.
2. Embed grounding strips in static-control adhesive. Extend grounding strips beyond perimeter of static-control resilient floor covering surfaces to ground connections.
3. Scribe, cut, and fit floor coverings to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
4. Extend floor coverings into toe spaces, door reveals, closets, and similar openings. Extend floor covering to center of door openings.
5. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor coverings as marked on substrates. Use chalk or other nonpermanent, nonstaining marking device.
6. Install floor coverings on covers for telephone and electrical ducts, and similar items in installation areas. Maintain overall continuity of color and pattern with pieces of floor coverings installed on covers. Tightly adhere floor covering edges to substrates that abut covers and to cover perimeters.
7. Adhere floor coverings to substrates using a full spread of static-control adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
8. Seamless Installation:
   a. Heat-Welded Seams: Comply with ASTM F 1516. Rout joints and heat weld with welding bead to permanently fuse sections into a seamless floor covering. Prepare, weld, and finish seams to produce surfaces flush with adjoining floor covering surfaces.
   b. Chemically Bonded Seams: Bond seams with chemical-bonding compound to permanently fuse sections into a seamless floor covering. Prepare seams and apply compound to produce tightly fitted seams without gaps, overlays, or excess bonding compound on floor covering surfaces.
9. Integral-Flash-Cove Base: Cove floor coverings 6 inches (152 mm) **OR** dimension indicated, **as directed**, up vertical surfaces. Support floor coverings at horizontal and vertical junction with cove strip. Butt at top against cap strip.
   a. Install metal corners at inside and outside corners.

C. Floor Tile Installation
1. Comply with manufacturer's written instructions for installing floor tile.
2. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so floor tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half floor tile at perimeter.
   a. Lay floor tiles square with room axis **OR** at a 45-degree angle with room axis **OR** in pattern indicated, **as directed**.

3. Match floor tiles for color and pattern by selecting floor tiles from cartons in same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed floor tiles.
   a. Lay static-dissipative, vinyl composition floor tiles with grain running in one direction **OR** with grain direction alternating in adjacent floor tiles (basket-weave pattern) **OR** in pattern of colors and sizes indicated, **as directed**.
4. In each space where conductive, solid vinyl floor tile is installed, install maintenance floor tile identifying conductive floor tile in location approved by Architect.

D. Sheet Floor Covering Installation
1. Comply with manufacturer's written instructions for installing sheet floor coverings.
2. Unroll sheet floor coverings and allow them to stabilize before cutting and fitting.
3. Lay out sheet floor coverings as follows:
   a. Maintain uniformity of sheet floor covering direction.
   b. Minimize number of seams and place them in inconspicuous and low-traffic areas, at least 6 inches (152 mm) away from parallel joints in floor covering substrates.
   c. Match edges of floor coverings for color shading at seams.
   d. Avoid cross seams.

E. Field Quality Control
1. Testing: Engage a qualified testing agency to test electrical resistance of static-control resilient floor covering systems for compliance with requirements.
   a. Arrange for testing after installation static-control adhesives have fully cured and floor covering systems have stabilized to ambient conditions and after ground connections are completed.
   b. Arrange for testing of floor coverings before **OR** after **OR** before and after, **as directed**, performing floor polish procedures.
2. Static-control resilient floor coverings will be considered defective if they do not pass tests and inspections.
3. Prepare test and inspection reports.

F. Cleaning And Protection
1. Comply with manufacturer's written instructions for cleaning and protection of floor coverings.
2. Perform the following operations immediately after completing floor covering installation:
   a. Remove static-control adhesive and other blemishes from exposed surfaces.
   b. Sweep and vacuum surfaces thoroughly.
   c. Damp-mop surfaces to remove marks and soil.
3. Protect floor coverings from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
   a. Do not wax static-control resilient floor coverings.
   b. If recommended in writing by manufacturer, apply protective static-control floor polish formulated to maintain or enhance floor covering's electrical properties to floor covering surfaces that are free from soil, static-control adhesive, and surface blemishes.
      1) Verify that both floor polish and its application method are approved by manufacturer and that floor polish will not leave an insulating film that reduces floor coverings' effectiveness for static control.
4. Cover floor coverings until Substantial Completion.

END OF SECTION 09660

Task	Specification	Specification Description
09670	09430	Resinous Matrix Terrazzo Flooring
09670	09620c	Resinous Flooring

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SECTION 09680 - CARPET

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for carpet. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Tufted carpet.
b. Woven carpet.
c. Carpet cushion.

C. Submittals
1. Product Data: For each product indicated.
2. Shop Drawings: Show the following:
a. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet.
b. Existing flooring materials to be removed.
c. Existing flooring materials to remain.
d. Carpet type, color, and dye lot.
e. Locations where dye lot changes occur.
f. Seam locations, types, and methods.
g. Type of subfloor.
h. Type of installation.
i. Pattern type, repeat size, location, direction, and starting point.
j. Pile direction.
k. Type, color, and location of insets and borders.
l. Type, color, and location of edge, transition, and other accessory strips.
m. Transition details to other flooring materials.
n. Type of carpet cushion.
3. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
a. Carpet: 12-inch- (300-mm-) square Sample.
b. Exposed Edge, Transition, and other Accessory Stripping: 12-inch- (300-mm-) long Samples.
c. Carpet Cushion: 6-inch- (150-mm-) square Sample.
d. Carpet Seam: 6-inch (150-mm) Sample.
e. Mitered Carpet Border Seam: 12-inch- (300-mm-) square Sample. Show carpet pattern alignment.
4. LEED Submittals:
a. Product Data for Credit EQ 4.3:
1) For carpet, documentation indicating compliance with testing and product requirements of Carpet and Rug Institute's "Green Label Plus" program.
2) For carpet cushion, documentation indicating compliance with testing and product requirements of Carpet and Rug Institute's "Green Label" program.
3) For installation adhesive, including printed statement of VOC content.
5. Product Schedule: For carpet and carpet cushion. Use same designations indicated on Drawings.
6. Maintenance data.

D. Quality Assurance
1. Installer Qualifications: An experienced installer who is certified by the Floor Covering Installation Board or who can demonstrate compliance with its certification program requirements.
2. Fire-Test-Response Characteristics: Provide products with the critical radiant flux classification indicated in Part 1.2, as determined by testing identical products per ASTM E 648 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
3. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
1. Comply with CRI 104, Section 5, "Storage and Handling."

F. Project Conditions
1. Comply with CRI 104, Section 7.2, "Site Conditions; Temperature and Humidity" and Section 7.12, "Ventilation."
2. Environmental Limitations: Do not install carpet and carpet cushion until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
3. Do not install carpet and carpet cushion over concrete slabs until slabs have cured, are sufficiently dry to bond with adhesive, and have pH range recommended by carpet manufacturer.
4. Where demountable partitions or other items are indicated for installation on top of carpet, install carpet before installing these items.

G. Warranty
1. Special Warranty for Carpet: Manufacturer's standard form in which manufacturer agrees to repair or replace components of carpet installation that fail in materials or workmanship within specified warranty period.
   a. Warranty does not include deterioration or failure of carpet due to unusual traffic, failure of substrate, vandalism, or abuse.
   b. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, loss of tuft bind strength, excess static discharge, and delamination.
   c. Warranty Period: 10 years from date of Substantial Completion.
2. Special Warranty for Carpet Cushion: Manufacturer's standard form in which manufacturer agrees to repair or replace components of carpet cushion installation that fail in materials or workmanship within specified warranty period.
   a. Warranty includes consequent removal and replacement of carpet and accessories.
   b. Warranty does not include deterioration or failure of carpet cushion due to unusual traffic, failure of substrate, vandalism, or abuse.
   c. Failure includes, but is not limited to, permanent indentation or compression.
   d. Warranty Period: 10 years from date of Substantial Completion.

1.2 PRODUCTS

A. Tufted Carpet
1. Fiber Content: 100 percent nylon 6, 6 **OR** 100 percent nylon 6 **OR** 100 percent polypropylene, **as directed**.
2. Pile Characteristic: Level-loop **OR** Cut **OR** Cut-and-loop **OR** Multilevel-loop **OR** Level tip shear **OR** Random shear **OR** Frieze **OR** Sculptured, **as directed**, pile.
3. Yarn Twist: as directed by the Owner.
4. Yarn Count: as directed by the Owner.
5. Density: as directed by the Owner.
6. Pile Thickness: finished carpet per ASTM D 6859.
7. Stitches: as directed by the Owner.
8. Gage: as directed by the Owner.
9. Face Weight: as directed by the Owner.

10. Total Weight: for finished carpet.
11. Primary Backing: Manufacturer's standard material **OR** Woven polypropylene **OR** Nonwoven, polypropylene or polyester, **as directed**.
12. Secondary Backing: Manufacturer's standard material **OR** Woven polypropylene **OR** Nonwoven, polypropylene or polyester **OR** Woven jute **OR** Fiberglass, **as directed**.
13. Backcoating: Manufacturer's standard material **OR** SBR latex **OR** PVC **OR** Thermoplastic copolymer, **as directed**.
14. Width: 12 feet (3.7 m) **OR** 6 feet (1.8 m) **OR** 13.5 feet (4.1 m) **OR** 15 feet (4.6 m), **as directed**.
15. Applied Soil-Resistance Treatment: Manufacturer's standard material.
16. Antimicrobial Treatment: Manufacturer's standard material.
17. Performance Characteristics: As follows:
    a. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm **OR** 0.22 W/sq. cm, **as directed**.
    b. Dry Breaking Strength: Not less than 100 lbf (445 N) per ASTM D 2646.
    c. Tuft Bind: Not less than 3 lbf (13 N) **OR** 5 lbf (22 N) **OR** 6.2 lbf (28 N) **OR** 8 lbf (36 N) **OR** 10 lbf (45 N), **as directed**, per ASTM D 1335.
    d. Delamination: Not less than 2.5 lbf/in. (12 N/mm) **OR** 3.5 lbf/in. (15 N/mm) **OR** 4 lbf/in. (18 N/mm), **as directed**, per ASTM D 3936.
    e. Resistance to Insects: Comply with AATCC 24.
    f. Noise Reduction Coefficient (NRC): per ASTM C 423.
    g. Colorfastness to Crocking: Not less than 4, wet and dry, per AATCC 165.
    h. Colorfastness to Light: Not less than 4 after 40 **OR** 60, **as directed**, AFU (AATCC fading units) per AATCC 16, Option E.
    i. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria; not less than 1-mm halo of inhibition for gram-negative bacteria; no fungal growth; per AATCC 174.
    j. Electrostatic Propensity: Less than 3.5 **OR** 2, **as directed**, kV per AATCC 134.
    k. Environmental Requirements: Provide carpet that complies with testing and product requirements of Carpet and Rug Institute's "Green Label Plus" program.

B. Woven Carpet
1. Fiber Content: 100 percent wool **OR** 80 percent wool; 20 percent nylon 6, 6 **OR** 80 percent wool; 20 percent nylon 6, **as directed**.
2. Face Construction: Axminster **OR** Wilton **OR** Velvet, **as directed**.
3. Pile Characteristic: Level-loop **OR** Cut **OR** Cut-and-loop, **as directed**, pile.
4. Yarn Twist: as directed by the Owner.
5. Yarn Count: as directed by the Owner.
6. Density: as directed by the Owner.
7. Pile Thickness: for finished carpet per ASTM D 6859.
8. Rows: as directed by the Owner.
9. Pitch: as directed by the Owner.
10. Face Weight: as directed by the Owner.
11. Total Weight: as directed by the Owner., for finished carpet.
12. Backing: Manufacturers standard **OR** As follows, **as directed**:
    a. Chain Warp: as directed by the Owner.
    b. Stuffer Warp: as directed by the Owner.
    c. Shot or Fill Weft: as directed by the Owner.
    d. Backcoating: as directed by the Owner.
13. Applied Soil-Resistance Treatment: Manufacturer's standard material.
14. Performance Characteristics: As follows:
    a. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm **OR** 0.22 W/sq. cm, **as directed**.
    b. Dry Breaking Strength: Not less than 100 lbf (445 N) per ASTM D 2646.
    c. Resistance to Insects: Comply with AATCC 24.
    d. Noise Reduction Coefficient (NRC): per ASTM C 423.
    e. Colorfastness to Crocking: Not less than 4, wet and dry, per AATCC 165.

f. Colorfastness to Light: Not less than 4 after 40 **OR** 60, **as directed**, AFU (AATCC fading units) per AATCC 16, Option E.
g. Electrostatic Propensity: Less than 3.5 **OR** 2, **as directed**, kV per AATCC 134.
h. Environmental Requirements: Provide carpet that complies with testing and product requirements of Carpet and Rug Institute's "Green Label Plus" program.

C. Carpet Cushion
1. Traffic Classification: CCC Class I, moderate **OR** II, heavy **OR** III, extra-heavy, **as directed**, traffic.
2. Fiber Cushion: Rubberized hair, mothproofed and sterilized **OR** Rubberized jute, mothproofed and sterilized **OR** Synthetic **OR** Resinated, recycled textile, **as directed**.
   a. Weight: as directed by the Owner.
   b. Thickness: as directed by the Owner.plus 5 percent maximum.
   c. Density: as directed by the Owner.
3. Rubber Cushion: Flat **OR** Rippled waffle **OR** Textured flat **OR** Reinforced, **as directed**.
   a. Weight: as directed by the Owner.
   b. Thickness: as directed by the Owner.plus 5 percent maximum.
   c. Compression Resistance: at 25 **OR** 65, **as directed**, percent per ASTM D 3676.
   d. Density: as directed by the Owner.
4. Polyurethane-Foam Cushion: Grafted prime **OR** Densified **OR** Bonded **OR** Mechanically frothed, **as directed**.
   a. Compression Force Deflection at 65 Percent: per ASTM D 3574.
   b. Thickness: as directed by the Owner.
   c. Density: as directed by the Owner.
5. Performance Characteristics: As follows:
   a. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm **OR** 0.22 W/sq. cm, **as directed**.
   b. Noise Reduction Coefficient (NRC): per ASTM C 423.
   c. Environmental Requirements: Provide carpet cushion that complies with testing and product requirements of Carpet and Rug Institute's "Green Label" program.

D. Installation Accessories
1. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet **OR** carpet cushion, **as directed**, manufacturer.
2. Adhesives: Water-resistant, mildew-resistant, nonstaining type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet and is recommended or provided by carpet manufacturer **OR** carpet and carpet cushion manufacturers, **as directed**.
   a. VOC Limits: Provide adhesives with VOC content not more than 50g/L when calculated according to 40 CFR 59, Subpart D (EPA method 24).
3. Tackless Carpet Stripping: Water-resistant plywood, in strips as required to match cushion thickness and that comply with CRI 104, Section 12.2.
4. Seam Adhesive: Hot-melt adhesive tape or similar product recommended by carpet manufacturer for sealing and taping seams and butting cut edges at backing to form secure seams and to prevent pile loss at seams.
5. Metal Edge Strips: Extruded aluminum with mill finish of width shown, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.

1.3 EXECUTION

A. Preparation
1. General: Comply with CRI 104, Section 7.3, "Site Conditions; Floor Preparation," and with carpet manufacturer's written installation instructions for preparing substrates.

2. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch (3 mm) wide or wider, and protrusions more than 1/32 inch (0.8 mm), unless more stringent requirements are required by manufacturer's written instructions.
3. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet **OR** carpet cushion, **as directed**, manufacturer.
4. Broom and vacuum clean substrates to be covered immediately before installing carpet.

B. Installation
1. Comply with CRI 104 and carpet manufacturer's **OR** carpet and carpet cushion manufacturers', **as directed**, written installation instructions for the following:
   a. Direct-Glue-Down Installation: Comply with CRI 104, Section 9, "Direct Glue-Down Installation."
   b. Double-Glue-Down Installation: Comply with CRI 104, Section 10, "Double Glue-Down Installation."
   c. Carpet with Attached-Cushion Installation: Comply with CRI 104, Section 11, "Attached-Cushion Installations."
   d. Preapplied Adhesive Installation: Comply with CRI 104, Section 11.4, "Pre-Applied Adhesive Systems (Peel and Stick)."
   e. Hook-and-Loop Installation: Comply with CRI 104, Section 11.5, "Hook and Loop Technology."
   f. Stretch-in Installation: Comply with CRI 104, Section 12, "Stretch-in Installation."
   g. Stair Installation: Comply with CRI 104, Section 13, "Carpet on Stairs" for stretch-in **OR** glue-down, **as directed**, installation.
2. Comply with carpet manufacturer's written recommendations and Shop Drawings for seam locations and direction of carpet; maintain uniformity of carpet direction and lay of pile. At doorways, center seams under the door in closed position.
   a. Bevel adjoining border edges at seams with hand shears **OR** Level adjoining border edges, **as directed**.
3. Do not bridge building expansion joints with carpet.
4. Cut and fit carpet to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet manufacturer.
5. Extend carpet into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
6. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.
7. Install pattern parallel to walls and borders to comply with CRI 104, Section 15, "Patterned Carpet Installations" and with carpet manufacturer's written recommendations.
8. Comply with carpet cushion manufacturer's written recommendations. Install carpet cushion seams at 90-degree angle with carpet seams.

C. Cleaning And Protecting
1. Perform the following operations immediately after installing carpet:
   a. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet manufacturer.
   b. Remove yarns that protrude from carpet surface.
   c. Vacuum carpet using commercial machine with face-beater element.
2. Protect installed carpet to comply with CRI 104, Section 16, "Protection of Indoor Installations."
3. Protect carpet against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet manufacturer and carpet cushion manufacturer **OR** and carpet adhesive manufacturer **OR** and carpet cushion and adhesive manufacturers, **as directed**.

END OF SECTION 09680

SECTION 09680a - CARPET TILE

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for carpet tile. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes modular, fusion-bonded **OR** tufted, **as directed**, carpet tile.

C. Submittals
1. Product Data: For each product indicated.
2. Shop Drawings: Show the following:
   a. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
   b. Existing flooring materials to be removed.
   c. Existing flooring materials to remain.
   d. Carpet tile type, color, and dye lot.
   e. Type of subfloor.
   f. Type of installation.
   g. Pattern of installation.
   h. Pattern type, location, and direction.
   i. Pile direction.
   j. Type, color, and location of insets and borders.
   k. Type, color, and location of edge, transition, and other accessory strips.
   l. Transition details to other flooring materials.
3. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
   a. Carpet Tile: Full-size Sample.
   b. Exposed Edge, Transition, and other Accessory Stripping: 12-inch- (300-mm-) long Samples.
4. LEED Submittal:
   a. Product Data for Credit EQ 4.3:
      1) For carpet tile, documentation indicating compliance with testing and product requirements of Carpet and Rug Institute's "Green Label Plus" program.
      2) For installation adhesive, including printed statement of VOC content.
5. Product Schedule: For carpet tile. Use same designations indicated on Drawings.
6. Maintenance data.

D. Quality Assurance
1. Installer Qualifications: An experienced installer who is certified by the Floor Covering Installation Board or who can demonstrate compliance with its certification program requirements.
2. Fire-Test-Response Characteristics: Provide products with the critical radiant flux classification indicated in Part 2, as determined by testing identical products per ASTM E 648 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
3. Preinstallation Conference: Conduct conference at Project site.

E. Delivery, Storage, And Handling
1. Comply with CRI 104, Section 5, "Storage and Handling."

F. Project Conditions
1. Comply with CRI 104, Section 7.2, "Site Conditions; Temperature and Humidity" and Section 7.12, "Ventilation."
2. Environmental Limitations: Do not install carpet tiles until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
3. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.
4. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

G. Warranty
1. Special Warranty for Carpet Tiles: Manufacturer's standard form in which manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
   a. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
   b. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, loss of tuft bind strength, dimensional stability, excess static discharge, and delamination.
   c. Warranty Period: 10 years from date of Substantial Completion.

1.2 PRODUCTS

A. Carpet Tile
1. Fiber Content: 100 percent nylon 6, 6 **OR** 100 percent nylon 6 **OR** 100 percent polypropylene **OR** 100 percent wool **OR** 80 percent wool; 20 percent nylon 6, 6 **OR** 80 percent wool; 20 percent nylon 6, **as directed**.
2. Fiber Type: <**Insert proprietary fiber type**.>
3. Pile Characteristic: Level-loop **OR** Cut **OR** Cut-and-loop, **as directed**, pile.
4. Yarn Twist: <**Insert twist in TPI (TPCM)**.>
5. Yarn Count: <**Insert yarn count**.>
6. Density: <**Insert oz./cu. yd. (g/cu. cm)**.>
7. Pile Thickness: <**Insert inches (mm)**> for finished carpet tile per ASTM D 6859.
8. Stitches: <**Insert stitches per inch (mm)**.>
9. Gage: <**Insert gage in ends per inch (mm)**.>
10. Surface Pile Weight: <**Insert oz./sq. yd. (g/sq. m)**.>
11. Total Weight: <**Insert oz./sq. yd. (g/sq. m)**> for finished carpet tile.
12. Primary Backing/Backcoating: Manufacturer's standard composite materials **OR** PVC **OR** Fiberglass-reinforced PVC **OR** Fiberglass-reinforced amorphous resin **OR** Reinforced polyurethane composite cushion **OR** Reinforced polyurethane composite **OR** Reinforced thermoplastic copolymer, **as directed**.
13. Secondary Backing: Manufacturer's standard material.
14. Backing System: <**Insert proprietary name**.>
15. Size: 18 by 18 inches (457 by 457 mm) **OR** 24 by 24 inches (610 by 610 mm) **OR** 18 by 36 inches (457 by 914 mm) **OR** 36 by 36 inches (914 by 914 mm), **as directed**.
16. Applied Soil-Resistance Treatment: Manufacturer's standard material.
17. Antimicrobial Treatment: Manufacturer's standard material.
18. Performance Characteristics: As follows:
    a. Critical Radiant Flux Classification: Not less than0.45 W/sq. cm **OR** 0.22 W/sq. cm, **as directed**.
    b. Dry Breaking Strength: Not less than 100 lbf (445 N) per ASTM D 2646.
    c. Tuft Bind: Not less than 3 lbf (13 N) **OR** 5 lbf (22 N) **OR** 6.2 lbf (28 N) **OR** 8 lbf (36 N) **OR** 10 lbf (45 N), **as directed**, per ASTM D 1335.

d. Delamination: Not less than 3.5 lbf/in. (15 N/mm) **OR** 4 lbf/in. (18 N/mm), **as directed**, per ASTM D 3936.
e. Dimensional Tolerance: Within 1/32 inch (0.8 mm) of specified size dimensions, as determined by physical measurement.
f. Dimensional Stability: 0.2 percent or less per ISO 2551 (Aachen Test).
g. Resistance to Insects: Comply with AATCC 24.
h. Noise Reduction Coefficient (NRC): <**Insert NRC**> per ASTM C 423.
i. Colorfastness to Crocking: Not less than 4, wet and dry, per AATCC 165.
j. Colorfastness to Light: Not less than 4 after 40 **OR** 60, **as directed**, AFU (AATCC fading units) per AATCC 16, Option E.
k. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria; not less than 1-mm halo of inhibition for gram-negative bacteria; no fungal growth; per AATCC 174.
l. Electrostatic Propensity: Less than 3.5 **OR** 2, **as directed**, kV per AATCC 134.
m. Environmental Requirements: Provide carpet tile that complies with testing and product requirements of Carpet and Rug Institute's "Green Label Plus" program.

B. Installation Accessories
1. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
2. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet tile and is recommended by carpet tile manufacturer for releasable installation.
a. VOC Limits: Provide adhesives with VOC content not more than 50 g/L when calculated according to 40 CFR 59, Subpart D (EPA method 24).

1.3 EXECUTION

A. Preparation
1. General: Comply with CRI 104, Section 6.2, "Site Conditions; Floor Preparation," and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile installation.
2. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch (3 mm) wide or wider and protrusions more than 1/32 inch (0.8 mm), unless more stringent requirements are required by manufacturer's written instructions.
3. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet tile manufacturer.
4. Clean metal substrates of grease, oil, soil and rust, and prime if directed by adhesive manufacturer. Rough sand painted metal surfaces and remove loose paint. Sand aluminum surfaces, to remove metal oxides, immediately before applying adhesive.
5. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

B. Installation
1. General: Comply with CRI 104, Section 14, "Carpet Modules," and with carpet tile manufacturer's written installation instructions.
2. Installation Method: As recommended in writing by carpet tile manufacturer **OR** Glue down; install every tile with full-spread, releasable, pressure-sensitive adhesive **OR** Partial glue down; install periodic tiles with releasable, pressure-sensitive adhesive **OR** Free lay; install carpet tiles without adhesive, **as directed**.
3. Maintain dye lot integrity. Do not mix dye lots in same area.
4. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.

5. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
6. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.
7. Install pattern parallel to walls and borders.
8. Stagger joints of carpet tiles so carpet tile grid is offset from access flooring panel grid. Do not fill seams of access flooring panels with carpet adhesive; keep seams free of adhesive.

C. Cleaning And Protection
1. Perform the following operations immediately after installing carpet tile:
   a. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet tile manufacturer.
   b. Remove yarns that protrude from carpet tile surface.
   c. Vacuum carpet tile using commercial machine with face-beater element.
2. Protect installed carpet tile to comply with CRI 104, Section 16, "Protection of Indoor Installations."
3. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 09680a

SECTION 09720 - WALL COVERINGS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for wall coverings. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Vinyl wall covering.
b. Woven glass-fiber wall covering.
c. Textile wall covering.
d. Heavy-duty synthetic textile wall covering.
e. Wood-veneer wall covering.
f. Wallpaper.

C. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that wood-veneer wall coverings comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
b. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content.
c. Product Data for Credit EQ 4.2: For paints and coatings, including printed statement of VOC content and chemical components.
3. Shop Drawings: Show location and extent of each wall-covering type. Indicate pattern placement, veneer matching, seams and termination points.
4. Samples: Full width by 36-inch- (914-mm-) long section of wall covering from same print run or dye lot to be used for the Work, with specified treatments, paint, applied. Show complete pattern repeat. Mark top and face of fabric.
5. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for wall covering.
6. Maintenance Data: For wall coverings to include in maintenance manuals.

D. Quality Assurance
1. Forest Certification: Fabricate products with wood veneer produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
2. Fire-Test-Response Characteristics: As determined by testing identical wall coverings applied with identical adhesives to substrates according to test method indicated below by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
a. Surface-Burning Characteristics: As follows, per ASTM E 84:
1) Flame-Spread Index: 25 or less.
2) Smoke-Developed Index: 50 **OR** 450, **as directed**, or less.
b. Fire-Growth Contribution: Textile wall coverings complying with acceptance criteria of UBC Standard 8-2.
c. Fire-Growth Contribution: Textile wall coverings tested according to NFPA 265 **OR** NFPA 286, **as directed**, and complying with test protocol and criteria in the 2003 IBC.

E. Project Conditions

1. Environmental Limitations: Do not deliver or install wall coverings until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
   a. Wood-Veneer Wall Coverings: Condition spaces for not less than 48 hours before installation.
2. Lighting: Do not install wall covering until a permanent level of lighting is provided on the surfaces to receive wall covering.
3. Ventilation: Provide continuous ventilation during installation and for not less than the time recommended by wall-covering manufacturer for full drying or curing.

1.2 PRODUCTS

A. Wall Coverings
   1. General: Provide rolls of each type of wall covering from same print run or dye lot.

B. Vinyl Wall Covering
   1. Vinyl Wall-Covering Standards: Provide products **OR** mildew-resistant products, **as directed**, complying with the following:
      a. FS CCC-W-408D and CFFA-W-101-D for Type I, Light-Duty **OR** Type II, Medium-Duty **OR** Type III, Heavy-Duty, **as directed**, products.
      b. ASTM F 793 for peelable **OR** strippable, **as directed**, wall coverings that qualify as Category I, Decorative Only **OR** Category II, Decorative with Medium Serviceability **OR** Category III, Decorative with High Serviceability **OR** Category IV, Type I, Commercial Serviceability **OR** Category V, Type II, Commercial Serviceability **OR** Category VI, Type III, Commercial Serviceability, **as directed**, products.
   2. Width: 27 inches (686 mm) **OR** 54 inches (1372 mm), **as directed**.
   3. Backing: Scrim **OR** Osnaburg **OR** Drill **OR** Nonwoven, **as directed**, fabric.
      a. Fiber Content: Cotton **OR** Polyester **OR** Polycotton **OR** Polyester cellulose, **as directed**.
   4. Repeat: Random.
   5. Colors, Textures, and Patterns: As selected from manufacturer's full range.

C. Woven Glass-Fiber Wall Covering
   1. Width: 39 inches (991 m).
   2. Colors, Textures, and Patterns: As selected from manufacturer's full range.

D. Textile Wall Covering
   1. Wall-Covering Standard: Provide mildew-resistant **OR** peelable **OR** strippable, **as directed**, wall coverings that comply with ASTM F 793 for Category I, Decorative Only **OR** Category II, Decorative with Medium Serviceability **OR** Category III, Decorative with High Serviceability **OR** Category IV, Type I, Commercial Serviceability **OR** Category V, Type II, Commercial Serviceability **OR** Category VI, Type III, Commercial Serviceability, **as directed**, products.
   2. Test Responses:
      a. Colorfastness to Wet and Dry Crocking: Passes AATCC 8, Grade 3, minimum.
      b. Colorfastness to Light: Passes AATCC 16, Option 1 or 3, Grade 4, minimum, at 40 hours.
   3. Repeat: Random.
   4. Applied Backing Material: Acrylic **OR** Paper, **as directed**.
   5. Colors, Textures, and Patterns: As selected from manufacturer's full range.

E. Heavy-Duty Synthetic Textile Wall Covering
   1. Wall-Covering Standard: Provide wall coverings **OR** mildew-resistant wall coverings, **as directed**, that comply with ASTM F 793 for Category IV, Type I, Commercial Serviceability **OR** Category V, Type II, Commercial Serviceability **OR** Category VI, Type III, Commercial Serviceability, **as directed**, products.

2. Test Responses:
   a. Colorfastness to Wet and Dry Crocking: Passes AATCC 8, Class 3, minimum.
   b. Colorfastness to Light: Passes AATCC 16A or AATCC 16E, Class 4, minimum, at 40 hours.
3. Width: 54 inches (1372 mm) **OR** 60 inches (1524 mm), **as directed**.
4. Colors, Textures, and Patterns: As selected from manufacturer's full range.

F. Wood-Veneer Wall Covering
1. Sheet Size: 24 by 96 inches (610 by 2440 mm) **OR** 48 by 96 inches (1220 by 2440 mm) **OR** 48 by 120 inches (1220 by 3050 mm), **as directed**.
2. Veneer Construction: Single ply veneer **OR** Two veneer plies assembled perpendicular to one another, **as directed**.
3. Wood Species: Red oak **OR** Maple **OR** Cherry, **as directed**.
4. Veneer Match: Book **OR** Slip, **as directed**.
5. Sheet Match: Running **OR** Balance **OR** Center **OR** Sequence, as indicated **OR** Blueprint, as indicated, **as directed**.
6. Applied Backing Material: Fabric.
7. Finish: Factory **OR** Field, **as directed**, applied using wall-covering manufacturer's standard stain and polyurethane system.
   a. Colors: As selected from manufacturer's full range.

G. Wallpaper
1. Wall-Covering Standard: Provide mildew-resistant **OR** peelable **OR** strippable, **as directed**, wallpaper that complies with ASTM F 793 for Category I, Decorative Only **OR** Category II, Decorative with Medium Serviceability **OR** Category III, Decorative with High Serviceability, **as directed**, products.
2. Width: 20-1/2 inches (520.7 mm) **OR** 28 inches (711.2 mm), **as directed**.
3. Repeat: Random.
4. Colors, Textures, and Patterns: As selected from manufacturer's full range.

H. Accessories
1. Adhesive: Mildew-resistant, nonstaining, strippable, **as directed**, adhesive, for use with specific wall covering and substrate application; as recommended in writing by wall-covering manufacturer and with a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Primer/Sealer: Mildew resistant, complying with requirements in Division 09 Section "Interior Painting" and recommended in writing by wall-covering manufacturer for intended substrate.
3. Wall Liner: Nonwoven, synthetic underlayment and adhesive as recommended by wall-covering manufacturer.
4. Seam Tape: As recommended in writing by wall-covering manufacturer.
5. Metal Primer: Interior ferrous metal primer complying with Division 09 Section "Interior Painting".

1.3 EXECUTION

A. Preparation
1. Comply with manufacturer's written instructions for surface preparation.
2. Clean substrates of substances that could impair bond of wall covering, including dirt, oil, grease, mold, mildew, and incompatible primers.
3. Prepare substrates to achieve a smooth, dry, clean, structurally sound surface free of flaking, unsound coatings, cracks, and defects.
   a. Moisture Content: Maximum of 5 percent on new plaster, concrete, and concrete masonry units when tested with an electronic moisture meter.
   b. Plaster: Allow new plaster to cure. Neutralize areas of high alkalinity. Prime with primer as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.

c. Metals: If not factory primed, clean and apply metal as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
d. Gypsum Board: Prime with primer as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
e. Painted Surfaces: Treat areas susceptible to pigment bleeding.

4. Check painted surfaces for pigment bleeding. Sand gloss, semigloss, and eggshell finish with fine sandpaper.
5. Remove hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.
6. Acclimatize wall-covering materials by removing them from packaging in the installation areas not less than 24 hours before installation.
7. Install wall liner, with no gaps or overlaps, where required by wall-covering manufacturer. Form smooth wrinkle-free surface for finished installation. Do not begin wall-covering installation until wall liner has dried.

B. Installation
1. General: Comply with wall-covering manufacturers' written installation instructions applicable to products and applications indicated except where more stringent requirements apply.
2. Cut wall-covering strips in roll number sequence. Change roll numbers at partition breaks and corners.
3. Install strips in same order as cut from roll.
4. Install reversing every other strip.
5. Install wall covering with no gaps or overlaps, no lifted or curling edges, and no visible shrinkage.
6. Match pattern 72 inches (1830 mm) above the finish floor.
7. Install seams vertical and plumb at least 6 inches (150 mm) from outside corners and 3 inches (75 mm) **OR** 6 inches (150 mm), **as directed**, from inside corners unless a change of pattern or color exists at corner. No horizontal seams are permitted.
8. Fully bond wall covering to substrate. Remove air bubbles, wrinkles, blisters, and other defects.
9. Trim edges and seams for color uniformity, pattern match, and tight closure. Butt seams without any overlay or spacing between strips.

C. Field Finishing Of Wood-Veneer Wall Coverings
1. Apply wall-covering manufacturer's standard stain and polyurethane system according to coating manufacturer's written instructions to produce finish that is consistent in color and gloss and matches approved Samples.
2. Apply no fewer than two **OR** three, **as directed**, finish coats.

D. Cleaning
1. Remove excess adhesive at finished seams, perimeter edges, and adjacent surfaces.
2. Use cleaning methods recommended in writing by wall-covering manufacturer.
3. Replace strips that cannot be cleaned.
4. Reinstall hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

END OF SECTION 09720

SECTION 09835 - ACOUSTICAL WALL PANELS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for acoustical wall panels. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes spline-mounted **OR** back-mounted, **as directed**, acoustical wall panels.

C. Definitions
1. NRC: Noise reduction coefficient.

D. Submittals
1. Product Data: For each type of panel edge, core material, and mounting indicated.
2. Shop Drawings: For acoustical wall panels. Include mounting devices and details.
3. Coordination Drawings: Show intersections with adjacent work.
4. Samples: For each fabric and sample panels.
5. LEED Submittal:
   a. Product Data for Credit EQ 4.1: For installation adhesive, including printed statement of VOC content.
6. Product certificates **OR** test reports, **as directed**.
7. Maintenance data.
8. Warranty: Special warranty specified in this Section.

E. Quality Assurance
1. Fire-Test-Response Characteristics: Provide acoustical wall panels with the following surface-burning characteristics as determined by testing identical products per ASTM E 84 **OR** UBC Standard 8-1, **as directed**, by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
   a. Flame-Spread Index: 25 or less.
   b. Smoke-Developed Index: 450 or less.
2. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Comply with fabric and acoustical wall panel manufacturers' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.
2. Deliver materials and panels in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.
3. Protect panel edges from crushing and impact.

G. Project Conditions
1. Environmental Limitations: Do not install acoustical wall panels until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
2. Lighting: Do not install acoustical wall panels until a permanent level of lighting **OR** a lighting level of not less than 50 fc (538 lux), **as directed**, is provided on surfaces to receive acoustical wall panels.
3. Air-Quality Limitations: Protect acoustical wall panels from exposure to airborne odors, such as tobacco smoke, and install panels under conditions free from odor contamination of ambient air.

4. Field Measurements: Verify locations of acoustical wall panels by field measurements before fabrication and indicate measurements on Shop Drawings.

H. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of acoustical wall panels that fail in performance, materials, or workmanship within two years from date of Substantial Completion.
a. Failure in performance includes, but is not limited to, acoustical performance.
b. Failures in materials include, but are not limited to, fabric sagging, distorting, or releasing from panel edge; or warping of core.

1.2 PRODUCTS

A. Core Materials
1. Glass-Fiber Board: ASTM C 612, Type IA or Types IA and IB; density as specified, unfaced, dimensionally stable, molded rigid board, with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.
2. Mineral-Fiber Board: Maximum flame-spread and smoke-developed indexes of 15 and 5, respectively.
3. Cementitious-Fiber Board Core: Density of not less than 20 lb/cu. ft. (320 kg/cu. m).
4. Tackable, Impact-Resistant, High-Density Face Layer: 1/8-inch- (3.2-mm-) thick layer of compressed molded glass-fiber board with a minimum nominal density of 16 to 18 lb/cu. ft. (256 to 288 kg/cu. m) laminated to face of core.
5. Impact-Resistant, Acoustically Transparent, Copolymer Face-Sheet Layer for High-Abuse Applications: 1/16- to 1/8-inch- (1.6- to 3.2-mm-) thick layer of perforated, noncombustible, copolymer sheet laminated to face of core.
6. Wood: Clear, vertical grain, straight, kiln-dried hardwood of manufacturer's standard species, AWPA C20, Interior Type A, fire-retardant treated, low-hygroscopic-type formulation. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Kiln-dry material after treatment to 5 to 10 percent moisture content.

B. Spline-Mounted Acoustical Wall Panels With Perforated Mineral-Fiber Board Core Or Cementitious-Fiber Board Core
1. Panel Construction: Manufacturer's standard panel construction consisting of facing material laminated to front face of a perforated, water-felted, mineral-fiber board **OR** cementitious-fiber board, **as directed**, core; with long edges kerfed and rabbeted to receive splines.
a. Mineral-Fiber Board: Not less than 13-lb/cu. ft. (208-kg/cu. m) **OR** 20-lb/cu. ft. (320-kg/cu. m), **as directed**, nominal density; with perforated surface.
2. Facing Material: Fabric from same dye lot; color and pattern as indicated by manufacturer's designations **OR** matching samples **OR** as selected from manufacturer's full range **OR** as indicated on Drawings, **as directed**.
a. Fiber Content: 100 percent woven polyester **OR** nonwoven polyester **OR** polyolefin **OR** acoustically transparent vinyl, **as directed**.
b. Width: 54 inches (1371 mm) **OR** 66 inches (1676 mm), **as directed**.
c. Applied Treatments: Stain resistance.
3. Nominal Overall Panel Thickness: 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**.
4. NRC: For Type A mounting per ASTM E 795, NRC 0.50 to NRC 0.90 **OR** NRC 0.60 to NRC 0.70 **OR** NRC 0.65 to NRC 0.75, **as directed**.
5. Panel Width: 24 inches (610 mm) **OR** 30 inches (762 mm) **OR** 48 inches (1220 mm) **OR** 600 mm **OR** As indicated on Drawings, **as directed**.
6. Panel Height: Fabricated from units 96 inches (2438 mm) **OR** 108 inches (2743 mm) **OR** 120 inches (3048 mm), **as directed**, in height; mounting height **as directed**.
7. Panel Edge: Core self-edge.
8. Panel Short Edge Detail: Square.

C. Spline-Mounted Acoustical Wall Panels With Glass-Fiber Board Core
   1. Panel Construction: Manufacturer's standard panel construction consisting of facing material laminated to front face of a dimensionally stable, rigid glass-fiber board core with a nominal density of 6 to 7 lb/cu. ft. (96 to 112 kg/cu. m); with long edges kerfed and rabbeted to receive splines.
   2. Core-Face Layer: Tackable, impact-resistant, high-density board **OR** Impact-resistant, acoustically transparent, copolymer face-sheet, **as directed**.
   3. Facing Material: Fabric from same dye lot; color and pattern as indicated by manufacturer's designations **OR** matching samples **OR** as selected from manufacturer's full range **OR** as indicated on Drawings, **as directed**.
      a. Fiber Content: 100 percent woven polyester **OR** nonwoven polyester **OR** polyolefin **OR** acoustically transparent vinyl, **as directed**.
      b. Width: 54 inches (1371 mm) **OR** 66 inches (1676 mm), **as directed**.
      c. Applied Treatments: Stain resistance.
   4. Nominal Overall Panel Thickness: 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (51 mm), **as directed**.
   5. NRC: For Type A mounting per ASTM E 795, not less than NRC 0.20 **OR** NRC 0.80 **OR** NRC 0.95, **as directed**.
   6. Panel Width: Manufacturer's standard **OR** 24 inches (610 mm) **OR** 30 inches (762 mm) **OR** 48 inches (1220 mm) **OR** 600 mm **OR** 1200 mm **OR** As indicated on Drawings, **as directed**.
   7. Panel Height: Fabricated from units 96 inches (2438 mm) **OR** 108 inches (2743 mm) **OR** 120 inches (3048 mm), **as directed**, in height; mounting height **as directed**.
   8. Panel Edge: Manufacturer's standard short edge.
   9. Panel Short Edge Detail: Square.

D. Back-Mounted Acoustical Wall Panels With Perforated Mineral-Fiber Board Core
   1. Panel Construction: Manufacturer's standard panel construction consisting of facing material laminated to front face of a perforated, water-felted, mineral-fiber board core of not less than 13-lb/cu. ft. (208-kg/cu. m) **OR** 20-lb/cu. ft. (320-kg/cu. m), **as directed**, nominal density; with perforated surface.
   2. Facing Material: Fabric from same dye lot; color and pattern as indicated by manufacturer's designations **OR** matching samples **OR** as selected from manufacturer's full range **OR** as indicated on Drawings, **as directed**.
      a. Fiber Content: 100 percent woven polyester **OR** nonwoven polyester **OR** polyolefin **OR** acoustically transparent vinyl, **as directed**.
      b. Width: 54 inches (1371 mm) **OR** 66 inches (1676 mm), **as directed**.
      c. Applied Treatments: Stain resistance.
   3. Nominal Core Thickness and Overall System NRC: 1/2 inch (13 mm) and not less than NRC 0.35 **OR** 3/4 inch (19 mm) and not less than NRC 0.45, **as directed**, for Type A mounting.
   4. Panel Width: 24 inches (610 mm) **OR** 30 inches (762 mm) **OR** 48 inches (1220 mm) **OR** 600 mm **OR** As indicated on Drawings, **as directed**.
   5. Panel Height: Fabricated from units 96 inches (2438 mm) **OR** 108 inches (2743 mm) **OR** 120 inches (3048 mm), **as directed**, in height; mounting height **as directed**.
   6. Panel Edge: Core self-edge.
   7. Panel Short Edge Detail: Square.

E. Back-Mounted, Edge-Reinforced Acoustical Wall Panels With Glass-Fiber Board Core
   1. Panel Construction: Manufacturer's standard panel construction consisting of facing material laminated to front face, edges, and back border of dimensionally stable, rigid glass-fiber **OR** rock-fiber/slag-fiber, **as directed**, board core; with edges chemically hardened or impact resistant and resilient to reinforce panel perimeter against warpage and damage.
   2. Nominal Core Density: 4 to 7 lb/cu. ft. (64 to 112 kg/cu. m) **OR** 6 to 7 lb/cu. ft. (96 to 112 kg/cu. m), **as directed**.
   3. Core-Face Layer: Tackable, impact-resistant, high-density board **OR** Impact-resistant, acoustically transparent, copolymer face-sheet, **as directed**.

4. Facing Material: Fabric from same dye lot; color and pattern as indicated by manufacturer's designations **OR** matching samples **OR** as selected from manufacturer's full range **OR** as indicated on Drawings, **as directed**.
   a. Fiber Content: 100 percent woven polyester **OR** nonwoven polyester **OR** polyolefin **OR** acoustically transparent vinyl, **as directed**.
   b. Width: 54 inches (1371 mm) **OR** 66 inches (1676 mm), **as directed**.
   c. Applied Treatments: Stain resistance.
5. Nominal Core Thickness and Overall System NRC: 3/4 inch (19 mm) and not less than NRC 0.65 **OR** 1 inch (25 mm) and not less than NRC 0.80 **OR** 1-1/2 inches (38 mm) and not less than NRC 0.85 **OR** 2 inches (51 mm) and not less than NRC 0.90 **OR** 2 inches (51 mm) and not less than NRC 1.00, **as directed**, for Type A mounting per ASTM E 795.
6. Panel Width: Manufacturer's standard **OR** 24 inches (610 mm) **OR** 30 inches (762 mm) **OR** 48 inches (1220 mm) **OR** 600 mm **OR** 1200 mm **OR** As indicated on Drawings, **as directed**.
7. Panel Height: Fabricated height as indicated on Drawings **OR as directed**; mounting height as indicated on Drawings **OR as directed**.
8. Panel Edge Detail: Square **OR** Bullnosed (radiused) **OR** Chamfered (beveled) **OR** Mitered **OR** Custom as indicated on Drawings, **as directed**.
9. Corner Detail: Square **OR** Round, radius as indicated **OR** Off-square, dimensions as indicated, **as directed**, to form continuous profile to match edge detail.

F. Back-Mounted, Edge-Framed Acoustical Wall Panels With Glass-Fiber Board Core
1. Panel Construction: Manufacturer's standard panel construction consisting of facing material stretched over front face of edge-framed, dimensionally stable, rigid glass-fiber board core and bonded or attached to edges and back of frame.
2. Nominal Core Density: 4 to 7 lb/cu. ft. (64 to 112 kg/cu. m) **OR** 6 to 7 lb/cu. ft. (96 to 112 kg/cu. m), **as directed**.
3. Core-Face Layer: Tackable, impact-resistant, high-density board **OR** Impact-resistant, acoustically transparent, copolymer face-sheet, **as directed**.
4. Facing Material: Fabric from same dye lot; color and pattern as indicated by manufacturer's designations **OR** matching samples **OR** as selected from manufacturer's full range **OR** as indicated on Drawings, **as directed**.
   a. Fiber Content: 100 percent woven polyester **OR** nonwoven polyester **OR** polyolefin **OR** acoustically transparent vinyl, **as directed**.
   b. Width: 54 inches (1371 mm) **OR** 66 inches (1676 mm), **as directed**.
   c. Applied Treatments: Stain resistance.
5. Nominal Core Thickness and Overall System NRC: 1 inch (25 mm) and not less than NRC 0.80 **OR** 1-1/2 inches (38 mm) and not less than NRC 0.85 **OR** 2 inches (51 mm) and not less than NRC 0.90, **as directed**, for Type A mounting per ASTM E 795.
6. Panel Width: Manufacturer's standard **OR** 24 inches (610 mm) **OR** 30 inches (762 mm) **OR** 48 inches (1220 mm) **OR** 600 mm **OR** 1200 mm **OR** As indicated on Drawings, **as directed**.
7. Panel Height: Fabricated height as indicated on Drawings **OR as directed**; mounting height as indicated on Drawings **OR as directed**.
8. Panel Edge and Frame: Extruded-aluminum or zinc-coated, rolled-steel shape **OR** Extruded PVC **OR** Hardwood, rabbeted, and splined with glued joints and machined corners, **as directed**.
   a. Panel Edge Detail: Square.

G. Fabrication
1. Sound-Absorption Performance: Provide acoustical wall panels with minimum NRCs indicated, as determined by testing per ASTM C 423 for mounting type specified.
2. Acoustical Wall Panels: Panel construction consisting of facing material adhered to face, **as directed**, edges and back border of dimensionally stable core; with rigid edges to reinforce panel perimeter against warpage and damage.
   a. Glass-Fiber Board: Resin harden areas of core for attachment of mounting devices.

3. Fabric Facing: Stretched straight, on the grain, tight, square, and free from puckers, ripples, wrinkles, sags, blisters, seams, adhesive, or other foreign matter. Applied with visible surfaces fully covered.
   a. Where square corners are indicated, tailor corners. Heat seal vinyl fabric seams at corners.
   b. Where radius or other nonsquare corners are indicated, attach facing material so there are no seams or gathering of material.
   c. Where fabrics with directional or repeating patterns or directional weave are indicated, mark fabric top and attach fabric in same direction so pattern or weave matches in adjacent panels.
4. Core-Face Layer: Evenly stretched over core face and edges and securely attached to core; free from puckers, ripples, wrinkles, sags.
5. Dimensional Tolerances of Finished Units: Plus or minus 1/16 inch (1.6 mm) for the following:
   a. Thickness.
   b. Edge straightness.
   c. Overall length and width.
   d. Squareness from corner to corner.
   e. Chords, radii, and diameters.
6. Spline-Mounting Accessories: Manufacturer's standard concealed, extruded-aluminum or plastic connecting splines designed and fabricated for screw attachment to walls, with other moldings and trim for interior and exterior corners, leveling and base support with factory-applied finish on exposed items.
   a. Finish Color: White **OR** Black **OR** Match color of facing material **OR** Match sample, **as directed**.
7. Back-Mounting Devices: Concealed on backside of panel, recommended to support weight of panel, with base-support bracket system where recommended by manufacturer for additional support of panels, and as follows:
   a. Adhesive. Use only adhesives that have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   b. Hook-and-loop tape.
   c. Impaling clips.
   d. Magnetic strip or devices.
   e. Metal "Z" Clips: Two-part panel clips, with one part of each clip mechanically attached to back of panel and the other part to wall substrate, designed to allow for panel removal.
   f. As recommended by manufacturer.
8. Owner-Furnished Fabric: Provide fabric acceptable to acoustical wall panel manufacturer for application indicated. Notify the Owner of fabric unacceptability.

1.3 EXECUTION

A. Installation
1. Install acoustical wall panels in locations indicated with vertical surfaces and edges plumb, top edges level and in alignment with other panels, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.
   a. Cut units to be at least 50 percent of unit width, with facing material extended over cut edge to match uncut edge. Scribe acoustical wall panels to fit adjacent work. Butt joints tightly.
2. Comply with acoustical wall panel manufacturer's written instructions for installation of panels using type of concealed mounting accessories indicated or, if not indicated, as recommended by manufacturer. Anchor panels securely to supporting substrate.
3. Match and level fabric pattern and grain among adjacent panels.
4. Installation Tolerances: As follows:
   a. Variation from Level and Plumb: Plus or minus 1/16 inch (1.6 mm).
   b. Variation of Panel Joints from Hairline: Not more than 1/16 inch (1.6 mm) **OR** 1/32 inch (0.79 mm), **as directed**, wide.

B. Cleaning
   1. Clip loose threads; remove pills and extraneous materials.
   2. Clean panels with fabric facing, on completion of installation, to remove dust and other foreign materials according to manufacturer's written instructions.

C. Protection
   1. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, to ensure that acoustical wall panels are without damage or deterioration at time of Substantial Completion.
   2. Replace acoustical wall panels that cannot be cleaned and repaired, in a manner approved by the Owner, before time of Substantial Completion.

END OF SECTION 09835

SECTION 09910 - EXTERIOR PAINTING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for exterior painting. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes surface preparation and the application of paint systems on the following exterior substrates:
   a. Concrete.
   b. Clay masonry.
   c. Concrete masonry units (CMU).
   d. Steel.
   e. Galvanized metal.
   f. Aluminum (not anodized or otherwise coated).
   g. Wood.
   h. Plastic trim fabrications.
   i. Exterior portland cement (stucco).
   j. Exterior gypsum board.

C. Submittals
1. Product Data: For each type of product indicated.
2. Samples: For each finish and for each color and texture required.
3. Product List: Printout of current "MPI Approved Products List" for each product category specified in Part 1.2, with the proposed product highlighted.

D. Quality Assurance
1. MPI Standards:
   a. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
   b. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated. For renovation projects, comply with requirements of "MPI Maintenance Repainting Manual" for products and paint systems indicated.

E. Delivery, Storage, And Handling
1. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
   a. Maintain containers in clean condition, free of foreign materials and residue.
   b. Remove rags and waste from storage areas daily.

F. Project Conditions
1. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).
2. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

1.2 PRODUCTS

A. Paint, General
1. Material Compatibility:
a. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
b. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
2. Colors: As selected from manufacturer's full range.

B. Block Fillers
1. Interior/Exterior Latex Block Filler: MPI #4.
a. VOC Content: E Range of E2 **OR** E3, **as directed**.

C. Primers/Sealers
1. Alkali-Resistant Primer: MPI #3.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
2. Bonding Primer (Water Based): MPI #17.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
3. Bonding Primer (Solvent Based): MPI #69.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
4. Wood-Knot Sealer: Sealer recommended in writing by topcoat manufacturer for use in paint system indicated.

D. Metal Primers
1. Alkyd Anticorrosive Metal Primer: MPI #79.
a. VOC Content: E Range of E1 **OR** E2, **as directed**.
2. Quick-Drying Alkyd Metal Primer: MPI #76.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
3. Cementitious Galvanized-Metal Primer: MPI #26.
a. VOC Content: E Range of E1.
4. Waterborne Galvanized-Metal Primer: MPI #134.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
5. Quick-Drying Primer for Aluminum: MPI #95.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

E. Wood Primers
1. Exterior Latex Wood Primer: MPI #6.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
2. Exterior Alkyd Wood Primer: MPI #5.
a. VOC Content: E Range of E2 **OR** E3, **as directed**.
3. Exterior Oil Wood Primer: MPI #7.
a. VOC Content: E Range of E2.

F. Exterior Latex Paints
1. Exterior Latex (Flat): MPI #10 (Gloss Level 1).
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
2. Exterior Latex (Semigloss): MPI #11 (Gloss Level 5).
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
3. Exterior Latex (Gloss): MPI #119 (Gloss Level 6, except minimum gloss of 65 units at 60 deg).
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

G. Exterior Alkyd Paints

1. Exterior Alkyd Enamel (Flat): MPI #8 (Gloss Level 1).
   a. VOC Content: E Range of E1.
2. Exterior Alkyd Enamel (Semigloss): MPI #94 (Gloss Level 5).
   a. VOC Content: E Range of E1 **OR** E2, **as directed**.
3. Exterior Alkyd Enamel (Gloss): MPI #9 (Gloss Level 6).
   a. VOC Content: E Range of E1 **OR** E2, **as directed**.

H. Quick-Drying Enamels
1. Quick-Drying Enamel (Semigloss): MPI #81 (Gloss Level 5).
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
2. Quick-Drying Enamel (High Gloss): MPI #96 (Gloss Level 7).
   a. VOC Content: E Range of E1 **OR** E **OR** E3, **as directed**.

I. Textured And High-Build Coatings
1. Latex Stucco and Masonry Textured Coating: MPI #42.
   a. VOC Content: E Range of E2 **OR** E3, **as directed**.
2. High-Build Latex (Exterior): MPI #40.
   a. VOC Content: E Range of E1 **OR** E3, **as directed**.

J. Aluminum Paint
1. Aluminum Paint: MPI #1.
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

K. Floor Coatings
1. Interior/Exterior Clear Concrete Floor Sealer (Water Based): MPI #99.
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
2. Interior/Exterior Clear Concrete Floor Sealer (Solvent Based): MPI #104.
   a. VOC Content: E Range of E1 **OR** E2, **as directed**.
3. Interior/Exterior Latex Floor and Porch Paint (Low Gloss): MPI #60 (maximum Gloss Level 3).
   a. VOC Content: E Range of E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 3.
4. Exterior/Interior Alkyd Floor Enamel (Gloss): MPI #27 (Gloss Level 6).
   a. VOC Content: E Range of E1 **OR** E2, **as directed**.
   b. Additives: Manufacturer's standard additive to increase skid resistance of painted surface.

1.3 EXECUTION

A. Examination
1. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.
2. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
   a. Concrete: 12 percent.
   b. Masonry (Clay and CMU): 12 percent.
   c. Wood: 15 percent.
   d. Plaster: 12 percent.
   e. Gypsum Board: 12 percent.
3. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
4. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
   a. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

B. Preparation And Application

1. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
2. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
   a. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.
3. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
4. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
5. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

C. Exterior Painting Schedule
1. Paint systems herein are based on "MPI Architectural Painting Specification Manual" (hereafter, "MPI Manual"). For renovation projects, consult "MPI Maintenance Repainting Manual" and revise paint systems accordingly.
2. For a Premium Grade system, "MPI Manual" requires intermediate coat; if Custom Grade system is required or if so directed, delete intermediate coat, **unless directed otherwise** or as otherwise required by manufacturer's recommendations.
3. Concrete Substrates, Nontraffic Surfaces:
   a. Latex System: MPI EXT 3.1A.
      1) Prime Coat: Exterior latex matching topcoat.
      2) Intermediate Coat: Exterior latex matching topcoat.
      3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
   b. Latex Aggregate/Latex System: MPI EXT 3.1 B.
      1) Prime Coat: Latex stucco and masonry textured coating.
      2) Intermediate Coat: Exterior latex matching topcoat.
      3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
   c. Latex Over Alkali-Resistant Primer System: MPI EXT 3.1K.
      1) Prime Coat: Alkali-resistant primer.
      2) Intermediate Coat: Exterior latex matching topcoat.
      3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
   d. High-Build Latex System: MPI EXT 3.1L, applied to form dry film thickness of not less than 10 mils (0.25 mm).
      1) Prime Coat: As recommended in writing by topcoat manufacturer.
      2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
      3) Topcoat: High-build latex (exterior).
   e. Latex Aggregate System: MPI EXT 3.1N.
      1) Prime Coat: As recommended in writing by topcoat manufacturer.
      2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
      3) Topcoat: Latex stucco and masonry textured coating.
4. Concrete Substrates, Traffic Surfaces:
   a. Latex Floor Paint System: MPI EXT 3.2A.
      1) Prime Coat: Interior/exterior latex floor and porch paint (low gloss).
      2) Intermediate Coat: Interior/exterior latex floor and porch paint (low gloss).
      3) Topcoat: Interior/exterior latex floor and porch paint (low gloss).
   b. Alkyd Floor Enamel System: MPI EXT 3.2D.
      1) Prime Coat: Exterior/interior alkyd floor enamel (gloss).
      2) Intermediate Coat: Exterior/interior alkyd floor enamel (gloss).
      3) Topcoat: Exterior/interior alkyd floor enamel (gloss).
   c. Clear Sealer System: MPI EXT 3.2G.
      1) Prime Coat: Interior/exterior clear concrete floor sealer (solvent based).

2) Intermediate Coat: Interior/exterior clear concrete floor sealer (solvent based).
3) Topcoat: Interior/exterior clear concrete floor sealer (solvent based).

d. Water-Based Clear Sealer System: MPI EXT 3.2H.
1) Prime Coat: Interior/exterior clear concrete floor sealer (water based).
2) Intermediate Coat: Interior/exterior clear concrete floor sealer (water based).
3) Topcoat: Interior/exterior clear concrete floor sealer (water based).

5. Clay-Masonry Substrates:
a. Latex System: MPI EXT 4.1A.
1) Prime Coat: Exterior latex matching topcoat.
2) Intermediate Coat: Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

b. High-Build Latex System: MPI EXT 4.1H, applied to form dry film thickness of not less than 10 mils (0.25 mm).
1) Prime Coat: As recommended in writing by topcoat manufacturer.
2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
3) Topcoat: High-build latex (exterior).

c. Latex Aggregate System: MPI EXT 4.1B.
1) Prime Coat: As recommended in writing by topcoat manufacturer.
2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
3) Topcoat: Latex stucco and masonry textured coating.

6. CMU Substrates:
a. Latex System: MPI EXT 4.2A.
1) Prime Coat: Interior/exterior latex block filler.
2) Intermediate Coat: Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

b. Latex Over Alkali-Resistant Primer System: MPI EXT 4.2L.
1) Prime Coat: Alkali-resistant primer.
2) Intermediate Coat: Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

c. High-Build Latex System: MPI EXT 4.2K, applied to form dry film thickness of not less than 10 mils (0.25 mm).
1) Prime Coat: As recommended in writing by topcoat manufacturer.
2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
3) Topcoat: High-build latex (exterior).

d. Latex Aggregate System: MPI EXT 4.2B.
1) Prime Coat: As recommended in writing by topcoat manufacturer.
2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
3) Topcoat: Latex stucco and masonry textured coating.

7. Steel Substrates:
a. Quick-Drying Enamel System: MPI EXT 5.1A.
1) Prime Coat: Quick-drying alkyd metal primer.
2) Intermediate Coat: Quick-drying enamel matching topcoat.
3) Topcoat: Quick-drying enamel (semigloss) **OR** (high gloss), **as directed**.

b. Alkyd System: MPI EXT 5.1D.
1) Prime Coat: Alkyd anticorrosive metal primer.
2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

c. Aluminum Paint System: MPI EXT 5.1K.
1) Prime Coat: Alkyd anticorrosive metal primer.
2) Intermediate Coat: Aluminum paint.
3) Topcoat: Aluminum paint.

8. Galvanized-Metal Substrates: Galvanized-metal substrates should not be chromate passivated (commercially known as "bonderized") if primer is field applied. If galvanized metal is chromate passivated, consult manufacturers for appropriate surface preparation and primers.
a. Latex System: MPI EXT 5.3A.
1) Prime Coat: Cementitious galvanized-metal primer.

2) Intermediate Coat: Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

b. Latex Over Water-Based Primer System: MPI EXT 5.3H. "MPI Manual" recommends latex over water-based primer system for low-contact/traffic areas.
1) Prime Coat: Waterborne galvanized-metal primer.
2) Intermediate Coat: Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

c. Alkyd System: MPI EXT 5.3B.
1) Prime Coat: Cementitious galvanized-metal primer.
2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

9. Aluminum Substrates:
a. Latex System: MPI EXT 5.4H.
1) Prime Coat: Quick-drying primer for aluminum.
2) Intermediate Coat: Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

b. Alkyd System: MPI EXT 5.4F.
1) Prime Coat: Quick-drying primer for aluminum.
2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

10. Glue-Laminated Beam and Column Substrates:
a. Latex System: MPI EXT 6.1L.
1) Prime Coat: Exterior latex wood primer.
2) Intermediate Coat: Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

b. Latex Over Alkyd Primer System: MPI EXT 6.1A.
1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
2) Intermediate Coat: Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

c. Alkyd System: MPI EXT 6.1B.
1) Prime Coat: Exterior alkyd **OR** oil, **as directed,** wood primer.
2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

11. Dressed Lumber Substrates: Including architectural woodwork **OR** doors, **as directed**.
a. Latex System: MPI EXT 6.3L.
1) Prime Coat: Exterior latex wood primer.
2) Intermediate Coat: Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**. Flat paint is not recommended for use on doors.

b. Latex Over Alkyd Primer System: MPI EXT 6.3A.
1) Prime Coat: Exterior alkyd **OR** oil, **as directed,** wood primer.
2) Intermediate Coat: Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**. Flat paint is not recommended for use on doors.

c. Alkyd System: MPI EXT 6.3B.
1) Prime Coat: Exterior alkyd **OR** oil, **as directed,** wood primer.
2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**. Flat paint is not recommended for use on doors.

12. Wood Panel Substrates: Including plywood siding **OR** fascias **OR** soffits, **as directed**.
a. Latex System: MPI EXT 6.4K.
1) Prime Coat: Exterior latex wood primer.
2) Intermediate Coat: Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

b. Latex Over Alkyd Primer System: MPI EXT 6.4G.

1) Prime Coat: Exterior alkyd wood primer.
2) Intermediate Coat: Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

c. Alkyd System: MPI EXT 6.4B.
1) Prime Coat: Exterior alkyd **OR** oil, **as directed,** wood primer.
2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

13. Wood Shingle and Shake Substrates (Excluding Roofs):
a. Latex System: MPI EXT 6.6E.
1) Prime Coat: Exterior latex wood primer.
2) Intermediate Coat: Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

b. Latex Over Alkyd Primer System: MPI EXT 6.6A.
1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
2) Intermediate Coat: Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

c. Alkyd System: MPI EXT 6.6B.
1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

14. Dimension Lumber Substrates, Nontraffic Surfaces: Including board siding **OR** fencing **OR** undersides of decking, **as directed**.
a. Latex System: MPI EXT 6.2M.
1) Prime Coat: Exterior latex wood primer.
2) Intermediate Coat: Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

b. Latex Over Alkyd Primer System: MPI EXT 6.2A.
1) Prime Coat: Exterior alkyd **OR** oil, **as directed,** wood primer.
2) Intermediate Coat: Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

c. Alkyd System: MPI EXT 6.2C.
1) Prime Coat: Exterior alkyd **OR** oil, **as directed,** wood primer.
2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

15. Dimension Lumber Substrates, Traffic Surfaces: Including lumber decking **OR** stairs, **as directed**.
a. Latex System: MPI EXT 6.5E.
1) Prime Coat: Exterior latex wood primer.
2) Intermediate Coat: Interior/exterior latex floor and porch (low gloss).
3) Topcoat: Interior/exterior latex floor and porch (low gloss).
a) With additive to increase skid resistance of painted surface.

b. Latex Over Alkyd Primer System: MPI EXT 6.5A.
1) Prime Coat: Exterior alkyd wood primer.
2) Intermediate Coat: Interior/exterior latex floor and porch (low gloss).
3) Topcoat: Interior/exterior latex floor and porch (low gloss).
a) With additive to increase skid resistance of painted surface.

c. Alkyd Floor Enamel System: MPI EXT 6.5B.
1) Prime Coat: Exterior/interior alkyd floor enamel (gloss).
2) Intermediate Coat: Exterior/interior alkyd floor enamel (gloss).
3) Topcoat: Exterior/interior alkyd floor enamel (gloss).
a) With additive to increase skid resistance of painted surface.

16. Plastic Trim Fabrication Substrates:
a. Latex System: MPI EXT 6.8A.
1) Prime Coat: Bonding primer (water based) **OR** (solvent based), **as directed**.
2) Intermediate Coat: Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

b. Alkyd System: MPI EXT 6.8B.
   1) Prime Coat: Bonding primer (water based) **OR** (solvent based , **as directed**.
   2) Intermediate Coat: Exterior alkyd enamel matching topcoat.
   3) Topcoat: Exterior alkyd enamel (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

17. Stucco Substrates:
   a. Latex System: MPI EXT 9.1A.
      1) Prime Coat: Exterior latex matching topcoat.
      2) Intermediate Coat: Exterior latex matching topcoat.
      3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
   b. Latex Over Alkali-Resistant Primer System: MPI EXT 9.1J.
      1) Prime Coat: Alkali-resistant primer.
      2) Intermediate Coat: Exterior latex matching topcoat.
      3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
   c. High-Build Latex System: MPI EXT 9.1H, applied to form dry film thickness of not less than 10 mils (0.25 mm).
      1) Prime Coat: As recommended in writing by topcoat manufacturer.
      2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
      3) Topcoat: High-build latex (exterior).

18. Exterior Gypsum Board Substrates:
   a. Latex System: MPI EXT 9.2A.
      1) Prime Coat: Exterior latex matching topcoat.
      2) Intermediate Coat: Exterior latex matching topcoat.
      3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

END OF SECTION 09910

SECTION 09910a - WOOD STAINS AND TRANSPARENT FINISHES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for wood stains and transparent finishes. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes surface preparation and the application of wood finishes on the following substrates:
   a. Exterior Substrates:
      1) Exposed glue-laminated beams and columns.
      2) Exposed dimension lumber (rough carpentry).
      3) Dressed lumber (finish carpentry).
      4) Exposed wood panel products.
      5) Wood decks and stairs.
      6) Wood shingles and shakes (excluding roofs).
   b. Interior Substrates:
      1) Exposed glue-laminated beams and columns.
      2) Exposed dimension lumber (rough carpentry).
      3) Dressed lumber (finish carpentry).
      4) Exposed wood panel products.

C. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:
   a. Product Data for Credit EQ 4.2: For interior primers, stains, and transparent finishes, including printed statement of VOC content.
3. Samples: For each finish and for each color and texture required.
4. Product List: Printout of MPI's current "MPI Approved Products List" for each product category specified in Part 1.2, with the product proposed for use highlighted.

D. Quality Assurance
1. MPI Standards:
   a. Products: Complying with MPI standards indicated and listed in its "MPI Approved Products List."
   b. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and finish systems indicated.

E. Delivery, Storage, And Handling
1. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
   a. Maintain containers in clean condition, free of foreign materials and residue.
   b. Remove rags and waste from storage areas daily.

F. Project Conditions
1. Apply finishes only when temperature of surfaces to be finished and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).
2. Do not apply exterior finishes in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

1.2 PRODUCTS

A. Materials, General
1. Material Compatibility:
a. Provide materials for use within each finish system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
b. For each coat in a finish system, provide products recommended in writing by manufacturers of topcoat for use in finish system and on substrate indicated.
2. VOC Content of Field-Applied Interior Primers, Stains, and Transparent Finishes: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24); these requirements do not apply to primers, stains, and transparent finishes that are applied in a fabrication or finishing shop:
a. Flat Primers: VOC content of not more than 50 g/L.
b. Nonflat Primers: VOC content of not more than 150 g/L.
c. Primers, Sealers, and Undercoaters: VOC content of not more than 200 g/L.
d. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
e. Clear Wood Finishes, Lacquers: VOC not more than 550 g/L.
f. Floor Coatings: VOC not more than 100 g/L.
g. Shellacs, Clear: VOC not more than 730 g/L.
h. Stains: VOC not more than 250 g/L.
3. Stain Colors: As selected from manufacturer's full range **OR** Match samples **OR** As indicated in a color schedule, **as directed**.

B. Wood Fillers
1. Wood Filler Paste: MPI #91.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

C. Primers And Sealers
1. Exterior Alkyd Wood Primer: MPI #5.
a. VOC Content: E Range of E2 **OR** E3, **as directed**.
2. Exterior Latex Wood Primer: MPI #6.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
3. Exterior Oil Wood Primer: MPI #7.
a. VOC Content: E Range of E2.
4. Wood Preservative: MPI #37.
a. VOC Content: E Range of E1 **OR** E3, **as directed**.
5. Alkyd Sanding Sealer: MPI #102.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
6. Lacquer Sanding Sealer: MPI #84.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
7. Shellac: MPI #88.
a. VOC Content: E Range of E2 **OR** E3, **as directed**.

D. Stains
1. Exterior Semitransparent Stain (Solvent Based): MPI #13.
a. VOC Content: E Range of E1 **OR** E2, **as directed**.
2. Exterior Solid-Color Stain (Solvent Based): MPI #14.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
3. Exterior, Solid-Color Latex Stain: MPI #16.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
4. Stain for Wood Decks: MPI #33.
a. VOC Content: E Range of E1 **OR** E3, **as directed**.
5. Interior Wood Stain (Semitransparent): MPI #90.

a. VOC Content: E Range of E1 **OR** E2, **as directed**.

E. Varnishes
1. Exterior Marine Spar Varnish (Gloss): MPI #28, Gloss Level 7.
a. VOC Content: E Range of E1 **OR** E2, **as directed**.
2. Exterior Varnish (Gloss): MPI #29, Gloss Level 6.
a. VOC Content: E Range of E1.
3. Exterior Varnish (Semigloss): MPI #30, Gloss Level 5.
a. VOC Content: E Range of E1.
4. Interior Varnish (Flat): MPI #73, Gloss Level 1, alkyd type.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
5. Interior Varnish (Semigloss): MPI #74, Gloss Level 5, alkyd type.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
6. Interior Varnish (Gloss): MPI #75, Gloss Level 6, alkyd type.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

F. Polyurethane Finishes
1. Two-Component Aliphatic Polyurethane (Clear): MPI #78.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
2. Interior, Oil-Modified, Clear Urethane (Satin): MPI #57, Gloss Level 4.
a. VOC Content: E Range of E1 **OR** E2, **as directed**.
3. Interior, Oil-Modified, Clear Urethane (Gloss): MPI #56, Gloss Level 6.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
4. Moisture-Cured Clear Polyurethane (Flat): MPI #71, Gloss Level 1.
a. VOC Content: E Range of E2.
5. Moisture-Cured Clear Polyurethane (Gloss): MPI #31.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

G. Waterborne Acrylic Finishes
1. Waterborne Clear Acrylic (Satin): MPI #128, Gloss Level 4.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
2. Waterborne Clear Acrylic (Semigloss): MPI #129, Gloss Level 5.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
3. Waterborne Clear Acrylic (Gloss): MPI #130, Gloss Level 6.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3**, as directed**.
b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.

H. Lacquers
1. Lacquer (Clear Flat): MPI #87, Gloss Level 1.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
2. Lacquer (Clear Satin): MPI #85, Gloss Level 4.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
3. Lacquer (Clear Gloss): MPI #86, Gloss Level 6.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

I. Oil Finish
1. Danish Oil: MPI #92.
a. VOC Content: E Range of E3.

1.3 EXECUTION

A. Preparation

1. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
2. Remove plates, machined surfaces, and similar items already in place that are not to be finished. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and finishing.
   a. After completing finishing operations, reinstall items that were removed; use workers skilled in the trades involved. Remove surface-applied protection if any.
3. Clean and prepare surfaces to be finished according to manufacturer's written instructions for each particular substrate condition and as specified.
   a. Remove surface dirt, oil, or grease by washing with a detergent solution; rinse thoroughly with clean water and allow to dry. Remove grade stamps and pencil marks by sanding lightly. Remove loose wood fibers by brushing.
   b. Remove mildew by scrubbing with a commercial wash formulated for mildew removal and as recommended by stain manufacturer.
   c. Countersink steel nails, if used, and fill with putty tinted to final color to eliminate rust leach stains.
4. Apply wood filler paste to open-grain woods, as defined in "MPI Architectural Painting Specification Manual," to produce smooth, glasslike finish.

B. Application
1. Apply finishes according to manufacturer's written instructions.
   a. Use applicators and techniques suited for finish and substrate indicated.
   b. Finish surfaces behind movable equipment and furniture same as similar exposed surfaces.
2. Apply finishes to produce surface films without cloudiness, holidays, lap marks, brush marks, runs, ropiness, or other surface imperfections.

C. Field Quality Control
1. Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when finishes are being applied:
   a. Owner will engage the services of a qualified testing agency to sample finish materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
   b. Testing agency will perform tests for compliance with product requirements.
   c. Owner may direct Contractor to stop applying finishes if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying materials from Project site, pay for testing, and refinish surfaces finished with rejected materials. Contractor will be required to remove rejected materials from previously finished surfaces if, on refinishing with complying materials, the two finishes are incompatible.

D. Cleaning And Protection
1. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
2. After completing finish application, clean spattered surfaces. Remove spattered materials by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
3. Protect work of other trades against damage from finish application. Correct damage by cleaning, repairing, replacing, and refinishing, as approved by the Owner, and leave in an undamaged condition.
4. At completion of construction activities of other trades, touch up and restore damaged or defaced finished wood surfaces.

E. Exterior Wood-Finish-System Schedule
1. Exposed Glue-Laminated Beam and Column Substrates:
   a. Solid-Color, Solvent-Based Stain System: MPI EXT 6.1C.
      1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.

2) Two Stain Coats: Exterior solid-color stain (solvent based).

b. Varnish Over Semitransparent Stain System: MPI EXT 6.1D.
1) Stain Coat: Exterior semitransparent stain (solvent based).
2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Exterior marine spar varnish (gloss) **OR** varnish (gloss) **OR** varnish (semigloss), **as directed**.

c. Varnish System: MPI EXT 6.1K.
1) Four (for a Premium Grade system) **OR** Three, **as directed**, Finish Coats: Exterior marine spar varnish (gloss) **OR** varnish (gloss) **OR** varnish (semigloss), **as directed**.

d. Clear, Two-Component Polyurethane Over Stain System: MPI EXT 6.1E.
1) Stain Coat: Exterior semitransparent stain (solvent based).
2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Two-component aliphatic polyurethane (clear).

e. Clear, Two-Component Polyurethane System: MPI EXT 6.1H.
1) Three Finish Coats: Two-component aliphatic polyurethane (clear).

2. Exposed Rough Carpentry Substrates:
a. Solid-Color Latex Stain System: MPI EXT 6.2B.
1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
2) Two Stain Coats (for a Premium Grade system) **OR** One Stain Coat, **as directed**: Exterior, solid-color latex stain.

b. Solid-Color, Solvent-Based Stain System: MPI EXT 6.2D.
1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.

c. Two Stain Coats (for a Premium Grade system) One Stain Coat, **as directed**: Exterior solid-color stain (solvent based).

d. Semitransparent Stain System: MPI EXT 6.2L.
1) Two Stain Coats: Exterior semitransparent stain (solvent based).

e. Varnish Over Semitransparent Stain System: MPI EXT 6.2E.
1) Stain Coat: Exterior semitransparent stain (solvent based).
2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Exterior marine spar varnish (gloss) **OR** varnish (gloss) **OR** varnish (semigloss), **as directed**.

f. Varnish System: MPI EXT 6.2K.
1) Four (for a Premium Grade system) **OR** Three, **as directed,** Finish Coats: Exterior varnish (marine spar, high gloss) **OR** (gloss) **OR** (semigloss), **as directed**.

g. Clear, Two-Component Polyurethane System: MPI EXT 6.2H.
1) Three Finish Coats: Two-component aliphatic polyurethane (clear).

3. Finish Carpentry Substrates:
a. Solid-Color Latex Stain System: MPI EXT 6.3K.
1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
2) Two Stain Coats (for a Premium Grade system) **OR** One Stain Coat, **as directed**: Exterior, solid-color latex stain.

b. Solid-Color, Solvent-Based Stain System: MPI EXT 6.3C.
1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
2) Two Stain Coats (for a Premium Grade system) **OR** One Stain Coat, **as directed**: Exterior solid-color stain (solvent based).

c. Semitransparent Stain System: MPI EXT 6.3D.
1) Two Stain Coats: Exterior semitransparent stain (solvent based).

d. Varnish Over Semitransparent Stain System: MPI EXT 6.3E.
1) Stain Coat: Exterior semitransparent stain (solvent based).
2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Exterior varnish (marine spar, high gloss) **OR** (gloss) **OR** (semigloss), **as directed**.

e. Varnish System: MPI EXT 6.3F.
1) Four (for a Premium Grade system) **OR** Three, **as directed**, Finish Coats: Exterior varnish (marine spar, high gloss) **OR** (gloss) **OR** (semigloss), **as directed**.

f. Clear, Two-Component Polyurethane System: MPI EXT 6.3G.
1) Three Finish Coats: Two-component aliphatic polyurethane (clear).

F. Exposed Wood Panel-Product Substrates:

a. Solid-Color Latex Stain System: MPI EXT 6.4A.
   1) Prime Coat: Exterior alkyd **OR** latex **OR** oil, **as directed**, wood primer.
   2) Two Stain Coats (for a Premium Grade system) **OR** One Stain Coat, **as directed**: Exterior, solid-color latex stain.
b. Solid-Color, Solvent-Based Stain System: MPI EXT 6.4C.
   1) Prime Coat (for a Premium Grade system): Exterior alkyd **OR** oil, **as directed**, wood primer.
   2) Two Stain Coats: Exterior solid-color stain (solvent based).
c. Semitransparent Stain System: MPI EXT 6.4D.
   1) Two Stain Coats: Exterior semitransparent stain (solvent based).
d. Varnish Over Semitransparent Stain System: MPI EXT 6.4J.
   1) Stain Coat: Exterior semitransparent stain (solvent based).
   2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Exterior varnish (marine spar, high gloss) **OR** (gloss) **OR** (semigloss), **as directed**.
e. Varnish System: MPI EXT 6.4H.
   1) Four (for a Premium Grade system) **OR** Three, **as directed**, Finish Coats: Exterior varnish (marine spar, high gloss) **OR** (gloss) **OR** (semigloss), **as directed**.

2. Wood Deck and Stair Substrates:
   a. MPI EXT 6.5D.
      1) Preservative Coat: Wood preservative.
      2) Two Stain Coats (for a Premium Grade system) **OR** One Stain Coat, **as directed**: Stain for wood decks.
   b. MPI EXT 6.5F.
      1) Two Stain Coats: Stain for wood decks.
3. Wood Shingle and Shake Substrates (Excluding Roofs):
   a. Solid-Color Latex Stain System: MPI EXT 6.6D.
      1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
      2) Two Stain Coats (for a Premium Grade system) **OR** One Stain Coat, **as directed**: Exterior, solid-color latex stain.
   b. Solid-Color, Solvent-Based Stain System: MPI EXT 6.6C.
      1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
      2) Two Stain Coats (for a Premium Grade system) **OR** One Stain Coat, **as directed**: Exterior solid-color stain (solvent based).
   c. Semitransparent Stain System: MPI EXT 6.6F.
      1) Two Stain Coats: Exterior semitransparent stain (solvent based).

G. Interior Wood-Finish-System Schedule
1. Exposed Glue-Laminated Beam and Column Substrates:
   a. Alkyd Varnish Over Stain System: MPI INT 6.1K.
      1) Stain Coat: Interior wood stain (semitransparent).
      2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Interior varnish (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
   b. Alkyd Varnish Over Stain and Sealer System: MPI INT 6.1P.
      1) Stain Coat: Interior wood stain (semitransparent).
      2) Seal Coat: Alkyd sanding sealer.
      3) Two Finish Coats (for a Premium Grade system) **OR** One Finish Coat, **as directed**: Interior varnish (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
   c. Alkyd Varnish Over Sealer System: MPI INT 6.1C.
      1) Seal Coat: Alkyd sanding sealer.
      2) Two Finish Coats: Interior varnish (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
   d. Polyurethane Varnish Over Stain System: MPI INT 6.1J.
      1) Stain Coat: Interior wood stain (semitransparent).
      2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Interior, oil-modified, clear urethane (satin) **OR** (gloss), **as directed**.
   e. Polyurethane Varnish System: MPI INT 6.1D.

1) One Factory-Applied Finish Coat: Matching field-applied finish coats.
2) Two Field-Applied Finish Coats: Interior, oil-modified, clear urethane (satin) **OR** (gloss), **as directed**.

f. Moisture-Cured Clear Polyurethane Over Stain System: MPI INT 6.1S.
1) Stain Coat: Interior wood stain (semitransparent).
2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Moisture-cured clear polyurethane (flat) **OR** (gloss), **as directed**.

g. Waterborne Clear Acrylic Over Stain System: MPI INT 6.1R.
1) Stain Coat: Interior wood stain (semitransparent).
2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Waterborne clear acrylic (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

h. Waterborne Clear Acrylic System: MPI INT 6.F.
1) Three Finish Coats: Waterborne clear acrylic (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

i. Solid-Color Latex Stain System: MPI INT 6.1T.
1) Prime Coat: Exterior alkyd **OR** oil, **as directed**, wood primer.
2) Two Stain Coats (for a Premium Grade system) **OR** One Stain Coat, **as directed**: Exterior, solid-color latex stain.

j. Solid-Color, Solvent-Based Stain System: MPI INT 6.1H.
1) Two Stain Coats: Exterior solid-color stain (solvent based).

k. Semitransparent Stain System: MPI INT 6.1G.
1) Two Stain Coats: Exterior semitransparent stain (solvent based).

2. Exposed Rough Carpentry Substrates:

a. Alkyd Varnish Over Stain and Sealer System: MPI INT 6.2K.
1) Stain Coat: Interior wood stain (semitransparent).
2) Seal Coat: Alkyd sanding sealer.
3) Two Finish Coats (for a Premium Grade system) **OR** One Finish Coat, **as directed**: Interior varnish (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

b. Alkyd Varnish Over Sealer System: MPI INT 6.2P.
1) Seal Coat: Alkyd sanding sealer.
2) Two Finish Coats (for a Premium Grade system) **OR** One Finish Coat, **as directed**: Interior varnish (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

c. Polyurethane Varnish Over Stain System: MPI INT 6.2J.
1) Stain Coat: Interior wood stain (semitransparent).
2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Interior, oil-modified, clear urethane (satin) **OR** (gloss), **as directed**.

d. Polyurethane Varnish System: MPI INT 6.2H.
1) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Interior, oil-modified, clear urethane (satin) **OR** (gloss), **as directed**.

e. Moisture-Cured Clear Polyurethane Over Stain System: MPI INT 6.2N.
1) Stain Coat: Interior wood stain (semitransparent).
2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Moisture-cured clear polyurethane (flat) **OR** (gloss), **as directed**.

f. Waterborne Clear Acrylic Over Stain System: MPI INT 6.2M.
1) Stain Coat: Interior wood stain (semitransparent).
2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Waterborne clear acrylic (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

3. Finish Carpentry Substrates:

a. Alkyd Varnish Over Stain and Sealer System: MPI INT 6.3D.
1) Stain Coat: Interior wood stain (semitransparent).
2) Seal Coat: Alkyd sanding sealer **OR** Shellac, **as directed**.
3) Two Finish Coats (for a Premium Grade system) **OR** One Finish Coat, **as directed**: Interior varnish (semigloss) **OR** (gloss), **as directed**.

b. Alkyd Varnish Over Sealer System: MPI INT 6.3J.
1) Seal Coat: Alkyd sanding sealer **OR** Shellac, **as directed**.

2) Two Finish Coats (for a Premium Grade system) **OR** One Finish Coat, **as directed**: Interior varnish (semigloss) **OR** (gloss), **as directed**.

c. Polyurethane Varnish Over Stain System: MPI INT 6.3E.
1) Stain Coat: Interior wood stain (semitransparent).
2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Interior, oil-modified, clear urethane (satin) **OR** (gloss), **as directed**.

d. Polyurethane Varnish System: MPI INT 6.3K.
1) One Factory-Applied Finish Coat: Matching field-applied finish coats.
2) Two Field-Applied Finish Coats: Interior, oil-modified, clear urethane (satin) **OR** (gloss), **as directed**.

e. Moisture-Cured Clear Polyurethane Over Stain System: MPI INT 6.3Y.
1) Stain Coat: Interior wood stain (semitransparent).
2) Three (for a Premium Grade system **OR** Two, **as directed**, Finish Coats: Moisture-cured clear polyurethane (flat) **OR** (gloss), **as directed**.

f. Moisture-Cured Clear Polyurethane System: MPI INT 6.3X.
1) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Moisture-cured clear polyurethane (flat) **OR** (gloss), **as directed**.

g. Clear, Two-Component Polyurethane System: MPI INT 6.3Z.
1) Three (for a Premium Grade system) Two, **as directed**, Finish Coats: Two-component aliphatic polyurethane (clear).

h. Waterborne Clear Acrylic Over Stain System: MPI INT 6.3W.
1) Stain Coat: Interior wood stain (semitransparent).
2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Waterborne clear acrylic (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

i. Waterborne Clear Acrylic System: MPI INT 6.3Q.
1) Three Finish Coats: Waterborne clear acrylic (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

j. Lacquer Over Stain and Sealer System: MPI INT 6.3F.
1) Stain Coat: Interior wood stain (semitransparent).
2) Seal Coat: Lacquer sanding sealer.
3) Two Finish Coats (for a Premium Grade system) **OR** One Finish Coat, **as directed**: Lacquer (clear flat **OR** satin **OR** gloss, **as directed**).

k. Lacquer Over Sealer System: MPI INT 6.3H.
1) Seal Coat: Lacquer sanding sealer.
2) Two Finish Coats (for a Premium Grade system) **OR** One Finish Coat, **as directed**: Lacquer (clear flat **OR** satin **OR** gloss, **as directed**).

l. Semitransparent Stain System: MPI INT 6.3C.
1) Two Stain Coats: Exterior semitransparent stain (solvent based).

m. Danish Oil System: MPI INT 6.3M.
1) Two Finish Coats: Danish oil.

4. Exposed Wood Panel-Product Substrates:

a. Alkyd Varnish Over Sealer and Stain System: MPI INT 6.4D.
1) Stain Coat: Interior wood stain (semitransparent).
2) Seal Coat: Alkyd sanding sealer **OR** Shellac, **as directed**.
3) Two Finish Coats (for a Premium Grade system) **OR** One Finish Coat, **as directed**: Interior varnish (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

b. Alkyd Varnish Over Sealer System: MPI INT 6.4G.
1) Seal Coat: Alkyd sanding sealer **OR** Shellac, **as directed**.
2) Two Finish Coats (for a Premium Grade system) **OR** One Finish Coat, **as directed**: Interior varnish (flat) **OR** (semigloss) **OR** (gloss), **as directed**.

c. Polyurethane Varnish Over Stain System: MPI INT 6.4E.
1) Stain Coat: Interior wood stain (semitransparent).
2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Interior, oil-modified, clear urethane (satin) **OR** (gloss), **as directed**.

d. Polyurethane Varnish System: MPI INT 6.4.J.

1) One Factory-Applied Finish Coat: Matching field-applied finish coats.
2) Two Field-Applied Finish Coats: Interior, oil-modified, clear urethane (satin) **OR** (gloss), **as directed**.

e. Moisture-Cured Clear Polyurethane Over Stain System: MPI INT 6.4V.
1) Stain Coat: Interior wood stain (semitransparent).
2) Three (for a Premium Grade system) Two, **as directed**, Finish Coats: Moisture-cured clear polyurethane (flat) **OR** (gloss), **as directed**.

f. Waterborne Clear Acrylic Over Stain System: MPI INT 6.4U.
1) Stain Coat: Interior wood stain (semitransparent).
2) Three (for a Premium Grade system) **OR** Two, **as directed**, Finish Coats: Waterborne clear acrylic (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

g. Lacquer Over Stain and Sealer System: MPI INT 6.4F.
1) Stain Coat: Interior wood stain (semitransparent).
2) Seal Coat: Lacquer sanding sealer.
3) Two Finish Coats (for a Premium Grade system) **OR** One Finish Coat, **as directed**: Lacquer (clear flat **OR** satin **OR** gloss, **as directed**).

h. Lacquer Over Sealer System: MPI INT 6.4Y.
1) Seal Coat: Lacquer sanding sealer.
2) Three (for a Premium Grade system) Two, **as directed**, Finish Coats: Lacquer (clear flat **OR** satin **OR** gloss, **as directed**).

i. Semitransparent Stain System: MPI INT 6.4C.
1) Two Stain Coats: Exterior semitransparent stain (solvent based).

j. Danish Oil System: MPI INT 6.4K.
1) Two Finish Coats: Danish oil.

END OF SECTION 09910a

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SECTION 09910b - HIGH-TEMPERATURE-RESISTANT COATINGS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for high-temperature-resistant coatings. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes surface preparation and application of high-temperature-resistant coating systems on steel substrates subject to high temperatures.

C. Submittals
1. Product Data: For each type of product indicated.
2. Samples: For each coating and for each color and texture required.
3. LEED Submittal:
   a. Product Data for Credit EQ 4.2: For coatings, including printed statement of VOC content and chemical components.

D. Quality Assurance
1. Master Painters Institute (MPI) Standards:
   a. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List" **OR** "MPI Maintenance Repainting Manual," **as directed**.
   b. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" **OR** "MPI Maintenance Repainting Manual," **as directed**, for products and coating systems indicated.

E. Delivery, Storage, And Handling
1. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
   a. Maintain containers in clean condition, free of foreign materials and residue.
   b. Remove rags and waste from storage areas daily.

F. Project Conditions
1. Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are between 50 and 104 deg F (10 and 40 deg C).
2. Do not apply coatings in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

1.2 PRODUCTS

A. High-Temperature-Resistant Coatings
1. VOC Content of Interior Paints and Coatings: Provide products that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24) :
   a. Flat Paints, Coatings, and Primers: VOC content of not more than 50 g/L.
   b. Nonflat Paints, Coatings, and Primers: VOC content of not more than 150 g/L.
   c. Anticorrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC content of not more than 250 g/L.
   d. Flat Interior Topcoat Paints: VOC content of not more than 50 g/L.
   e. Nonflat Interior Topcoat Paints: VOC content of not more than 150 g/L.

f. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
g. Primers, Sealers, and Undercoaters: VOC content of not more than 200 g/L.
h. Zinc-Rich Industrial Maintenance Primers: VOC content of not more than 340 g/L.

2. Chemical Components of Interior Paints and Coatings: Provide topcoat paints and anti-corrosive and anti-rust paints applied to ferrous metals that comply with the following chemical restrictions; these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:
   a. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing 1 or more benzene rings).
   b. Restricted Components: Paints and coatings shall not contain any of the following:
      1) Acrolein.
      2) Acrylonitrile.
      3) Antimony.
      4) Benzene.
      5) Butyl benzyl phthalate.
      6) Cadmium.
      7) Di (2-ethylhexyl) phthalate.
      8) Di-n-butyl phthalate.
      9) Di-n-octyl phthalate.
      10) 1,2-dichlorobenzene.
      11) Diethyl phthalate.
      12) Dimethyl phthalate.
      13) Ethylbenzene.
      14) Formaldehyde.
      15) Hexavalent chromium.
      16) Isophorone.
      17) Lead.
      18) Mercury.
      19) Methyl ethyl ketone.
      20) Methyl isobutyl ketone.
      21) Methylene chloride.
      22) Naphthalene.
      23) Toluene (methylbenzene).
      24) 1,1,1-trichloroethane.
      25) Vinyl chloride.
3. Colors: As selected from manufacturer's full range **OR** Match samples, **as directed**.
4. Primer: Undercoating recommended in writing for use in coating system by manufacturer of high-temperature-resistant coating under conditions indicated.
5. Heat-Resistant Enamel (Gloss): MPI #21.
   a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
6. Inorganic Zinc Primer: MPI #19.
   a. VOC Content: Minimum E Range of 0 **OR** E1 **OR** E2 **OR** E3, **as directed**.
7. Aluminum Heat-Resistant Enamel: MPI #2.
   a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
8. High-Heat-Resistant Coating: MPI #22.
   a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.

1.3 EXECUTION

A. Preparation

1. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" **OR** "MPI Maintenance Repainting Manual," **as directed,** applicable to substrates indicated.
2. Remove plates, machined surfaces, and similar items already in place that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.
    a. After completing coating operations, reinstall items that were removed; use workers skilled in the trades involved.
3. Clean steel substrates of substances that could impair bond of coatings, including dirt, oil, grease, and incompatible paints and encapsulants.
    a. Remove incompatible primers as required to produce coating systems indicated.

B. Application
1. Apply high-temperature-resistant coating systems according to manufacturer's written instructions.
    a. Use applicators and techniques suited for coating and substrate indicated.
    b. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
    c. Coat back sides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.

C. Field Quality Control
1. Contractor shall invoke the following procedure at any time and as often as necessary during the period when coatings are being applied:
    a. Engage the services of a qualified testing agency to sample coating material being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
    b. Testing agency will perform tests for compliance with specified requirements.
    c. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with specified requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

D. Cleaning And Protection
1. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
2. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
3. Protect work of other trades against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by the Owner, and leave in an undamaged condition.
4. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

E. High-Temperature-Resistant Coating Schedule
1. Heat-Resistant Enamel (Gloss) Coating System (System below corresponds with MPI EXT 5.2A and MPI INT 5.2A coating systems) {suitable for use on surfaces that reach a maximum temperature of 400 deg F (205 deg C)}:
    a. Surface Preparation: Clean using methods recommended in writing by finish-coat manufacturer, but not less than blast cleaning according to SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning **OR** SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning **OR** SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning," **as directed**.
    b. Prime Coat: Primer.

c. Finish Coat(s): Heat-resistant enamel (gloss), MPI #21, in number of coats recommended in writing by manufacturer for conditions indicated.

2. Inorganic Zinc Primer Coating System (System below corresponds with MPI EXT 5.2C and MPI INT 5.2C coating systems) {suitable for use on surfaces that reach a maximum temperature of 750 deg F (400 deg C)}:
   a. Surface Preparation: Clean using methods recommended in writing by finish-coat manufacturer, but not less than blast cleaning according to SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning **OR** SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning **OR** SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning," **as directed**.
   b. Prime Coat: Primer.
   c. Finish Coat(s): Inorganic zinc primer, MPI #19, in number of coats recommended in writing by manufacturer for conditions indicated.
3. Aluminum Heat-Resistant Enamel Coating System (System below corresponds with MPI EXT 5.2B and MPI INT 5.2B coating systems) {suitable for use on surfaces that reach a maximum temperature of 800 deg F (427 deg C)}:
   a. Surface Preparation: Clean using methods recommended in writing by finish-coat manufacturer, but not less than blast cleaning according to SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning **OR** SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning **OR** SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning," **as directed**.
   b. Prime Coat: Primer.
   c. Finish Coat(s): Aluminum heat-resistant enamel, MPI #2, in number of coats recommended in writing by manufacturer for conditions indicated.
4. High-Heat-Resistant Coating System (System below corresponds with MPI EXT 5.2D and MPI INT 5.2D coating systems) {suitable for use on surfaces that reach a maximum temperature of 1100 deg F (593 deg C)}:
   a. Surface Preparation: Clean using methods recommended in writing by finish-coat manufacturer, but not less than blast cleaning according to SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning **OR** SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning **OR** SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning," **as directed**.
   b. Prime Coat: Primer.
   c. Finish Coat(s): High-heat-resistant coating, MPI #22, in number of coats recommended in writing by manufacturer for conditions indicated.

END OF SECTION 09910b

Task	Specification	Specification Description
09910	01352	No Specification Required

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SECTION 09920 - INTERIOR PAINTING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for interior painting. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes surface preparation and the application of paint systems on the following interior substrates:
   a. Concrete.
   b. Clay masonry.
   c. Concrete masonry units (CMU).
   d. Steel.
   e. Galvanized metal.
   f. Aluminum (not anodized or otherwise coated).
   g. Wood.
   h. Gypsum board.
   i. Plaster.
   j. Spray-textured ceilings.
   k. Cotton or canvas insulation covering.

C. Submittals
1. Product Data: For each type of product indicated.
2. Samples: For each finish and for each color and texture required.
3. Product List: Printout of current "MPI Approved Products List" for each product category specified in Part 1.2, with the proposed product highlighted.
4. LEED Submittal:
   a. Product Data for Credit EQ 4.2: For paints, including printed statement of VOC content and chemical components.

D. Quality Assurance
1. MPI Standards:
   a. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
   b. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.

E. Delivery, Storage, And Handling
1. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
   a. Maintain containers in clean condition, free of foreign materials and residue.
   b. Remove rags and waste from storage areas daily.

F. Project Conditions
1. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).
2. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

1.2 PRODUCTS

A. Paint, General
1. Material Compatibility:
a. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
b. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
2. VOC Content of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24); these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:
a. Flat Paints, Coatings, and Primers: VOC content of not more than 50 g/L.
b. Nonflat Paints, Coatings, and Primers: VOC content of not more than 150 g/L.
c. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
d. Floor Coatings: VOC not more than 100 g/L.
e. Shellacs, Clear: VOC not more than 730 g/L.
f. Shellacs, Pigmented: VOC not more than 550 g/L.
g. Flat Topcoat Paints: VOC content of not more than 50 g/L.
h. Nonflat Topcoat Paints: VOC content of not more than 150 g/L.
i. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
j. Floor Coatings: VOC not more than 100 g/L.
k. Shellacs, Clear: VOC not more than 730 g/L.
l. Shellacs, Pigmented: VOC not more than 550 g/L.
m. Primers, Sealers, and Undercoaters: VOC content of not more than 200 g/L.
n. Dry-Fog Coatings: VOC content of not more than 400 g/L.
o. Zinc-Rich Industrial Maintenance Primers: VOC content of not more than 340 g/L.
p. Pre-Treatment Wash Primers: VOC content of not more than 420 g/L.
3. Chemical Components of Field-Applied Interior Paints and Coatings: Provide topcoat paints and anti-corrosive and anti-rust paints applied to ferrous metals that comply with the following chemical restrictions; these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:
a. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
b. Restricted Components: Paints and coatings shall not contain any of the following:
1) Acrolein.
2) Acrylonitrile.
3) Antimony.
4) Benzene.
5) Butyl benzyl phthalate.
6) Cadmium.
7) Di (2-ethylhexyl) phthalate.
8) Di-n-butyl phthalate.
9) Di-n-octyl phthalate.
10) 1,2-dichlorobenzene.
11) Diethyl phthalate.
12) Dimethyl phthalate.
13) Ethylbenzene.
14) Formaldehyde.
15) Hexavalent chromium.
16) Isophorone.

17) Lead.
18) Mercury.
19) Methyl ethyl ketone.
20) Methyl isobutyl ketone.
21) Methylene chloride.
22) Naphthalene.
23) Toluene (methylbenzene).
24) 1,1,1-trichloroethane.
25) Vinyl chloride.

4. Colors: As selected from manufacturer's full range **OR** Match samples **OR** As indicated in a color schedule, **as directed**.

B. Block Fillers
1. Interior/Exterior Latex Block Filler: MPI #4.
a. VOC Content: E Range of E2 **OR** E3, **as directed**.

C. Primers/Sealers
1. Interior Latex Primer/Sealer: MPI #50.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
2. Interior Alkyd Primer/Sealer: MPI #45.
a. VOC Content: E Range of E1 **OR** E2, **as directed**.
3. Wood-Knot Sealer: Sealer recommended in writing by topcoat manufacturer for use in paint systems indicated.

D. Metal Primers
1. Alkyd Anticorrosive Metal Primer: MPI #79.
a. VOC Content: E Range of E1 **OR** E2, **as directed**.
2. Quick-Drying Alkyd Metal Primer: MPI #76.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
3. Rust-Inhibitive Primer (Water Based): MPI #107.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
4. Cementitious Galvanized-Metal Primer: MPI #26.
a. VOC Content: E Range of E1.
5. Waterborne Galvanized-Metal Primer: MPI #134.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
6. Vinyl Wash Primer: MPI #80.
a. VOC Content: E Range of E2 **OR** E3, **as directed**.
7. Quick-Drying Primer for Aluminum: MPI #95.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

E. Wood Primers
1. Interior Latex-Based Wood Primer: MPI #39.
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.

F. Latex Paints
1. Interior Latex (Flat): MPI #53 (Gloss Level 1).
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
b. Environmental Performance Rating: EPR 0.5 **OR** EPR 1.5 **OR** EPR 2.5, **as directed**.
2. Interior Latex (Low Sheen): MPI #44 (Gloss Level 2).
a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
3. Interior Latex (Eggshell): MPI #52 (Gloss Level 3).

a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.

4. Interior Latex (Satin): MPI #43 (Gloss Level 4).
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 1.5 **OR** EPR 2 **OR** EPR 2.5 **OR** EPR 3.5, **as directed**.
5. Interior Latex (Semigloss): MPI #54 (Gloss Level 5).
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 2 **OR** EPR 3 **OR** EPR 4, **as directed**.
6. Interior Latex (Gloss): MPI #114 (Gloss Level 6, except minimum gloss of 65 units at 60 deg).
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 2 **OR** EPR 3 **OR** EPR 4, **as directed**.
7. Institutional Low-Odor/VOC Latex (Flat): MPI #143 (Gloss Level 1).
   a. VOC Content: E Range of E3.
   b. Environmental Performance Rating: EPR 4 **OR** EPR 5.5, **as directed**.
8. Institutional Low-Odor/VOC Latex (Low Sheen): MPI #144 (Gloss Level 2).
   a. VOC Content: E Range of E3.
   b. Environmental Performance Rating: EPR 4.5.
9. Institutional Low-Odor/VOC Latex (Eggshell): MPI #145 (Gloss Level 3).
   a. VOC Content: E Range of E3.
   b. Environmental Performance Rating: EPR 4.5.
10. Institutional Low-Odor/VOC Latex (Semigloss): MPI #147 (Gloss Level 5).
    a. VOC Content: E Range of E3.
    b. Environmental Performance Rating: EPR 3 **OR** EPR 5.5, **as directed**.
11. High-Performance Architectural Latex (Low Sheen): MPI #138 (Gloss Level 2).
    a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
    b. Environmental Performance Rating: EPR 4 **OR** EPR 5 **OR** EPR 6, **as directed**.
12. High-Performance Architectural Latex (Eggshell): MPI #139 (Gloss Level 3).
    a. VOC Content: E Range of E2 **OR** E3, **as directed**.
    b. Environmental Performance Rating: EPR 5 **OR** EPR 6, **as directed**.
13. High-Performance Architectural Latex (Satin): MPI #140 (Gloss Level 4).
    a. VOC Content: E Range of E1 **OR** E3, **as directed**.
    b. Environmental Performance Rating: EPR 4.5 **OR** EPR 6.5, **as directed**.
14. High-Performance Architectural Latex (Semigloss): MPI #141 (Gloss Level 5).
    a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
    b. Environmental Performance Rating: EPR 5 **OR** EPR 6 **OR** EPR 7, **as directed**.
15. Exterior Latex (Flat): MPI #10 (Gloss Level 1).
    a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
16. Exterior Latex (Semigloss): MPI #11 (Gloss Level 5).
    a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
17. Exterior Latex (Gloss): MPI #119 (Gloss Level 6, except minimum gloss of 65 units at 60 deg).
    a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

G. Alkyd Paints
1. Interior Alkyd (Flat): MPI #49 (Gloss Level 1).
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
2. Interior Alkyd (Eggshell): MPI #51 (Gloss Level 3).
   a. VOC Content: E Range of E1 **OR** E2, **as directed**.
3. Interior Alkyd (Semigloss): MPI #47 (Gloss Level 5).
   a. VOC Content: E Range of E1 **OR** E2, **as directed**.
   b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
4. Interior Alkyd (Gloss): MPI #48 (Gloss Level 6).
   a. VOC Content: E Range of E1 **OR** E2, **as directed**.

H. Quick-Drying Enamels

1. Quick-Drying Enamel (Semigloss): MPI #81 (Gloss Level 5).
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
2. Quick-Drying Enamel (High Gloss): MPI #96 (Gloss Level 7).
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

I. Textured Coating
1. Latex Stucco and Masonry Textured Coating: MPI #42.
   a. VOC Content: E Range of E2 **OR** E3, **as directed**.

J. Dry Fog/Fall Coatings
1. Latex Dry Fog/Fall: MPI #118.
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
2. Waterborne Dry Fall: MPI #133.
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 1 **OR** EPR 2 **OR** EPR 3, **as directed**.
3. Interior Alkyd Dry Fog/Fall: MPI #55.
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

K. Aluminum Paint
1. Aluminum Paint: MPI #1.
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.

L. Floor Coatings
1. Interior Concrete Floor Stain: MPI #58.
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 2.
2. Interior/Exterior Clear Concrete Floor Sealer (Water Based): MPI #99.
   a. VOC Content: E Range of E1 **OR** E2 **OR** E3, **as directed**.
3. Interior/Exterior Clear Concrete Floor Sealer (Solvent Based): MPI #104.
   a. VOC Content: E Range of E1 **OR** E2, **as directed**.
4. Interior/Exterior Latex Floor and Porch Paint (Low Gloss): MPI #60 (maximum Gloss Level 3).
   a. VOC Content: E Range of E2 **OR** E3, **as directed**.
   b. Environmental Performance Rating: EPR 3.
5. Exterior/Interior Alkyd Floor Enamel (Gloss): MPI #27 (Gloss Level 6).
   a. VOC Content: E Range of E1 **OR** E2, **as directed**.
   b. Additives: Manufacturer's standard additive to increase skid resistance of painted surface.

1.3 EXECUTION

A. Preparation
1. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
2. Remove plates, machined surfaces, and similar items already in place that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
   a. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
   b. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
3. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
   a. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.

4. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
5. Clay Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content of surfaces or alkalinity of mortar joints to be painted exceed that permitted in manufacturer's written instructions.
6. Concrete Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
7. Steel Substrates: Remove rust and loose mill scale. Clean using methods recommended in writing by paint manufacturer.
8. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
9. Aluminum Substrates: Remove surface oxidation.
10. Wood Substrates:
    a. Scrape and clean knots, and apply coat of knot sealer before applying primer.
    b. Sand surfaces that will be exposed to view, and dust off.
    c. Prime edges, ends, faces, undersides, and backsides of wood.
    d. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.
11. Gypsum Board Substrates: Do not begin paint application until finishing compound is dry and sanded smooth.
12. Plaster Substrates: Do not begin paint application until plaster is fully cured and dry.
13. Spray-Textured Ceiling Substrates: Do not begin paint application until surfaces are dry.
14. Cotton or Canvas Insulation Covering Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

B. Application
1. Apply paints according to manufacturer's written instructions.
    a. Use applicators and techniques suited for paint and substrate indicated.
    b. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
    c. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
2. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
3. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
4. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
5. Painting Mechanical and Electrical Work: Paint items exposed in equipment rooms and occupied spaces including, but not limited to, the following:
    a. Mechanical Work:
        1) Uninsulated metal piping.
        2) Uninsulated plastic piping.
        3) Pipe hangers and supports.
        4) Tanks that do not have factory-applied final finishes.
        5) Visible portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets.
        6) Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.

7) Mechanical equipment that is indicated to have a factory-primed finish for field painting.

b. Electrical Work:
1) Switchgear.
2) Panelboards.
3) Electrical equipment that is indicated to have a factory-primed finish for field painting.

C. Field Quality Control
1. Testing of Paint Materials: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when paints are being applied:
a. Owner will engage the services of a qualified testing agency to sample paint materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
b. Testing agency will perform tests for compliance with product requirements.
c. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying-paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

D. Cleaning And Protection
1. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
2. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
3. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by the Owner, and leave in an undamaged condition.
4. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

E. Interior Painting Schedule
1. Concrete Substrates, Nontraffic Surfaces:
a. Latex System: MPI INT 3.1E.
1) Prime Coat: Interior latex matching topcoat.
2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
b. Latex Over Sealer System: MPI INT 3.1A.
1) Prime Coat: Interior latex primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
c. Latex Over Latex Aggregate System: MPI INT 3.1B.
1) Prime Coat: Latex stucco and masonry textured coating.
2) Intermediate Coat (for MPI Premium Grade system): Exterior latex matching topcoat.
3) Topcoat: Exterior latex (flat) **OR** (semigloss) **OR** (gloss), **as directed**.
d. Alkyd System: MPI INT 3.1D.
1) Prime Coat: Interior latex primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
e. Institutional Low-Odor/VOC Latex System: MPI INT 3.1M.
1) Prime Coat: Institutional low-odor/VOC interior latex matching topcoat.

2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.

f. High-Performance Architectural Latex System: MPI INT 3.1C.
1) Prime Coat: Interior latex primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.

2. Concrete Substrates, Traffic Surfaces:
a. Latex Floor Enamel System: MPI INT 3.2A.
1) Prime Coat: Interior/exterior latex floor and porch paint (low gloss).
2) Intermediate Coat (for MPI Premium Grade system): Interior/exterior latex floor and porch paint (low gloss).
3) Topcoat: Interior/exterior latex floor and porch paint (low gloss).

b. Alkyd Floor Enamel System: MPI INT 3.2B.
1) Prime Coat: Exterior/interior alkyd floor enamel (gloss).
2) Intermediate Coat (for MPI Premium Grade system): Exterior/interior alkyd floor enamel (gloss).
3) Topcoat: Exterior/interior alkyd floor enamel (gloss).

c. Concrete Stain System: MPI INT 3.2E.
1) First Coat (for MPI Premium Grade system): Interior concrete floor stain.
2) Topcoat: Interior concrete floor stain.

d. Clear Sealer System: MPI INT 3.2F.
1) First Coat: Interior/exterior clear concrete floor sealer (solvent based).
2) Topcoat: Interior/exterior clear concrete floor sealer (solvent based).

e. Water-Based Clear Sealer System: MPI INT 3.2G.
1) First Coat: Interior/exterior clear concrete floor sealer (water based).
2) Topcoat: Interior/exterior clear concrete floor sealer (water based).

3. Clay-Masonry Substrates:
a. Latex System: MPI INT 4.1A.
1) Prime Coat: Interior latex matching topcoat.
2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

b. Alkyd System: MPI INT 4.1D.
1) Prime Coat: Interior latex primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.

c. Latex Aggregate System: MPI INT 4.1B.
1) Prime Coat: As recommended in writing by topcoat manufacturer.
2) Intermediate Coat: As recommended in writing by topcoat manufacturer.
3) Topcoat: Latex stucco and masonry textured coating.

d. Institutional Low-Odor/VOC Latex System: MPI INT 4.1M.
1) Prime Coat: Institutional low-odor/VOC interior latex matching topcoat.
2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.

e. High-Performance Architectural Latex System: MPI INT 4.1L.
1) Prime Coat: High-performance architectural latex matching topcoat.
2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.

3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.

4. CMU Substrates:
   a. Latex System: MPI INT 4.2A.
      1) Prime Coat: Interior/exterior latex block filler.
      2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
      3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
   b. Alkyd System: MPI INT 4.2C.
      1) Prime Coat: Interior/exterior latex block filler.
      2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
      3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
   c. Alkyd Over Latex Sealer System: MPI INT 4.2N.
      1) Prime Coat: Interior/exterior latex block filler.
      2) Sealer Coat: Interior latex primer/sealer.
      3) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
      4) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
   d. Institutional Low-Odor/VOC Latex System: MPI INT 4.2E.
      1) Prime Coat: Interior/exterior latex block filler.
      2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
      3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.
   e. High-Performance Architectural Latex System: MPI INT 4.2D.
      1) Prime Coat: Interior/exterior latex block filler.
      2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
      3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.
5. Steel Substrates:
   a. Quick-Drying Enamel System: MPI INT 5.1A.
      1) Prime Coat: Quick-drying alkyd metal primer.
      2) Intermediate Coat: Quick-drying enamel matching topcoat.
      3) Topcoat: Quick-drying enamel (semigloss) **OR** (high gloss), **as directed**.
   b. Water-Based Dry-Fall System: MPI INT 5.1C.
      1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
      2) Topcoat: Latex dry fog/fall **OR** Waterborne dry fall, **as directed**.
   c. Alkyd Dry-Fall System: MPI INT 5.1D.
      1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
      2) Topcoat: Interior alkyd dry fog/fall.
   d. Latex Over Alkyd Primer System: MPI INT 5.1Q.
      1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
      2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
      3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
   e. Alkyd System: MPI INT 5.1E.
      1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
      2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
      3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
   f. Aluminum Paint System: MPI INT 5.1M.
      1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
      2) Intermediate Coat (for MPI Premium Grade system): Aluminum paint.
      3) Topcoat: Aluminum paint.

g. Institutional Low-Odor/VOC Latex System: MPI INT 5.1S.
   1) Prime Coat: Rust-inhibitive primer (water based).
   2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
   3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.

h. High-Performance Architectural Latex System: MPI INT 5.1R.
   1) Prime Coat: Alkyd anticorrosive **OR** Quick-drying alkyd, **as directed**, metal primer.
   2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
   3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.

6. Galvanized-Metal Substrates:
   a. Water-Based Dry-Fall System: MPI INT 5.3H.
      1) Prime Coat: Waterborne dry fall.
      2) Topcoat: Waterborne dry fall.
   b. Alkyd Dry-Fall System: MPI INT 5.3F.
      1) Prime Coat: Cementitious galvanized-metal primer.
      2) Topcoat: Interior alkyd dry fog/fall.
   c. Latex System: MPI INT 5.3A.
      1) Prime Coat: Cementitious galvanized-metal primer.
      2) Intermediate Coat: Interior latex matching topcoat.
      3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
   d. Latex Over Waterborne Primer System: MPI INT 5.3J.
      1) Prime Coat: Waterborne galvanized-metal primer.
      2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
      3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.
   e. Alkyd System: MPI INT 5.3C.
      1) Prime Coat: Cementitious galvanized-metal primer.
      2) Intermediate Coat: Interior alkyd matching topcoat.
      3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.
   f. Aluminum Paint System: MPI INT 5.3G.
      1) Prime Coat: Cementitious galvanized-metal primer.
      2) Intermediate Coat (for MPI Premium Grade system): Aluminum paint.
      3) Topcoat: Aluminum paint.
   g. Institutional Low-Odor/VOC Latex System: MPI INT 5.3N.
      1) Prime Coat: Waterborne galvanized-metal primer.
      2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
      3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.
   h. High-Performance Architectural Latex System: MPI INT 5.3M.
      1) Prime Coat: Waterborne galvanized-metal primer.
      2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
      3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.

7. Aluminum (Not Anodized or Otherwise Coated) Substrates:
   a. Latex System: MPI INT 5.4H.
      1) Prime Coat: Quick-drying primer for aluminum.
      2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
      3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

b. Alkyd Over Vinyl Wash Primer System: MPI INT 5.4A.
   1) Prime Coat: Vinyl wash primer.
   2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
   3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.

c. Alkyd Over Quick-Drying Primer System: MPI INT 5.4J.
   1) Prime Coat: Quick-drying primer for aluminum.
   2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
   3) Topcoat: Interior alkyd (flat **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.

d. Aluminum Paint System: MPI INT 5.4D.
   1) Prime Coat: Vinyl wash primer.
   2) Intermediate Coat (for MPI Premium Grade system): Aluminum paint.
   3) Topcoat: Aluminum paint.

e. Institutional Low-Odor/VOC Latex System: MPI INT 5.4G.
   1) Prime Coat: Quick-drying primer for aluminum.
   2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
   3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.

f. High-Performance Architectural Latex System: MPI INT 5.4F.
   1) Prime Coat: Quick-drying primer for aluminum.
   2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
   3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.

8. Glue-Laminated Beam and Column Substrates:
   a. Latex System: MPI INT 6.1M.
      1) Prime Coat: Interior latex-based wood primer.
      2) Intermediate Coat: Interior latex matching topcoat.
      3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

   b. Latex Over Alkyd Primer System: MPI INT 6.1A.
      1) Prime Coat: Interior alkyd primer/sealer.
      2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
      3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

   c. Alkyd System: MPI INT 6.1B.
      1) Prime Coat: Interior alkyd primer/sealer.
      2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
      3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.

   d. Institutional Low-Odor/VOC Latex System: MPI INT 6.1Q.
      1) Prime Coat: Interior latex-based wood primer.
      2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
      3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.

   e. High-Performance Architectural Latex System: MPI INT 6.1N.
      1) Prime Coat: Interior latex-based wood primer.
      2) Intermediate Coat: High-performance architectural latex matching topcoat.
      3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.

9. Dressed Lumber Substrates: Including architectural woodwork and doors.
   a. Latex System: MPI INT 6.3T.
      1) Prime Coat: Interior latex-based wood primer.

2) Intermediate Coat: Interior latex matching topcoat.
3) Topcoat: Interior latex (semigloss) **OR** (gloss), **as directed**.

b. Latex Over Alkyd Primer System: MPI INT 6.3U.
1) Prime Coat: Interior alkyd primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
3) Topcoat: Interior latex (semigloss) **OR** (gloss), **as directed**.

c. Alkyd System: MPI INT 6.3B.
1) Prime Coat: Interior alkyd primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
3) Topcoat: Interior alkyd (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.

d. Institutional Low-Odor/VOC Latex System: MPI INT 6.3V.
1) Prime Coat: Interior latex-based wood primer.
2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.

e. High-Performance Architectural Latex System: MPI INT 6.3A.
1) Prime Coat: Interior latex-based wood primer.
2) Intermediate Coat: High-performance architectural latex matching topcoat.
3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.

10. Wood Panel Substrates: Including painted plywood, medium-density fiberboard, and hardboard.
a. Latex System: MPI INT 6.4R.
1) Prime Coat: Interior latex-based wood primer.
2) Intermediate Coat: Interior latex matching topcoat.
3) Topcoat: Interior latex (semigloss) **OR** (gloss), **as directed**.

b. Latex Over Alkyd Primer System: MPI INT 6.4A.
1) Prime Coat: Interior alkyd primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

c. Alkyd System: MPI INT 6.4B.
1) Prime Coat: Interior alkyd primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.

d. Institutional Low-Odor/VOC Latex System: MPI INT 6.4T.
1) Prime Coat: Interior latex-based wood primer.
2) Intermediate Coat : Institutional low-odor/VOC interior latex matching topcoat.
3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.

e. High-Performance Architectural Latex System: MPI INT 6.4S.
1) Prime Coat: Interior latex-based wood primer.
2) Intermediate Coat: High-performance architectural latex matching topcoat.
3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.

11. Dimension Lumber Substrates, Nontraffic Surfaces: Including exposed joists and exposed beams.
a. Latex System: MPI INT 6.2D.
1) Prime Coat: Interior latex-based wood primer.
2) Intermediate Coat: Interior latex matching topcoat.
3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

b. Latex Over Alkyd Primer System: MPI INT 6.2A.

1) Prime Coat: Interior alkyd primer/sealer.
2) Intermediate Coat : Interior latex matching topcoat.
3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

c. Alkyd System: MPI INT 6.2C.
1) Prime Coat: Interior alkyd primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.

d. Institutional Low-Odor/VOC Latex System: MPI INT 6.2L.
1) Prime Coat: Interior latex-based wood primer.
2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.

e. High-Performance Architectural Latex System: MPI INT 6.2B.
1) Prime Coat: Interior alkyd primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.

12. Wood Substrates, Traffic Surfaces:
a. Latex Floor Paint System: MPI INT 6.5G.
1) Prime Coat: Interior alkyd primer/sealer.
2) Intermediate Coat: Interior/exterior latex floor and porch paint (low gloss).
3) Topcoat: Interior/exterior latex floor and porch paint (low gloss).

b. Alkyd Floor Enamel System: MPI INT 6.5A.
1) Prime Coat: Exterior/interior alkyd floor enamel (gloss).
2) Intermediate Coat: Exterior/interior alkyd floor enamel (gloss).
3) Topcoat: Exterior/interior alkyd floor enamel (gloss).

13. Gypsum Board Substrates:
a. Latex System: MPI INT 9.2A.
1) Prime Coat: Interior latex primer/sealer (for MPI Premium Grade system) **OR** matching topcoat, **as directed**.
2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

b. Alkyd Over Latex Primer System: MPI INT 9.2C.
1) Prime Coat: Interior latex primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.

c. Institutional Low-Odor/VOC Latex System: MPI INT 9.2M.
1) Prime Coat: Interior latex primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.

d. High-Performance Architectural Latex System: MPI INT 9.2B.
1) Prime Coat: Interior latex primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.

14. Plaster Substrates:
a. Latex System: MPI INT 9.2A.

1) Prime Coat: Interior latex primer/sealer (for MPI Premium Grade system) **OR** matching topcoat, **as directed**.
2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

b. Latex Over Alkyd Primer System: MPI INT 9.2K.
1) Prime Coat: Interior alkyd primer/sealer.
2) Intermediate Coat: Interior latex matching topcoat.
3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

c. Alkyd Over Latex Primer System: MPI INT 9.2C.
1) Prime Coat: Interior latex primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.

d. Institutional Low-Odor/VOC Latex System: MPI INT 9.2M.
1) Prime Coat: Interior latex primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.

e. High-Performance Architectural Latex System: MPI INT 9.2B.
1) Prime Coat: Interior latex primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): High-performance architectural latex matching topcoat.
3) Topcoat: High-performance architectural latex (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.

15. Spray-Textured Ceiling Substrates:
a. Latex (Flat) System: MPI INT 9.1A, spray applied.
1) Prime Coat: Interior latex primer/sealer **OR** (flat), **as directed**.
2) Topcoat: Interior latex (flat).

b. Latex System: MPI INT 9.1E, spray applied.
1) Prime Coat: Interior latex matching topcoat.
2) Intermediate Coat: Interior latex matching topcoat.
3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss), **as directed**.

c. Latex Over Alkyd Primer System: MPI INT 9.1B.
1) Prime Coat: Interior alkyd primer/sealer.
2) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

d. Alkyd (Flat) System: MPI INT 9.1C.
1) Prime Coat: Interior alkyd (flat).
2) Topcoat: Interior alkyd (flat).

e. Alkyd System: MPI INT 9.1D.
1) Prime Coat: Interior alkyd primer/sealer.
2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
3) Topcoat: Interior alkyd (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.

16. Cotton or Canvas Insulation-Covering Substrates: Including pipe and duct coverings.
a. Latex System: MPI INT 10.1A.
1) Prime Coat: Interior latex primer/sealer (for MPI Premium Grade system) **OR** matching topcoat, **as directed**.
2) Intermediate Coat (for MPI Premium Grade system): Interior latex matching topcoat.
3) Topcoat: Interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (satin) **OR** (semigloss) **OR** (gloss), **as directed**.

b. Alkyd Over Latex Primer System: MPI INT 10.1B.
   1) Prime Coat: Interior latex primer/sealer.
   2) Intermediate Coat (for MPI Premium Grade system): Interior alkyd matching topcoat.
   3) Topcoat: Interior alkyd (flat) **OR** (eggshell) **OR** (semigloss) **OR** (gloss), **as directed**.

c. Aluminum Paint System: MPI INT 10.1C.
   1) Prime Coat: Interior latex primer/sealer.
   2) Intermediate Coat (for MPI Premium Grade system): Aluminum paint.
   3) Topcoat: Aluminum paint.

d. Institutional Low-Odor/VOC Latex System: MPI INT 10.1D.
   1) Prime Coat: Interior latex primer/sealer.
   2) Intermediate Coat (for MPI Premium Grade system): Institutional low-odor/VOC interior latex matching topcoat.
   3) Topcoat: Institutional low-odor/VOC interior latex (flat) **OR** (low sheen) **OR** (eggshell) **OR** (semigloss), **as directed**.

END OF SECTION 09920

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SECTION 09920a - MULTICOLORED INTERIOR COATINGS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for multicolored interior coatings. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes surface preparation and field application of multicolor interior coating systems applied on the following substrates:
   a. Vertical concrete.
   b. Cementitious composition board.
   c. Clay masonry units.
   d. Concrete masonry units (CMU).
   e. Wood.
   f. Fiberglass moldings and trim.
   g. Plastic moldings and trim.
   h. Plaster, Gypsum veneer plaster, and Gypsum board.

C. Submittals
1. Product Data: For each type of product indicated.
2. Samples: For each finish-coat product and for each color and texture required.
3. LEED Submittal:
   a. Product Data for Credit EQ 4.2: For coatings, including printed statement of VOC content and chemical components.

D. Quality Assurance
1. Fire-Test-Response Characteristics: Provide coatings with flame-spread and smoked-developed indexes of 25 or less and 450 or less, respectively, as determined by testing identical products per ASTM E 84 by testing and inspecting agency acceptable to authorities having jurisdiction.
2. Master Painters Institute (MPI) Standards: Comply with recommendations in "MPI Architectural Painting Specification Manual" **OR** "MPI Maintenance Repainting Manual," **as directed**, applicable to products and coating systems indicated.

E. Delivery, Storage, And Handling
1. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
   a. Maintain containers in clean condition, free of foreign materials and residue.
   b. Remove rags and waste from storage areas daily.

1.2 PRODUCTS

A. Multicolor Coating Systems, General
1. Material Compatibility: Provide materials for use within each coating system that are compatible with one another and substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
2. VOC Content of Interior Paints and Coatings: Provide products that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
   a. Flat Paints, Coatings, and Primers: VOC content of not more than 50 g/L.
   b. Nonflat Paints, Coatings, and Primers: VOC content of not more than 150 g/L.

c. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
d. Shellacs, Clear: VOC not more than 730 g/L.
e. Shellacs, Pigmented: VOC not more than 550 g/L.
f. Flat Topcoat Paints: VOC content of not more than 50 g/L.
g. Nonflat Topcoat Paints: VOC content of not more than 150 g/L.
h. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
i. Shellacs, Clear: VOC not more than 730 g/L.
j. Shellacs, Pigmented: VOC not more than 550 g/L.
k. Primers, Sealers, and Undercoaters: VOC content of not more than 200 g/L.

3. Chemical Components of Interior Paints and Coatings: Provide topcoat paints that comply with the following chemical restrictions; these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:
   a. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing 1 or more benzene rings).
   b. Restricted Components: Paints and coatings shall not contain any of the following:
      1) Acrolein.
      2) Acrylonitrile.
      3) Antimony.
      4) Benzene.
      5) Butyl benzyl phthalate.
      6) Cadmium.
      7) Di (2-ethylhexyl) phthalate.
      8) Di-n-butyl phthalate.
      9) Di-n-octyl phthalate.
      10) 1,2-dichlorobenzene.
      11) Diethyl phthalate.
      12) Dimethyl phthalate.
      13) Ethylbenzene.
      14) Formaldehyde.
      15) Hexavalent chromium.
      16) Isophorone.
      17) Lead.
      18) Mercury.
      19) Methyl ethyl ketone.
      20) Methyl isobutyl ketone.
      21) Methylene chloride.
      22) Naphthalene.
      23) Toluene (methylbenzene).
      24) 1,1,1-trichloroethane.
      25) Vinyl chloride.
4. Colors and Patterns: Match samples **OR** As selected from manufacturer's full range **OR** As indicated in color schedule, **as directed**.

B. Fillers And Primers
1. General: Undercoatings recommended in writing for use in coating systems by manufacturer of multicolor interior coating on substrates and under conditions indicated.
2. Latex Block Filler: Waterborne, high-solids, emulsion-type, pigmented coating product recommended in writing for use in coating system indicated by manufacturer of multicolor interior coating, with bridging and filling properties, and formulated for filling surfaces of CMU for subsequent applications of finish coatings.
   a. VOC Content: Minimum E Range of E2 **OR** E3, **as directed**, according to requirements for MPI #4.
3. Wood Filler Paste: Solvent-based, high-solids, clear paste product recommended in writing for use in coating system indicated by manufacturer of multicolor interior coating, for use on open-

grained or damaged woods and that fills hardwood pores with minimal surface residues and without showing cracking or shrinkage. When dry, sanding filler produces a smooth surface without clogging or gumming sandpaper.
   a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**, according to requirements for MPI #91.
4. Wood-Knot Sealer: White shellac or other sealer recommended in writing for this purpose by manufacturer of multicolor interior coating.
5. Primer/Sealer for Multicolor Systems: Acrylic or acrylic/polyvinyl acetate (PVA) co-polymer emulsion-type, pigmented primer/sealer product recommended in writing for use in coating system indicated by manufacturer of multicolor interior coating.
   a. VOC Content: Minimum E Range of E2 **OR** E3, **as directed**, according to requirements for MPI #125.
6. Interior Alkyd Primer/Sealer: Solvent-based, pigmented primer/sealer.
   a. VOC Content: Minimum E Range of E1 **OR** E2, **as directed**, according to requirements for MPI #45.
7. Water-Based Bonding Primer: Water-based, emulsion-type, pigmented primer product recommended in writing for use in coating system indicated by manufacturer of multicolor interior coating, and formulated to promote adhesion of subsequent coatings.
   a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**, according to requirements for MPI #17.
8. Solvent-Based Bonding Primer: Solvent-based, pigmented product recommended in writing for use in coating system indicated by manufacturer of multicolor interior coating, and formulated to promote adhesion of subsequent coatings to substrate.
   a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**, according to requirements for MPI #69.

C. Multicolor Coatings
1. Multicolor Coatings: Complying with MPI #112 and listed in "MPI Approved Products List."
   a. VOC Content: Minimum E Range of E1 **OR** E3, **as directed**.
2. Clear Topcoat: Product of multicolor coating manufacturer complying with MPI #121 and listed in "MPI Approved Products List."
   a. VOC Content: Minimum E Range of E1 **OR** E2, **as directed**.

1.3 EXECUTION

A. Preparation
1. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
2. Remove plates, machined surfaces, and similar items already in place that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.
   a. After completing coating operations, reinstall items that were removed; use workers skilled in the trades involved.
3. Clean substrates of substances that could impair bond of coatings, including dirt, oil, grease, and incompatible primers, paints, and encapsulants.
4. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
5. Clay Masonry Substrates: Remove efflorescence and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
6. Concrete Masonry Substrates: Remove efflorescence and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
7. Wood Substrates:

a. Scrape and clean small, dry, seasoned knots, and apply a thin coat of knot sealer before applying primer.
b. Sand surfaces that will be exposed to view and dust off.
c. Prime edges, ends, faces, undersides, and back sides of wood.
d. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

B. Application
1. Apply coatings according to manufacturer's written instructions using applicators and techniques suited for coating and substrate indicated.
2. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Coat back sides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
4. Apply coating systems to produce uniformly textured, colored, and patterned finished-surface films without substrates, undercoats, marks, or stains showing through. Produce sharp, even glass lines and color breaks.

C. Cleaning And Protection
1. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
2. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
3. Protect work of other trades against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by the Owner, and leave in an undamaged condition.
4. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

D. Multicolor Interior Coating Schedule
1. Vertical Concrete Substrates: System below corresponds to MPI INT 3.1H
a. Prime Coat: Primer/sealer for multicolor systems.
b. Multicolor Base Coat: Multicolor coating, MPI #112.
c. Multicolor Pattern Coat: Multicolor coating, MPI #112.
d. Topcoat (for a Premium Grade system): Clear topcoat, MPI #121.
2. Cementitious Composition Board Substrates: System below corresponds to MPI INT 3.3F
a. Prime Coat: Primer/sealer for multicolor systems.
b. Multicolor Base Coat: Multicolor coating, MPI #112.
c. Multicolor Pattern Coat: Multicolor coating, MPI #112.
d. Topcoat (for a Premium Grade system): Clear topcoat, MPI #121.
3. Clay Masonry Units Substrates: System below corresponds to MPI INT 4.1H
a. Prime Coat: Primer/sealer for multicolor systems tinted to match multicolor basecoat.
b. Multicolor Base Coat: Multicolor coating, MPI #112.
c. Multicolor Pattern Coat: Multicolor coating, MPI #112.
d. Topcoat (for a Premium Grade system): Clear topcoat, MPI #121.
4. CMU Substrates: System below corresponds to MPI INT 4.2H
a. Block Filler: Latex block filler.
b. Prime Coat: Primer/sealer for multicolor systems.
c. Multicolor Base Coat: Multicolor coating, MPI #112.
d. Multicolor Pattern Coat: Multicolor coating, MPI #112.
e. Topcoat (for a Premium Grade system): Clear topcoat, MPI #121.
5. Wood Substrates: System below corresponds to MPI INT 6.2E, MPI INT 6.3N, and MPI INT 6.4L
a. Fill Coat: Wood filler paste (Fill coat is optional component and is for use on open-grained woods where a smooth, glasslike finish is desired).

b. Prime Coat: Interior alkyd primer/sealer tinted to match multicolor base coat {for dressed lumber (finished carpentry)}.
c. Multicolor Base Coat: Multicolor coating, MPI #112.
d. Multicolor Pattern Coat: Multicolor coating, MPI #112.
e. Topcoat (for a Premium Grade system): Clear topcoat, MPI #121.

6. Fiberglass Molding and Trim Substrates: System below corresponds to MPI INT 6.7G
   a. Prime Coat: Water-based **OR** Solvent-based, **as directed**, bonding primer.
   b. Multicolor Base Coat: Multicolor coating, MPI #112.
   c. Multicolor Pattern Coat: Multicolor coating, MPI #112.
   d. Topcoat (for a Premium Grade system): Clear topcoat, MPI #121.
7. Plastic Molding and Trim Substrates: System below corresponds to MPI INT 6.8D
   a. Prime Coat: Solvent-based bonding primer.
   b. Multicolor Base Coat: Multicolor coating, MPI #112.
   c. Multicolor Pattern Coat: Multicolor coating, MPI #112.
   d. Topcoat (for a Premium Grade system): Clear topcoat, MPI #121.
8. Plaster **OR** Gypsum Veneer Plaster **OR** Gypsum Board, **as directed**, Substrates: System below corresponds to MPI INT 9.2G
   a. Prime Coat: Primer/sealer for multicolor systems.
   b. Multicolor Base Coat: Multicolor coating, MPI #112.
   c. Multicolor Pattern Coat: Multicolor coating, MPI #112.
   d. Topcoat (for a Premium Grade system): Clear topcoat, MPI #121.

END OF SECTION 09920a

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Task	Specification	Specification Description
09920	09910	Exterior Painting
09925	09910	Exterior Painting

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SECTION 09930 - FLOOR TREATMENT REFINISHING WOOD FLOORS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for refinishing wood floors. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each type of product indicated.

1.2 PRODUCTS

A. Cleaning Compound: A liquid chemical cleaner containing non-ionic and anionic type detergents, non-reactive to wood flooring. Compound shall have no free metal alkalies, no artificial coloring and no fatty acids. Compound shall be UL listed as "slip-resistant."

B. Varnish Remover: Non-flammable paint and varnish remover.

C. Stain: Penetrating type non-fading wood stain.

D. Wood Filler: Paste type wood filler, pigmented if necessary to match sample, complying with Fed. Spec. TT-F-336.

E. Floor Sealer: Penetrating type, pliable, wood-hardening finish/sealer.

F. Floor Varnish: Alkyd resin varnish, specially compounded for floor finish, Fed. Spec. TT-V-109.

G. Urethane Finish: Specially compounded for wood floor finish, moisture curing type, for multiple-coat application.

H. Floor Wax: Liquid, solvent-type, slip-resistant, CID A-A-1550, Type II.

1.3 EXECUTION

A. Preparation:
1. Cleaning: Scrub thoroughly with cleaning compound and warm water. Rinse with clean water, mop dry, and buff with polishing machine.
2. Varnish Removal: Apply paint and varnish remover as required.
3. Sanding: Traverse floors two times with an electric-powered sanding machine. A rotary disc sander may be used for the final cut, but first cut shall be made with a drum-type machine. The first cut may be made crosswise of the grain or at a 45-degree angle. Make second cut in direction of grain. Use No. 1/2 sandpaper for first traverse and No. 0 for second traverse. Use an electric edger or hand sander for sanding areas near walls, in corners, and small closets.

B. Installation:
1. Apply Wood Paste Filler, followed by wiping cross-grain to work into pores and cracks.
2. Apply Stain if needed to match selected finish.

3. Apply Sealer (2 coats) complying with Fed. Spec. TT-S-176. Use Class I for white oak and red oak floors and Class II for beech, birch, and hard maple floors.
4. Apply Floor Varnish, (3 coats) buffing after each coat. First coat may be thinned as a sealer.
5. Apply Urethane Finish. Apply as many coats as needed to build a dry film thickness of 1.0 mil.
6. When Floors are Dry, apply two coats of wax complying with Fed. Spec. P-W-155; concentration 12 percent. Spread the wax at the rate of 1,500 square feet per gallon and polish the floors with a weighted floor brush or an electric polisher.
7. Protection: Upon completion of work, cover all traffic areas immediately with nonstaining kraft paper or polyethylene, taped along edges, and maintain floor protection until acceptance.

END OF SECTION 09930

SECTION 09930a - HIGH-PERFORMANCE COATINGS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for high performance coatings. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes surface preparation and application of high-performance coating systems on the following substrates:
   a. Exterior Substrates:
      1) Concrete, vertical and horizontal surfaces.
      2) Clay masonry.
      3) Concrete masonry units (CMU).
      4) Steel.
      5) Galvanized metal.
      6) Aluminum (not anodized or otherwise coated).
      7) Wood.
   b. Interior Substrates:
      1) Concrete, vertical and horizontal surfaces.
      2) Clay masonry.
      3) Concrete masonry units (CMU).
      4) Steel.
      5) Galvanized metal.
      6) Aluminum (not anodized or otherwise coated).
      7) Wood.
      8) Gypsum board.

C. Submittals
1. Product Data: For each type of product indicated.
2. Samples: For each type of finish-coat product indicated.
3. Product List: For each product indicated. Cross-reference products to coating system and locations of application areas. Use same designations indicated on Drawings and in schedules.
4. LEED Submittals:
   a. Product Data for Credit EQ 4.2: For coatings, including printed statement of VOC content and chemical components.

D. Quality Assurance
1. Master Painters Institute (MPI) Standards:
   a. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
   b. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" **OR** "MPI Maintenance Repainting Manual," **as directed**, for products and coating systems indicated.

E. Delivery, Storage, And Handling
1. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
   a. Maintain containers in clean condition, free of foreign materials and residue.
   b. Remove rags and waste from storage areas daily.

F. Project Conditions
1. Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are between 50 and 95 deg F (10 and 35 deg C).
2. Do not apply coatings in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

1.2 PRODUCTS

A. High-Performance Coatings, General
1. Material Compatibility:
a. Provide materials for use within each coating system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
b. Provide products of same manufacturer for each coat in a coating system.
2. VOC Content of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
a. Flat Paints, Coatings, and Primers: VOC content of not more than 50 g/L.
b. Nonflat Paints, Coatings, and Primers: VOC content of not more than 150 g/L.
c. Anticorrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC content of not more than 250 g/L.
d. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
e. Clear Wood Finishes, Lacquers: VOC not more than 550 g/L.
f. Floor Coatings: VOC not more than 100 g/L.
g. Shellacs, Clear: VOC not more than 730 g/L.
h. Shellacs, Pigmented: VOC not more than 550 g/L.
i. Stains: VOC content of not more than 250 g/L.
j. Flat Interior Topcoat Paints: VOC content of not more than 50 g/L.
k. Nonflat Interior Topcoat Paints: VOC content of not more than 150 g/L.
l. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
m. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
n. Clear Wood Finishes, Lacquers: VOC not more than 550 g/L.
o. Floor Coatings: VOC not more than 100 g/L.
p. Shellacs, Clear: VOC not more than 730 g/L.
q. Shellacs, Pigmented: VOC not more than 550 g/L.
r. Stains: VOC not more than 250 g/L.
s. Primers, Sealers, and Undercoaters: VOC content of not more than 200 g/L.
t. Zinc-Rich Industrial Maintenance Primers: VOC content of not more than 340 g/L.
u. Pre-Treatment Wash Primers: VOC content of not more than 420 g/L.
3. Chemical Components of Field-Applied Interior Paints and Coatings: Provide topcoat paints and anti-corrosive and anti-rust paints applied to ferrous metals that comply with the following chemical restrictions; these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:
a. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing 1 or more benzene rings).
b. Restricted Components: Paints and coatings shall not contain any of the following:
1) Acrolein.
2) Acrylonitrile.
3) Antimony.
4) Benzene.
5) Butyl benzyl phthalate.
6) Cadmium.

7) Di (2-ethylhexyl) phthalate.
8) Di-n-butyl phthalate.
9) Di-n-octyl phthalate.
10) 1,2-dichlorobenzene.
11) Diethyl phthalate.
12) Dimethyl phthalate.
13) Ethylbenzene.
14) Formaldehyde.
15) Hexavalent chromium.
16) Isophorone.
17) Lead.
18) Mercury.
19) Methyl ethyl ketone.
20) Methyl isobutyl ketone.
21) Methylene chloride.
22) Naphthalene.
23) Toluene (methylbenzene).
24) 1,1,1-trichloroethane.
25) Vinyl chloride.

4. Colors: As selected from manufacturer's full range **OR** Match samples **OR** As indicated in color schedule, **as directed**.

B. Block Fillers
1. Interior/Exterior Latex Block Filler: MPI#4.
   a. VOC Content: Minimum E Range of E2 **OR** E3, **as directed**.
2. Epoxy Block Filler: MPI #116.
   a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.

C. Interior Primers/Sealers
1. Interior Latex Primer/Sealer: MPI #50.
   a. Environmental Characteristics:
      1) VOC Content:
         a) Minimum E Range of E2 **OR** E3, **as directed**.
         b) Meets or exceeds LEED requirements for VOC content.
      2) Environmental Performance Rating (EPR): Minimum EPR 2 **OR** 3, **as directed**.
2. Interior Alkyd Primer/Sealer: MPI #45.
   a. VOC Content: Minimum E Range of E1 **OR** E2, **as directed**.
3. Interior Latex-Based Wood Primer: MPI #39.
   a. Environmental Characteristics:
      1) VOC Content:
         a) Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
         b) Meets or exceeds LEED requirements for VOC content.
      2) Environmental Performance Rating (EPR): Minimum EPR 1 **OR** 2 **OR** 3, **as directed**.
4. Wood-Knot Sealer: White shellac or other sealer recommended in writing by manufacturer for this purpose.

D. Metal Primers
1. Inorganic Zinc Primer: MPI #19.
   a. VOC Content: Minimum E Range of 0 **OR** E1 **OR** E2 **OR** E3, **as directed**.
2. Epoxy Zinc Primer: MPI #20.
   a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
3. Rust-Inhibitive Primer (Water Based): MPI #107.
   a. Environmental Characteristics:
      1) VOC Content:
         a) Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.

b) Meets or exceeds LEED requirements for VOC content.
2) Environmental Performance Rating (EPR): Minimum EPR 1 **OR** 2 **OR** 3, **as directed**.

4. Cold-Curing Epoxy Primer: MPI #101.
   a. VOC Content: Minimum E Range of E1 **OR** E3, **as directed**.
5. Alkyd Anticorrosive Metal Primer: MPI #79.
   a. VOC Content: Minimum E Range of E1 **OR** E2, **as directed**.
6. Quick-Dry Alkyd Metal Primer: MPI #76.
   a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
7. Cementitious Galvanized-Metal Primer: MPI #26.
   a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
8. Waterborne Galvanized-Metal Primer: MPI #134.
   a. Environmental Characteristics:
      1) VOC Content:
         a) Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
         b) Meets or exceeds LEED requirements for VOC content.
      2) Environmental Performance Rating (EPR): Minimum EPR 1 **OR** 2 **OR** 3, **as directed**.
9. Quick-Drying Primer for Aluminum: MPI #95.
   a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
10. Vinyl Wash Primer: MPI #80.
    a. VOC Content: Minimum E Range of E2 **OR** E3, **as directed**.

E. Water-Based, Light-Industrial Coatings
1. Gloss, Water-Based, Light-Industrial Coating: MPI #110-G6.
   a. Environmental Characteristics:
      1) VOC Content: Minimum E Range of E2.
      2) Environmental Performance Rating (EPR): Minimum EPR 2.
2. Semigloss, Water-Based, Light-Industrial Coating: MPI #110-G5.
   a. Environmental Characteristics:
      1) VOC Content:
         a) Minimum E Range of E2 **OR** E3, **as directed**.
         b) Meets or exceeds LEED requirements for VOC content.
      2) Environmental Performance Rating (EPR): Minimum EPR 2 **OR** 3, **as directed**.
3. Eggshell, Water-Based, Light-Industrial Coating: MPI #110-G3.
   a. Environmental Characteristics:
      1) VOC Content:
         a) Minimum E Range of E2 **OR** E3, **as directed**.
         b) Meets or exceeds LEED requirements for VOC content.
      2) Environmental Performance Rating (EPR): Minimum EPR 2 **OR** 3, **as directed**.

F. Epoxy Coatings
1. Epoxy, Cold-Cured, Gloss: MPI #77.
   a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
2. Water-Based Epoxy (Interior and Exterior): MPI #115.
   a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
3. High-Build Epoxy Marine Coating, Low Gloss: MPI #108.
   a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
4. Epoxy Deck Coating: MPI #82.
   a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
5. Water-Based Epoxy Floor Paint: MPI #93.
   a. Environmental Characteristics:
      1) VOC Content:
         a) Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
         b) Meets or exceeds LEED requirements for VOC content.

2) Environmental Performance Rating (EPR): Minimum EPR 1 **OR** 2 **OR** 3, **as directed**.

G. Polyurethane Coatings
1. Polyurethane, Two-Component, Pigmented, Gloss: MPI #72.
a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
2. Two-Component, Aliphatic Polyurethane, Clear: MPI #78.
a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
3. Polyurethane, Moisture Cured, Clear, Gloss: MPI #31.
a. VOC Content: Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
4. Polyurethane, Moisture Cured, Clear, Flat: MPI #71.
a. VOC Content: Minimum E Range of E2.

H. Interior High-Performance Architectural Latex Coatings
1. High-Performance Architectural Latex, Velvet Finish: MPI #138, Gloss Level 2.
a. Environmental Characteristics:
1) VOC Content:
a) Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
b) Meets or exceeds LEED requirements for VOC content.
2) Environmental Performance Rating (EPR): Minimum EPR 4 **OR** 5 **OR** 6, **as directed**.
2. High-Performance Architectural Latex, Eggshell Finish: MPI #139, Gloss Level 3.
a. Environmental Characteristics:
1) VOC Content:
a) Minimum E Range of E2 **OR** E3, **as directed**.
b) Meets or exceeds LEED requirements for VOC content.
2) Environmental Performance Rating (EPR): Minimum EPR 5 **OR** 6, **as directed**.
3. High-Performance Architectural Latex, Satin Finish: MPI #140, Gloss Level 4.
a. Environmental Characteristics:
1) VOC Content:
a) Minimum E Range of E1 **OR** E3, **as directed**.
b) Meets or exceeds LEED requirements for VOC content.
2) Environmental Performance Rating (EPR): Minimum EPR 4.5 **OR** 6.5, **as directed**.
4. High-Performance Architectural Latex, Semigloss Finish: MPI #141, Gloss Level 5.
a. Environmental Characteristics:
1) VOC Content:
a) Minimum E Range of E1 **OR** E2 **OR** E3, **as directed**.
b) Meets or exceeds LEED requirements for VOC content.
2) Environmental Performance Rating (EPR): Minimum EPR 5 **OR** 6 **OR** 7, **as directed**.

I. Wood Stains
1. Exterior Semitransparent Stain (Solvent Based): MPI #13.
a. VOC Content: Minimum E Range of E1 **OR** E2, **as directed**.
2. Interior Wood Stain, Semitransparent (Solvent Based): MPI #90.
a. VOC Content: Minimum E Range of E1 **OR** E2, **as directed**.

1.3 EXECUTION

A. Preparation
1. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
2. Remove plates, machined surfaces, and similar items already in place that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.

a. After completing coating operations, reinstall items that were removed; use workers skilled in the trades involved.

3. Clean substrates of substances that could impair bond of coatings, including dirt, oil, grease, and incompatible paints and encapsulants.
   a. Remove incompatible primers and reprime substrate with compatible primers as required to produce coating systems indicated.
4. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
   a. Clean surfaces with pressurized water. Use pressure range of 1500 to 4000 psi (10 350 to 27 580 kPa) at 6 to 12 inches (150 to 300 mm) **OR** 4000 to 10,000 psi (27 580 to 68 950 kPa), **as directed**.
      OR
      Abrasive blast clean surfaces to comply with SSPC-SP 7/NACE No. 4, "Brush-Off Blast Cleaning."
5. Clay Masonry Substrates: Remove efflorescence and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
   a. Clean surfaces with pressurized water. Use pressure range of 100 to 600 psi (690 to 4140 kPa) **OR** 1500 to 4000 psi (10 350 to 27 580 kPa), **as directed**, at 6 to 12 inches (150 to 300 mm).
6. CMU Substrates: Remove efflorescence and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
7. Steel Substrates (for field applied primers): Remove rust and loose mill scale.
   a. Clean using methods recommended in writing by coating manufacturer.

      Blast clean according to SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning **OR** SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning **OR** SSPC-SP 7/NACE No. 4, "Brush-Off Blast Cleaning **OR** SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning," **as directed**.
8. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied coatings.
9. Aluminum Substrates: Remove surface oxidation.
10. Wood Substrates:
    a. Scrape and clean small, dry, seasoned knots, and apply a thin coat of knot sealer before applying primer.
    b. Sand surfaces that will be exposed to view and dust off.
    c. Prime edges, ends, faces, undersides, and back sides of wood.
    d. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

B. Application
1. Apply high-performance coatings according to manufacturer's written instructions.
   a. Use applicators and techniques suited for coating and substrate indicated.
   b. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
   c. Coat back sides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
2. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of the same material are to be applied. Tint undercoats to match color of finish coat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
3. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.

4. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

C. Field Quality Control
1. Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when coatings are being applied:
   a. Owner will engage the services of a qualified testing agency to sample coating material being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
   b. Testing agency will perform tests for compliance with specified requirements.
   c. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with specified requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

D. Cleaning And Protection
1. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
2. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
3. Protect work of other trades against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by the Owner, and leave in an undamaged condition.
4. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

E. Exterior High-Performance Coating Schedule
1. Coating systems in this Article are based on "MPI Architectural Painting Specification Manual." For renovation projects, consult "MPI Maintenance Repainting Manual" and revise coating systems accordingly.
2. Concrete Substrates, Vertical Surfaces:
   a. Water-Based, Light-Industrial Coating System (System below corresponds to MPI EXT 3.1C):
      1) Prime Coat: Water-based, light-industrial coating, MPI #110, gloss matching topcoat.
      2) Intermediate Coat: Not required **OR** Water-based, light-industrial coating, MPI #110, gloss matching topcoat, **as directed**.
      3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.
   b. Epoxy Coating System (System below corresponds to MPI EXT 3.1D):
      1) Prime Coat: Epoxy, cold-cured, gloss, MPI #77.
      2) Intermediate Coat: Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
      3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.
   c. Water-Based Epoxy Coating System (System below corresponds to MPI EXT 3.1E):
      1) Prime Coat: Water-based epoxy (interior and exterior), MPI #115.
      2) Intermediate Coat: Not required **OR** Water-based epoxy (interior and exterior), MPI #115, **as directed**.
      3) Topcoat: Water-based epoxy (interior and exterior), MPI #115.
3. Concrete Substrates, Horizontal Surfaces (System below corresponds to MPI EXT 3.2C):
   a. Epoxy Slip-Resistant Deck Coating System:
      1) Topcoat: Epoxy deck coating, MPI #82.
4. Clay-Masonry Substrates (System below corresponds to MPI EXT 4.1C):
   a. Water-Based, Light-Industrial Coating System:

1) Prime Coat: Water-based, light-industrial coating, MPI #110, gloss matching topcoat.
2) Intermediate Coat: Not required **OR** Water-based, light-industrial coating, MPI #110, gloss matching topcoat, **as directed**.
3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.

b. Epoxy Coating System (System below corresponds to MPI EXT 4.1D) (MPI recommends this system for smooth brick.):
1) Prime Coat: Epoxy, cold-cured, gloss, MPI #77.
2) Intermediate Coat : Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.

c. Water-Based Epoxy Coating System (System below corresponds to MPI EXT 4.1E) (MPI recommends this system for smooth brick.):
1) Prime Coat: Water-based epoxy (interior and exterior), MPI #115.
2) Intermediate Coat: Not required **OR** Water-based epoxy (interior and exterior), MPI #115, **as directed**.
3) Topcoat: Water-based epoxy (interior and exterior), MPI #115.

d. Polyurethane, Pigmented, Over Epoxy Coating System (System below corresponds to MPI EXT 4.1J):
1) Prime Coat: Epoxy, cold-cured, gloss, MPI #77.
2) Intermediate Coat: Epoxy, cold-cured, gloss, MPI #77.
3) Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.

5. CMU Substrates:
a. Water-Based, Light-Industrial Coating System (System below corresponds to MPI EXT 4.2C):
1) Prime Coat: Interior/exterior latex block filler, MPI #4.
2) Intermediate Coat: Not required **OR** Water-based, light-industrial coating, MPI #110, gloss matching topcoat, **as directed**.
3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.

b. Epoxy Coating System (System below corresponds to MPI EXT 4.2E):
1) Block Filler: Epoxy block filler, MPI #116.
2) Intermediate Coat: Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.

c. Water-Based Epoxy Coating System (System below corresponds to MPI EXT 4.2F):
1) Block Filler: Epoxy block filler, MPI #116.
2) Intermediate Coat: Not required **OR** Water-based epoxy (interior and exterior), MPI #115, **as directed**.
3) Topcoat: Water-based epoxy (interior and exterior), MPI #115.

d. Polyurethane, Pigmented, Over High-Build Epoxy Coating System (System below corresponds to MPI EXT 4.2G):
1) Block Filler: Epoxy block filler, MPI #116.
2) Intermediate Coat: High-build epoxy marine coating, low gloss, MPI #108.
3) Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.

6. Steel Substrates:
a. Water-Based, Light-Industrial Coating System (System below corresponds to MPI EXT 5.1B, MPI EXT 5.1C, MPI EXT 5.1M and MPI EXT 5.1N, depending on primer selected):
1) Prime Coat: Inorganic zinc primer, MPI #19 **OR** Alkyd anticorrosive metal primer, MPI #79 **OR** Rust-inhibitive primer, (water based), MPI #107 **OR** Cold-curing epoxy primer, MPI #101, **as directed**, primer.

2) Intermediate Coat: Water-based, light-industrial coating, MPI #110, gloss matching topcoat (intermediate coat is required for coating systems except MPI Custom Grade system using inorganic zinc primer).
3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.

b. High-Build Epoxy Coating System (System below corresponds to MPI EXT 5.1F):
1) Prime Coat: Cold-curing epoxy primer, MPI #101.
2) Intermediate Coat: High-build epoxy marine coating, low gloss, MPI #108.
3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.

c. Water-Based Epoxy Coating System (System below corresponds to MPI EXT 5.1E):
1) Prime Coat: Rust-inhibitive primer, (water based), MPI #107.
2) Intermediate Coat: Water-based epoxy (interior and exterior), MPI #115.
3) Topcoat: Water-based epoxy (interior and exterior), MPI #115.

d. Polyurethane, Pigmented, Over Epoxy Coating System (System below corresponds to MPI EXT 5.1H):
1) Prime Coat: Cold-curing epoxy primer, MPI #101.
2) Intermediate Coat: Epoxy, cold-cured, gloss, MPI #77.
3) First Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
4) Second Topcoat (for Premium Grade system): Polyurethane, two-component, pigmented, gloss, MPI #72.

e. Polyurethane, Pigmented, Over Epoxy Coating System (System below corresponds to MPI EXT 5.1P)
1) Prime Coat: Epoxy zinc primer, MPI#20.
2) Intermediate Coat: Epoxy, cold-cured, gloss, MPI #77.
3) First Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
4) Second Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.

f. Polyurethane, Pigmented, Over High-Build Epoxy Coating System (System below corresponds to MPI EXT 5.1G):
1) Prime Coat: Epoxy zinc primer, MPI#20.
2) Intermediate Coat: High-build epoxy marine coating, low gloss, MPI #108.
3) First Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
4) Second Topcoat (for Premium Grade system): Polyurethane, two-component, pigmented, gloss, MPI #72.

g. Polyurethane, Pigmented, Over High-Build Epoxy Coating System (System below corresponds to MPI EXT 5.1J):
1) Prime Coat: Cold-curing epoxy primer, MPI #101.
2) Intermediate Coat: High-build epoxy marine coating, low gloss, MPI #108.
3) First Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
4) Second Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.

h. Polyurethane, Pigmented, Over High-Build Epoxy Coating System (System below corresponds to MPI EXT 5.1L):
1) Prime Coat: Inorganic zinc primer, MPI #19.
2) Intermediate Coat: High-build epoxy marine coating, low gloss, MPI #108.
3) First Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
4) Second Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.

7. Galvanized-Metal Substrates:

a. Water-Based, Light-Industrial Coating System (System below corresponds to MPI EXT 5.3G and MPI EXT 5.3J, depending on primer selected):
1) Prime Coat: Cementitious galvanized-metal primer, MPI #26 **OR** Waterborne galvanized-metal primer, MPI #134, **as directed**.
2) Intermediate Coat (for Premium Grade system): Not required **OR** Water-based, light-industrial coating, MPI #110, gloss matching topcoat, **as directed**.
3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.

b. Epoxy Coating System (System below corresponds to MPI EXT 5.3C) (MPI recommends this system for high-contact and -traffic areas.):

1) Prime Coat: Cold-curing epoxy primer, MPI #101.
2) Intermediate Coat (for Premium Grade system): Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.

c. Polyurethane, Pigmented Coating System (System below corresponds to MPI EXT 5.3D) (MPI recommends these systems for high-contact and -traffic areas.):
1) Prime Coat: Vinyl wash primer, MPI #80.
2) Intermediate Coat: Not required **OR** Cold-curing epoxy primer, MPI #101, **as directed**.
3) First Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
4) Second Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.

d. Polyurethane, Pigmented Coating System (System below corresponds to MPI EXT 5.3L):
1) Prime Coat: Cold-curing epoxy primer, MPI #101.
2) Intermediate Coat: Not required **OR** Polyurethane, two-component, pigmented, gloss, MPI #72, **as directed**.
3) First Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
4) Second Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.

8. Aluminum (Not Anodized or Otherwise Coated) Substrates:
a. Water-Based, Light-Industrial Coating System (System below corresponds to MPI EXT 5.4G):
1) Prime Coat: Quick-drying primer for aluminum, MPI #95.
2) Intermediate Coat: Not required **OR** Water-based, light-industrial coating, MPI #110, gloss matching topcoat, **as directed**.
3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.

b. Epoxy Coating System (System below corresponds to MPI EXT 5.4E):
1) Prime Coat: Vinyl wash primer, MPI #80.
2) Intermediate Coat (for Premium Grade system): Epoxy, cold-cured, gloss, MPI #77.
3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.

c. Polyurethane, Pigmented Coating System (System below corresponds to MPI EXT 5.4B) (MPI recommends these systems for high-contact and -traffic areas.):
1) Prime Coat: Vinyl wash primer, MPI #80.
2) Intermediate Coat: Cold-curing epoxy primer, MPI #101.
3) First Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
4) Second Topcoat (for Premium Grade system): Polyurethane, two-component, pigmented, gloss, MPI #72.

9. Wood Substrates:
a. Pigmented Polyurethane Coating System (System below corresponds to MPI EXT 6.1J, MPI EXT 6.2J, and MPI EXT 6.3H):
1) Prime Coat: Polyurethane, two-component, pigmented, gloss, MPI #72.
2) Intermediate Coat: Polyurethane, two-component, pigmented, gloss, MPI #72.
3) Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.

b. Polyurethane, Clear, Two-Component Coating System (System below corresponds to MPI EXT 6.1E for use on glue-laminated beams and columns):
1) Stain Coat: Exterior semitransparent stain (solvent based), MPI #13.
2) Intermediate Coat: Two-component, aliphatic polyurethane, clear, MPI #78.
3) First Topcoat: Two-component, aliphatic polyurethane, clear, MPI #78.
4) Second Topcoat (for Premium Grade systems): Two-component, aliphatic polyurethane, clear, MPI #78.

F. Interior High-Performance Coating Schedule
1. Coating systems in this Article are based on "MPI Architectural Painting Specification Manual." For renovation projects, consult "MPI Maintenance Repainting Manual" and revise coating systems accordingly.
2. Concrete Substrates, Vertical Surfaces (System below corresponds to MPI INT 3.1C):

a. High-Performance Architectural Latex Coating System:
   1) Prime Coat: Interior latex primer/sealer, MPI #50.
   2) Intermediate Coat: Not required **OR** High-performance architectural latex matching topcoat, **as directed**.
   3) Topcoat: High-performance architectural latex, velvet finish, MPI #138, Gloss Level 2 **OR** eggshell finish, MPI #139, Gloss Level 3 **OR** satin finish, MPI #140, Gloss Level 4 **OR** semigloss finish, MPI #141, Gloss Level 5, **as directed**.

b. Water-Based, Light-Industrial Coating System (System below corresponds to MPI INT 3.1L):
   1) Prime Coat: Water-based, light-industrial coating, MPI #110, gloss matching topcoat.
   2) Intermediate Coat: Not required **OR** Water-based, light-industrial coating, MPI #110, gloss matching topcoat, **as directed**.
   3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.

c. Epoxy Coating System (System below corresponds to MPI INT 3.1F.) (MPI recommends this system for smooth concrete.):
   1) Prime Coat: Epoxy, cold-cured, gloss, MPI #77.
   2) Intermediate Coat: Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
   3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.

d. Water-Based Epoxy Coating System (System below corresponds to MPI INT 3.1G) (MPI recommends this system for smooth concrete.):
   1) Prime Coat: Water-based epoxy (interior and exterior), MPI #115.
   2) Intermediate Coat: Not required **OR** Water-based epoxy (interior and exterior), MPI #115, **as directed**.
   3) Topcoat: Water-based epoxy (interior and exterior), MPI #115.

3. Concrete Substrates, Horizontal Surfaces.

a. Epoxy Coating System (System below corresponds to MPI INT 3.2C):
   1) Prime Coat: Epoxy, cold-cured, gloss, MPI #77.
   2) Intermediate Coat: Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
   3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.

b. Water-Based Epoxy Floor Paint Coating System (System below corresponds to MPI INT 3.2L).
   1) Prime Coat: Water-based epoxy floor paint, MPI #93.
   2) Intermediate Coat: Not required **OR** Water-based epoxy floor paint, MPI #93, **as directed**.
   3) Topcoat: Water-based epoxy floor paint, MPI #93.

c. Polyurethane, Pigmented Coating System (System below corresponds to MPI INT 3.2D):
   1) Prime Coat: Epoxy, cold-cured, gloss, MPI #77.
   2) Intermediate Coat: Not required **OR** Polyurethane, two-component, pigmented, gloss, MPI #72, **as directed**.
   3) Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.

d. Polyurethane, Clear, Two-Component Coating System (System below corresponds to MPI INT 3.2K):
   1) Prime Coat: Two-component, aliphatic polyurethane, clear, MPI #78.
   2) Intermediate Coat: Not required **OR** Two-component, aliphatic polyurethane, clear, MPI #78, **as directed**.
   3) Topcoat: Two-component, aliphatic polyurethane, clear, MPI #78.

4. Clay-Masonry Substrates:

a. High-Performance Architectural Latex Coating System (System below corresponds to MPI INT 4.1L):
   1) Prime Coat: High-performance architectural latex matching topcoat.
   2) Intermediate Coat: Not required **OR** High-performance architectural latex matching topcoat, **as directed**.

3) Topcoat: High-performance architectural latex, velvet finish, MPI #138, Gloss Level 2 **OR** eggshell finish, MPI #139, Gloss Level 3 **OR** satin finish, MPI #140, Gloss Level 4 **OR** semigloss finish, MPI #141, Gloss Level 5, **as directed**.

b. Water-Based, Light-Industrial Coating System (System below corresponds to MPI INT 4.1C):
1) Prime Coat: Water-based, light-industrial coating, MPI #110, gloss matching topcoat.
2) Intermediate Coat: Not required **OR** Water-based, light-industrial coating, MPI #110, gloss matching topcoat, **as directed**.
3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.

c. Epoxy Coating System (System below corresponds to MPI INT 4.1F) (MPI recommends this system for smooth brick.):
1) Prime Coat: Epoxy, cold-cured, gloss, MPI #77.
2) Intermediate Coat: Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.

d. Water-Based Epoxy Coating System (System below corresponds to MPI INT 4.1G) (MPI recommends this system for smooth brick.):
1) Prime Coat: Water-based epoxy (interior and exterior), MPI #115.
2) Intermediate Coat: Not required **OR** Water-based epoxy (interior and exterior), MPI #115, **as directed**.
3) Topcoat: Water-based epoxy (interior and exterior), MPI #115.

e. Polyurethane, Clear, Two-Component Coating System (System below corresponds to MPI INT 4.1K):
1) Prime Coat: Two-component, aliphatic polyurethane, clear, MPI #78.
2) Intermediate Coat: Not required **OR** Two-component, aliphatic polyurethane, clear, MPI #78, **as directed**.
3) Topcoat: Two-component, aliphatic polyurethane, clear, MPI #78.

5. CMU Substrates:
a. High-Performance Architectural Latex Coating System (System below corresponds to MPI INT 4.2D):
1) Prime Coat: Interior/exterior latex block filler, MPI #4.
2) Intermediate Coat: Not required **OR** High-performance architectural latex matching topcoat, **as directed**.
3) Topcoat: High-performance architectural latex, velvet finish, MPI #138, Gloss Level 2 **OR** eggshell finish, MPI #139, Gloss Level 3 **OR** satin finish, MPI #140, Gloss Level 4 **OR** semigloss finish, MPI #141, Gloss Level 5, **as directed**.

b. Water-Based, Light-Industrial Coating System (System below corresponds to MPI INT 4.2K):
1) Prime Coat: Interior/exterior latex block filler, MPI #4.
2) Intermediate Coat: Not required **OR** Water-based, light-industrial coating, MPI #110, gloss matching topcoat, **as directed**.
3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.

c. Epoxy Coating System (System below corresponds to MPI INT 4.2F and MPI INT 4.2G, depending on primer selected) (MPI recommends these systems for dry environments.):
1) Prime Coat: Interior/exterior latex block filler, MPI #4 **OR** Epoxy block filler, MPI #116, **as directed**.
2) Intermediate Coat: Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.

d. Water-Based Epoxy Coating System (System below corresponds to MPI INT 4.2J) (MPI recommends this system for wet environments.):
1) Prime Coat: Interior/exterior latex block filler, MPI #4.

2) Intermediate Coat: Not required **OR** Water-based epoxy (interior and exterior), MPI #115, **as directed**.
3) Topcoat: Water-based epoxy (interior and exterior), MPI #115.

6. Steel Substrates:
   a. High-Performance Architectural Latex Coating System (System below corresponds to MPI INT 5.1R):
      1) Prime Coat: Alkyd anticorrosive metal primer, MPI #79 **OR** Quick-dry alkyd metal primer, MPI #76, **as directed**.
      2) Intermediate Coat: Not required **OR** High-performance architectural latex matching topcoat, **as directed**.
      3) Topcoat: High-performance architectural latex, velvet finish, MPI #138, Gloss Level 2 **OR** eggshell finish, MPI #139, Gloss Level 3 **OR** satin finish, MPI #140, Gloss Level 4 **OR** semigloss finish, MPI #141, Gloss Level 5, **as directed**.
   b. Water-Based, Light-Industrial Coating System (System below corresponds to MPI INT 5.1B and MPI INT 5.1N, depending on primer selected.):
      1) Prime Coat: Rust-inhibitive primer (water based), MPI #107 **OR** Cold-curing epoxy primer, MPI #101, **as directed**.
      2) Intermediate Coat: Not required **OR** Water-based, light-industrial coating, MPI #110, gloss matching topcoat, **as directed**.
      3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.
   c. High-Build Epoxy Coating System - Premium Grade (System below corresponds to MPI INT 5.1P):
      1) Prime Coat: Epoxy zinc primer, MPI#20.
      2) Intermediate Coat: High-build epoxy marine coating, low gloss, MPI #108.
      3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.
   d. High-Build Epoxy Coating System – Custom Grade (System below corresponds to MPI INT 5.1P):
      1) Prime Coat: Epoxy zinc primer, MPI#20.
      2) Topcoat: High-build epoxy marine coating, low gloss, MPI #108.
   e. Epoxy Coating System (System below corresponds to MPI INT 5.1L):
      1) Prime Coat: Cold-curing epoxy primer, MPI #101.
      2) Intermediate Coat: Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
      3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.
   f. Water-Based Epoxy Coating System (System below corresponds to MPI INT 5.1K):
      1) Prime Coat: Rust-inhibitive primer (water based), MPI #107.
      2) Intermediate Coat: Water-based epoxy (interior and exterior), MPI #115.
      3) Topcoat: Water-based epoxy (interior and exterior), MPI #115.
   g. Polyurethane, Pigmented Coating System (System below corresponds to MPI INT 5.1F):
      1) Prime Coat: Cold-curing epoxy primer, MPI #101.
      2) Intermediate Coat: Not required **OR** Polyurethane, two-component, pigmented, gloss, MPI #72, **as directed**.
      3) Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
   h. Polyurethane, Pigmented Coating System (System below corresponds to MPI INT 5.1H):
      1) Prime Coat: Inorganic zinc primer, MPI #19.
      2) Intermediate Coat: Epoxy, cold-cured, gloss, MPI #77.
      3) Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
   i. Polyurethane, Pigmented Coating System (System below corresponds to MPI INT 5.1J):
      1) Prime Coat: Epoxy zinc primer, MPI#20.
      2) Intermediate Coat: Epoxy, cold-cured, gloss, MPI #77.
      3) Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
   j. Polyurethane, Pigmented, Over High-Build Epoxy Coating System (System below corresponds to MPI INT 5.1G):
      1) Prime Coat: Cold-curing epoxy primer, MPI #101.
      2) Intermediate Coat: High-build epoxy marine coating, low gloss, MPI #108.

3) Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.

7. Galvanized-Metal Substrates:
   a. High-Performance Architectural Latex Coating System (System below corresponds to MPI INT 5.3M):
      1) Prime Coat: Waterborne galvanized-metal primer, MPI #134.
      2) Intermediate Coat: Not required **OR** High-performance architectural latex matching topcoat, **as directed**.
      3) Topcoat: High-performance architectural latex, velvet finish, MPI #138, Gloss Level 2 **OR** eggshell finish, MPI #139, Gloss Level 3 **OR** satin finish, MPI #140, Gloss Level 4 **OR** semigloss finish, MPI #141, Gloss Level 5, **as directed**.
   b. Water-Based, Light-Industrial Coating System (System below corresponds to MPI INT 5.3B and MPI INT 5.3K, depending on primer selected.):
      1) Prime Coat: Cementitious galvanized-metal primer, MPI #26 **OR** Waterborne galvanized-metal primer, MPI #134, **as directed**.
      2) Intermediate Coat: Not required **OR** Water-based, light-industrial coating, MPI #110, gloss matching topcoat, **as directed**.
      3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.
   c. Epoxy Coating System (System below corresponds to MPI INT 5.3D):
      1) Prime Coat: Cold-curing epoxy primer, MPI #101.
      2) Intermediate Coat: Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
      3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.
8. Aluminum (Not Anodized or Otherwise Coated) Substrates (System below corresponds to MPI INT 5.4F):
   a. High-Performance Architectural Latex Coating System:
      1) Prime Coat: Quick-drying primer for aluminum, MPI #95.
      2) Intermediate Coat: Not required **OR** High-performance architectural latex, matching topcoat, **as directed**.
      3) Topcoat: High-performance architectural latex, velvet finish, MPI #138, Gloss Level 2 **OR** eggshell finish, MPI #139, Gloss Level 3 **OR** satin finish, MPI #140, Gloss Level 4 **OR** semigloss finish, MPI #141, Gloss Level 5, **as directed**.
   b. Water-Based, Light-Industrial Coating System (System below corresponds to MPI INT 5.4E):
      1) Prime Coat: Quick-drying primer for aluminum, MPI #95.
      2) Intermediate Coat: Not required **OR** Water-based, light-industrial coating, MPI #110, gloss matching topcoat, **as directed**.
      3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.
   c. Epoxy Coating System (System below corresponds to MPI INT 5.4B):
      1) Prime Coat: Vinyl wash primer, MPI #80.
      2) Intermediate Coat: Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
      3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.
   d. Polyurethane, Pigmented Coating System (System below corresponds to MPI INT 5.4C):
      1) Prime Coat: Vinyl wash primer, MPI #80.
      2) Intermediate Coat: Epoxy, cold-cured, gloss, MPI #77.
      3) Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.
9. Wood Substrates:
   a. High-Performance Architectural Latex Coating System (System below corresponds to MPI INT 6.1N, MPI INT 6.3A, and MPI INT 6.4S):
      1) Prime Coat: Interior latex-based wood primer, MPI #39.
      2) Intermediate Coat: High-performance architectural latex matching topcoat.

3) Topcoat: High-performance architectural latex, velvet finish, MPI #138, Gloss Level 2 **OR** eggshell finish, MPI #139, Gloss Level 3 **OR** satin finish, MPI #140, Gloss Level 4 **OR** semigloss finish, MPI #141, Gloss Level 5, **as directed**.

b. Water-Based, Light-Industrial Coating System (System below corresponds to MPI INT 6.3P and MPI INT 6.4N):
   1) Prime Coat: Interior alkyd primer/sealer, MPI #45.
   2) Intermediate Coat: Water-based, light-industrial coating, MPI #110, gloss matching topcoat.
   3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.

c. Epoxy Coating System (System below corresponds to MPI INT 6.1L and MPI INT 6.3L):
   1) Prime Coat: Epoxy, cold-cured, gloss, MPI #77.
   2) Intermediate Coat: Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
   3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.

d. Pigmented Polyurethane Coating System (System below corresponds to MPI INT 6.1E):
   1) Prime Coat: Polyurethane, two-component, pigmented, gloss, MPI #72.
   2) Intermediate Coat: Polyurethane, two-component, pigmented, gloss, MPI #72.
   3) Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.

e. Polyurethane, Clear, Moisture-Cured Coating System (System below corresponds to MPI INT 6.1S, MPI INT 6.2N, MPI INT 6.3Y, and MPI INT 6.4V):
   1) Stain Coat: Interior wood stain, semitransparent (solvent based), MPI #90.
   2) Intermediate Coat: Polyurethane, moisture cured, clear, flat, MPI #71 **OR** Polyurethane, moisture cured, clear, gloss, MPI #31, **as directed**.
   3) First Topcoat: Polyurethane, moisture cured, clear, flat, MPI #71 **OR** Polyurethane, moisture cured, clear, gloss, MPI #31, **as directed**.
   4) Second Topcoat: Not required **OR** Polyurethane, moisture cured, clear, flat, MPI #71 **OR** Polyurethane, moisture cured, clear, gloss, MPI #31, **as directed**.

f. Polyurethane, Clear, Moisture-Cured Coating System (System below corresponds to MPI INT 6.3X):
   1) Intermediate Coat: Polyurethane, moisture cured, clear, flat, MPI #71 **OR** Polyurethane, moisture cured, clear, gloss, MPI #31, **as directed**.
   2) First Topcoat: Polyurethane, moisture cured, clear, flat, MPI #71 **OR** Polyurethane, moisture cured, clear, gloss, MPI #31, **as directed**.
   3) Second Topcoat: Not required **OR** Polyurethane, moisture cured, clear, flat, MPI #71 **OR** Polyurethane, moisture cured, clear, gloss, MPI #31, **as directed**.

g. Polyurethane, Clear, Two-Component Coating System (System below corresponds to MPI INT 6.3Z):
   1) Stain Coat: Exterior semitransparent stain (solvent based), MPI #13.
   2) Intermediate Coat: Not required **OR** Two-component, aliphatic polyurethane, clear, MPI #78, **as directed**.
   3) Topcoat: Two-component, aliphatic polyurethane, clear, MPI #78.

10. Gypsum Board Substrates:

a. High-Performance Architectural Latex Coating System (System below corresponds to MPI INT 9.2B):
   1) Prime Coat: Interior latex primer/sealer, MPI #50.
   2) Intermediate Coat: High-performance architectural latex matching topcoat.
   3) Topcoat: High-performance architectural latex, velvet finish, MPI #138, Gloss Level 2 **OR** eggshell finish, MPI #139, Gloss Level 3 **OR** satin finish, MPI #140, Gloss Level 4 **OR** semigloss finish, MPI #141, Gloss Level 5, **as directed**.

b. Water-Based, Light-Industrial Coating System (System below corresponds to MPI INT 9.2L):
   1) Prime Coat: Interior latex primer/sealer, MPI #50.
   2) Intermediate Coat: Water-based, light-industrial coating, MPI #110, gloss matching topcoat.

3) Topcoat: Water-based, light-industrial coating, MPI #110-G6, gloss **OR** 5, semigloss **OR** 3, eggshell, **as directed**.

c. Epoxy Coating System (System below corresponds to MPI INT 9.2E):
   1) Prime Coat: Interior latex primer/sealer, MPI #50.
   2) Intermediate Coat: Not required **OR** Epoxy, cold-cured, gloss, MPI #77, **as directed**.
   3) Topcoat: Epoxy, cold-cured, gloss, MPI #77.

d. Water-Based Epoxy Coating System (System below corresponds to MPI INT 9.2F):
   1) Prime Coat: Interior latex primer/sealer, MPI #50.
   2) Intermediate Coat: Not required **OR** Water-based epoxy (interior and exterior), MPI #115, **as directed**.
   3) Topcoat: Water-based epoxy (interior and exterior), MPI #115.

END OF SECTION 09930a

Task	Specification	Specification Description
09930	09910a	Wood Stains and Transparent Finishes
09945	03920	Concrete Rehabilitation
09949	09910a	Wood Stains and Transparent Finishes
09949	09910b	High-Temperature-Resistant Coatings
09952	09930a	High-Performance Coatings
09953	09930a	High-Performance Coatings

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SECTION 09954 - CEMENTITIOUS COATINGS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for cementitious coatings. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes surface preparation and application of cementitious coating systems on the following substrates:
   a. Exterior and Interior concrete.
   b. Exterior and Interior concrete masonry units.
   c. Exterior and Interior brick.

C. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:
   a. Product Data for Credit EQ 4.2: For paints and coatings, including printed statement of VOC content and chemical components.
3. Samples: In each color and gloss of finish coat indicated.
   a. Submit Samples on rigid backing **OR** actual substrate, **as directed**, not less than 4 by 8 inches (100 by 200 mm), with mortar joint in center, **as directed**.
   b. Step coats on Samples to show each coat required for system.
   c. Label each coat of each Sample.
4. Material Certificates: For each cementitious coating, from manufacturer.
5. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency or by a qualified testing agency, for each product formulation.

D. Quality Assurance
1. Source Limitations: Obtain cementitious coating materials from single source from single manufacturer.

E. Delivery, Storage, And Handling
1. Deliver materials to Project site in manufacturer's original, new, unopened packages and containers bearing manufacturer's name and label, and the following information:
   a. Product name or title of material.
   b. Manufacturer's stock number and date of manufacture.
   c. Contents by volume, for pigment and vehicle constituents.
   d. Application instructions.
   e. Color name and number.
   f. Handling instructions and precautions.
2. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F (7 deg C). Maintain containers used in storage of coatings in a clean condition, free of foreign materials and residue.
   a. Protect cementitious coating materials from freezing. Keep materials dry and storage area neat and orderly. Remove waste daily. Take necessary measures to ensure that workers and work areas are protected from health hazards resulting from handling, mixing, and applying the coating.

F. Project Conditions

1. Apply coatings only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).
2. Do not apply coatings when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

1.2 PRODUCTS

A. Cementitious Coatings
1. Polymer-Modified Cementitious Coating: Containing portland cement, polymer, and hydrated lime or aggregates.
2. Performance Requirements: Comply with the following:
   a. Compressive Strength: Not less than 3500 psi (24.1 MPa) at 28 days according to ASTM C 109/C 109M.
   b. Tensile Strength: Not less than 350 psi (2.41 MPa) at 28 days according to ASTM C 109/C 109M.
   c. Flexural Strength: as directed by the Owner.
   d. Adhesion: as directed by the Owner.
   e. Permeance: as directed by the Owner.
   f. Accelerated Weathering: as directed by the Owner.
   g. UV Resistance: as directed by the Owner.
   h. Salt-Spray Resistance: as directed by the Owner.
3. Other Materials: Provide crack fillers, block fillers, and related materials that are compatible with cementitious finish-coat materials and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
4. Chemical Components of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24) and the following chemical restrictions:
   a. Flat Paints and Coatings: VOC content of not more than 50 g/L.
   b. Nonflat Paints and Coatings: VOC content of not more than 150 g/L.
5. Chemical Components of Interior Paints and Coatings: Provide topcoat paints that comply with the following chemical restrictions:
   a. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
   b. Restricted Components: Paints and coatings shall not contain any of the following:
      1) Acrolein.
      2) Acrylonitrile.
      3) Antimony.
      4) Benzene.
      5) Butyl benzyl phthalate.
      6) Cadmium.
      7) Di (2-ethylhexyl) phthalate.
      8) Di-n-butyl phthalate.
      9) Di-n-octyl phthalate.
      10) 1,2-dichlorobenzene.
      11) Diethyl phthalate.
      12) Dimethyl phthalate.
      13) Ethylbenzene.
      14) Formaldehyde.
      15) Hexavalent chromium.
      16) Isophorone.
      17) Lead.
      18) Mercury.

19) Methyl ethyl ketone.
20) Methyl isobutyl ketone.
21) Methylene chloride.
22) Naphthalene.
23) Toluene (methylbenzene).
24) 1,1,1-trichloroethane.
25) Vinyl chloride.

6. Colors: As selected from manufacturer's full range **OR** As indicated in a color schedule, **as directed**.

1.3 EXECUTION

A. Examination
1. Examine substrates and conditions, with Applicator present, for compliance with requirements and other conditions affecting performance of the Work.
2. Verify suitability of substrates, including surface conditions and compatibility.
3. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
a. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

B. Preparation
1. Comply with manufacturer's written instructions for mixing and preparing materials and as applicable to substrates indicated.
2. Remove plates, machined surfaces, and similar items already in place that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.
a. After completing coating operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
3. Clean substrates of substances that could impair bond of coatings, including dirt, oil, grease, incompatible coatings, and loose substrate materials.
4. Cementitious and Masonry Surfaces: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
5. Crack Repair: Fill cracks according to manufacturer's written instructions before coating surfaces.
a. Cracks Larger Than 1/32 Inch (0.8 mm): Cut out static cracks, voids, or honeycombing larger than 1/32 inch (0.8 mm) and patch with materials recommended in writing by coating manufacturer. Identify dynamic cracks and treat according to manufacturer's written instructions before beginning application.

C. Application
1. Apply coatings according to manufacturer's written instructions. Use applicators and techniques suited for coating and substrate indicated.
a. Dampen substrate of surfaces to receive cementitious coatings one hour before beginning application to prevent surface drag. Immediately before applying coatings, redampen substrate. Substrates shall be saturated surface dry at time of application.
b. Brushes: Use tampico or masonry brushes best suited for material being applied.
c. Spray Equipment: Use spray equipment recommended in writing by manufacturer for material and texture required.
2. Apply each material at not less than manufacturer's recommended spreading rate. Provide total cured material thickness indicated or as recommended in writing by manufacturer.
3. Brush Application: Brush-out and work brush coats into surfaces in an even film, filling all pores and voids at rate recommended in writing by manufacturer to achieve cured material thickness indicated. Finish coat with smooth, horizontal strokes.

4. Spray Application: Apply each coat according to manufacturer's written instructions to provide the equivalent hiding of brush-applied coats. Follow spray application with a general light brooming of coated surface to impart a slight texture.

D. Field Quality Control
   1. Testing of Coating Materials: Contractor shall invoke the following procedure at any time and as often as necessary during the period when coating operations are being conducted:
      a. Engage the services of a qualified testing agency to sample coating materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
      b. Testing agency will perform tests for compliance with the following product requirements.
         1) Quantitative material analysis.
         2) Compressive strength.
         3) Tensile strength.
         4) Flexural strength.
         5) Permeance.
         6) Accelerated weathering.
      c. Owner may direct Contractor to stop coating application if test results show materials being used do not comply with requirements. Contractor shall remove noncomplying materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

E. Cleaning And Protection
   1. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
   2. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
   3. Protect work of other trades against damage from coating application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by the Owner, and leave in an undamaged condition.
   4. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

F. Coating Schedule
   1. General: Apply additional coats when undercoats or other conditions show through final coat until cured film is of uniform coating finish, color, and appearance.
   2. Above-Grade Concrete and Masonry: Two finish coats with total cured thickness not less than 40 mils (1.0 mm).
      a. First Coat: Apply polymer-modified cementitious coating material at the rate of 2 lb/sq. yd. (1 kg/sq. m) to achieve a total cured thickness of 25 mils (0.6 mm).
      b. Second Coat: Apply polymer-modified cementitious coating material at the rate of 1 lb/sq. yd. (0.5 kg/sq. m) to achieve a total cured thickness of 15 mils (0.4 mm).
   3. Surfaces Previously Coated with Polymer-Modified Cementitious Coating: One finish coat with a total cured thickness of not less than 15 mils (0.4 mm).
      a. Apply polymer-modified cementitious coating material at the rate of 1 lb/sq. yd. (0.5 kg/sq. m) to achieve a total cured thickness of 15 mils (0.4 mm).

END OF SECTION 09954

Task	Specification	Specification Description
09955	09930a	High-Performance Coatings

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SECTION 09975 - FIBERGLASS REINFORCED EPOXY COATING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for fiberglass reinforced epoxy coating. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Product Data: For each coating system specified.

C. Material Storage
1. Store materials in a temperature controlled environment (50ºF - 90ºF) and out of direct sunlight.
2. Keep resins, hardeners, and solvents separated from each other and away from sources of ignition. One year shelf life is expected for products stored between 50ºF - 90ºF.

1.2 PRODUCTS

A. Materials
1. Multi-Layer, High Build Wall and Ceiling Surfacing System
   a. Primer
      1) Water-based epoxy base coating.
   b. Base Coat
      1) High performance epoxy coating.
   c. Fiberglass Mesh Reinforcement
      1) Bound fiberglass cloth, 5.6 oz.
   d. Saturant
      1) High performance epoxy coating.
   e. Level Coat
      1) High performance epoxy coating.
   f. Chemical Resistant Finish Coat
      1) 100% solids polyurethane.

1.3 EXECUTION

A. Primer
1. Mixing and Application: Water Based Epoxy Wall Coating should only be used on unpainted, porous surfaces. If the surface is painted with latex or an epoxy coating, clean and abrade the surface then apply the primer.
2. Premix resin and hardener separately, using a low speed drill and Jiffy mixer. Mix for three minutes and until uniform, exercising caution not to whip air into the materials.
3. Add 2 parts resin to 1 part hardener, mix with low speed drill and Jiffy mixer for three minutes and until uniform. Apply material using a 1/4" short nap roller at a spread rate of 300-350 sq. ft. per gallon to yield 5 mils WFT.
4. Allow to cure for a minimum of 3 hours depending upon air movement. Lightly "pole sand" smooth rough edges of the flake before applying base coat.

B. Base Coat
1. Mixing and Application

a. Premix resin and hardener separately, using a low speed drill and Jiffy mixer. Mix for three minutes and until uniform, exercising caution not to introduce air into the material.
b. Add 3 parts resin to 1 part hardener by volume. Mix with low speed drill and Jiffy mixer for three minutes and until uniform. To insure proper system cure and performance, strictly follow mix ratio recommendations.
c. Base coat may be applied via spray, roller or brush. Apply using a 1/4" nap roller at a spread rate of 200-250 sq. ft. per gallon to yield 6-8 mils WFT evenly with no runs. Coverage will vary depending upon porosity of the substrate and surface texture.

C. Fiberglass Reinforcement
1. Apply 5.6 oz. bound fiberglass cloth for walls and 4 oz. for ceilings directly into wet resin. Do not allow material to cure or recoating will be necessary.
2. Hang fiberglass cloth directly to the wall similar to hanging wallpaper so seams are uniform and even. Overlap each strip using a double cut method. Remove the trimmed material behind the front strip.
3. After hand affixing to wall, use a broad knife to remove air pockets, wrinkles or any irregularities.

D. Saturant Coat
1. Mixing and Application
a. Premix resin and hardener separately, using a low speed drill and Jiffy mixer. Mix for three minutes and until uniform, exercising caution not to introduce air into the material.
b. Add 3 parts 3548PA (resin) to 1 part 3548B (hardener) by volume. Mix with low speed drill and Jiffy mixer for three minutes and until uniform. To insure proper system cure and performance, strictly follow mix ratio recommendations.
c. Saturant coat may be applied via spray, roller or brush. Apply at a spread rate of 250-400 sq. ft. per gallon to yield 4-6 mils WFT evenly with no runs. Allow to cure overnight (minimum 10 hours) before lightly sanding seams, bumps and other imperfections with 60-80 grit sandpaper caused by the saturant coat.

E. Level Coat
1. Mixing and Application
a. Apply leveling coat as described in previous step.
b. Allow to cure overnight.
c. An additional level coat may be applied.
d. Sand any imperfections prior to applying finish coat.

F. Finish Coat
1. Mixing and Application
a. Premix resin using a low speed drill and Jiffy mixer. Mix for three minutes and until uniform, exercising caution not to introduce air into the material.
b. Add 1 part resin to 1 part hardener by volume. Mix with low speed drill and Jiffy mixer for three minutes and until uniform. To insure proper system cure and performance, strictly follow mix ratio recommendations.
c. Finish coat may be applied via spray, roller or brush. Apply using a 1/4" nap non-shedding, urethane enamel roller at a spread rate of 250-400 sq. ft. per gallon to yield 4-6 WFT mils evenly with no runs. If second coat is required, the surface must be abraded with 80-120 grit paper or screen and tack wiped prior to second application.
d. Allow to cure 48 hours for water exposure and 7 days for chemical exposure. In cool and/or high humidity conditions, a surface film may form which can be washed with soap and water.

END OF SECTION 09975

Task	Specification	Specification Description
09977	09930a	High-Performance Coatings
09979	09930a	High-Performance Coatings

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SECTION 10110 - VISUAL DISPLAY SURFACES

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for visual display surfaces. Product shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Chalkboards.
   b. Markerboards.
   c. Tackboards.
   d. Visual display rails.
   e. Visual display wall panels.
   f. Support systems for visual display boards.
   g. Sliding visual display units.
   h. Visual display conference units.
   i. Visual display wall coverings.
   j. Electronic markerboards.

C. Definitions
1. Tackboard: Framed or unframed, tackable, visual display board assembly.
2. Visual Display Board Assembly: Visual display surface that is factory fabricated into composite panel form, either with or without a perimeter frame; includes chalkboards, markerboards, and tackboards.
3. Visual Display Surface: Surfaces that are used to convey information visually, including surfaces of chalkboards, markerboards, tackboards, and surfacing materials that are not fabricated into composite panel form but are applied directly to walls.

D. Submittals
1. Product Data: For each type of product indicated.
   a. Include rated capacities, operating characteristics, electrical characteristics and individual panel weights for sliding visual display units.
   b. Include computer system requirements for electronic markerboards.
2. LEED Submittals:
   a. Product Data for Credit EQ 4.4: For composite wood products, documentation indicating that the product contains no urea formaldehyde.
   b. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content and chemical components.
3. Shop Drawings: For visual display surfaces. Include plans, elevations, sections, details, and attachments to other work.
   a. Show locations of panel joints.
   b. Show locations of special-purpose graphics for visual display surfaces.
   c. Include sections of typical trim members.
   d. Wiring Diagrams: For power, signal, and control wiring.
4. Samples: For each exposed product and for each color and texture specified.
5. Qualification Data: For qualified Installer.
6. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for surface-burning characteristics of fabrics.
7. Operation and Maintenance Data: For visual display surfaces and power-operated units to include in maintenance manuals.

8. Warranties: Sample of special warranties.

E. Quality Assurance
1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of motor-operated, sliding visual display units required for this Project.
2. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   a. Flame-Spread Index: 25 or less.
   b. Smoke-Developed Index: 50 **OR** 450, **as directed**, or less.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Deliver factory-built visual display surfaces, including factory-applied trim where indicated, completely assembled in one piece without joints, where possible. If dimensions exceed maximum manufactured panel size, provide two or more pieces of equal length as acceptable to the Owner. When overall dimensions require delivery in separate units, prefit components at the factory, disassemble for delivery, and make final joints at the site.
2. Store visual display surfaces vertically with packing materials between each unit.

G. Project Conditions
1. Environmental Limitations: Do not deliver or install visual display surfaces until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Field Measurements: Verify actual dimensions of construction contiguous with visual display surfaces by field measurements before fabrication.
   a. Allow for trimming and fitting where taking field measurements before fabrication might delay the Work.

H. Warranty
1. Special Warranty for Porcelain-Enamel Face Sheets: Manufacturer's standard form in which manufacturer agrees to repair or replace porcelain-enamel face sheets that fail in materials or workmanship within specified warranty period.
   a. Failures include, but are not limited to, the following:
      1) Surfaces lose original writing and erasing qualities.
      2) Surfaces exhibit crazing, cracking, or flaking.
   b. Warranty Period: 50 years from date of Substantial Completion **OR** Life of the building, **as directed**.
2. Special Warranty for Electronic Markerboards: Manufacturer's standard form in which manufacturer agrees to repair or replace electronic markerboards that fail in materials or workmanship within two years from date of Substantial Completion.

1.2 PRODUCTS

A. Materials, General
1. Porcelain-Enamel Face Sheet: ASTM A 424, enameling-grade steel, uncoated thickness indicated; with exposed face and edges coated with primer, 1.7-to-2.5-mil- (0.043-to-0.064-mm-) thick ground coat, and color cover coat; and with concealed face coated with primer and 1.7-to-2.5-mil- (0.043-to-0.064-mm-) thick ground coat.
   a. Matte-Finish Cover Coat: Low reflective; chalk wipes clean with dry cloth or standard eraser. Minimum 2.0-to-2.5-mil- (0.051-to-0.064-mm-) thick cover coat. Cover and ground

coats shall be fused to steel at manufacturer's standard firing temperatures but not less than 1250 deg F (677 deg C).

b. Gloss-Finish Cover Coat: Gloss as indicated; dry-erase markers wipe clean with dry cloth or standard eraser. Minimum 3.0-to-4.0-mil- (0.076-to-0.102-mm-) thick cover coat. Cover and ground coats shall be fused to steel at manufacturer's standard firing temperatures but not less than 1475 deg F (802 deg C).

2. Porcelain-Enamel Face Sheet: Porcelain-enamel-clad, ASTM A 463/A 463M, Type 1, stretcher-leveled aluminized steel, with 0.024-inch (0.60-mm) uncoated thickness; with porcelain-enamel coating fused to steel at approximately 1000 deg F (538 deg C).
   a. Matte Finish: Low reflective; chalk wipes clean with dry cloth or standard eraser.
   b. Gloss Finish: Low gloss; dry-erase markers wipe clean with dry cloth or standard eraser. Suitable for use as projection screen.
3. Porcelain-Enamel Face Sheet: Manufacturer's standard steel sheet with porcelain-enamel coating fused to steel; uncoated thickness indicated.
   a. Matte Finish: Low reflective; chalk wipes clean with dry cloth or standard eraser.
   b. Gloss Finish: Gloss as indicated; dry-erase markers wipe clean with dry cloth or standard eraser.
4. Melamine: Thermally fused, melamine-impregnated decorative paper complying with LMA SAT-1.
5. High-Pressure Plastic Laminate: NEMA LD 3.
6. Natural Cork Sheet: Seamless, single-layer, compressed fine-grain cork sheet; bulletin board quality; face sanded for natural finish with surface-burning characteristics indicated.
7. Plastic-Impregnated Cork Sheet: Seamless, homogeneous, self-sealing sheet consisting of granulated cork, linseed oil, resin binders, and dry pigments that are mixed and calendared onto fabric backing; with washable vinyl finish and integral color throughout with surface-burning characteristics indicated.
8. Vinyl Fabric: Mildew resistant, washable, complying with FS CCC-W-408D, Type II, burlap weave; weighing not less than 13 oz./sq. yd. (440 g/sq. m); with surface-burning characteristics indicated.
9. Polyester Fabric: Nondirectional weave, 100 percent polyester; weighing not less than 15 oz./sq. yd. (508 g/sq. m); with surface-burning characteristics indicated.
10. Hardboard: ANSI A135.4, tempered.
11. Particleboard: ANSI A208.1, Grade M-1, made with binder containing no urea formaldehyde.
12. Fiberboard: ASTM C 208.
13. Extruded Aluminum: ASTM B 221 (ASTM B 221M), Alloy 6063.

B. Chalkboard Assemblies
1. Porcelain-Enamel Chalkboards: Balanced, high-pressure, factory-laminated chalkboard assembly of three-ply construction consisting of backing sheet, core material, and 0.021-inch- (0.53-mm-) thick, **OR** 0.013-inch- (0.33-mm-) thick, **as directed**, porcelain-enamel face sheet with matte finish.
   a. Hardboard Core: 1/4 inch (6 mm) thick; with 0.005-inch- (0.127-mm-) thick, aluminum foil **OR** 0.015-inch- (0.38-mm-) thick, aluminum sheet **OR** 0.0129-inch- (0.35-mm-) thick, galvanized-steel sheet, **as directed**, backing.
   b. Particleboard Core: 3/8 inch (9.5 mm) thick; with 0.005-inch- (0.127-mm-) thick, aluminum foil **OR** 0.015-inch- (0.38-mm-) thick, aluminum sheet **OR** 0.0129-inch- (0.35-mm-) thick, galvanized-steel sheet, **as directed**, backing.
   c. Fiberboard Core: 3/8 inch (9.5 mm) **OR** 1/2 inch (13 mm), **as directed**, thick; with 0.001-inch- (0.025-mm-) thick, aluminum foil **OR** 0.015-inch- (0.38-mm-) thick, aluminum sheet **OR** 0.0129-inch- (0.35-mm-) thick, galvanized-steel sheet, **as directed**, backing.
   d. Manufacturer's Standard Core: Minimum 1/4 inch (6 mm) thick, with manufacturer's standard moisture-barrier backing.
   e. Laminating Adhesive: Manufacturer's standard, moisture-resistant thermoplastic type.
2. High-Pressure-Laminate Chalkboards: Balanced, high-pressure, factory-laminated chalkboard assembly of two-ply construction consisting of fiberboard core material and high-pressure-laminate writing surface.

3. Melamine Chalkboards: Fabricated from 1/4-inch- (6-mm-) thick, sealed and primed hardboard panels permanently bonded with melamine writing surface.
4. Painted-Finish Chalkboards: Fabricated from two plies of 1/4-inch- (6-mm-) thick, treated, tempered hardboard panels permanently surfaced with manufacturer's standard, heat-cured organic coating formulated for chalk-receptive matte finish.
5. Natural-Slate Chalkboards: Select grade, resurfaced, natural slate; free from ribbons and other natural marks that impair their functional use and durability as a writing surface.
   a. Writing surface shall be free of tooling marks, pits, chipping, scratches, and surface spalls in excess of those that can be easily corrected; and shall be free of surface-applied stain, dye, or other artificial coloring.
   b. Thickness: Not less than 1/4 inch (6 mm) or more than 3/8 inch (9.5 mm) thick with maximum deviation of 1/16 inch (1.6 mm) when an average thickness of at least 1/4 inch (6 mm) is maintained.

C. Markerboard Assemblies
1. Porcelain-Enamel Markerboards: Balanced, high-pressure, factory-laminated markerboard assembly of three-ply construction consisting of backing sheet, core material, and 0.021-inch- (0.53-mm-) thick, **OR** 0.013-inch- (0.33-mm-) thick, **as directed**, porcelain-enamel face sheet with high-gloss **OR** low-gloss, **as directed**, finish.
   a. Hardboard Core: 1/4 inch (6 mm) thick; with 0.005-inch- (0.127-mm-) thick, aluminum foil **OR** 0.015-inch- (0.38-mm-) thick, aluminum sheet **OR** 0.013-inch- (0.35-mm-) thick, galvanized-steel sheet, **as directed**, backing.
   b. Particleboard Core: 3/8 inch (9.5 mm) **OR** 1/2 inch (13 mm), **as directed**, thick; with 0.005-inch- (0.127-mm-) thick, aluminum foil **OR** 0.015-inch- (0.38-mm-) thick, aluminum sheet **OR** 0.013-inch- (0.35-mm-) thick, galvanized-steel sheet, **as directed**, backing.
   c. Fiberboard Core: 3/8 inch (9.5 mm) **OR** 1/2 inch (13 mm), **as directed**, thick; with 0.001-inch- (0.025-mm-) thick, aluminum foil **OR** 0.015-inch- (0.38-mm-) thick, aluminum sheet **OR** 0.013-inch- (0.35-mm-) thick, galvanized-steel sheet, **as directed**, backing.
   d. Manufacturer's Standard Core: Minimum 1/4 inch (6 mm) thick, with manufacturer's standard moisture-barrier backing.
   e. Laminating Adhesive: Manufacturer's standard, moisture-resistant thermoplastic type.
2. Melamine Markerboards: Fabricated from 1/4-inch- (6-mm-) thick, sealed and primed hardboard panels permanently bonded with melamine or another high-pressure-laminate writing surface.
3. High-Pressure-Laminate Markerboard Assembly: Balanced, high-pressure, factory-laminated chalkboard assembly of three-ply construction consisting of backing sheet, fiberboard core material, and high-pressure-laminate writing surface.

D. Tackboard Assemblies
1. Natural-Cork Tackboard:
   a. 1/16-inch- (1.6-mm-) thick, natural cork sheet factory laminated to 3/8-inch- (9.5-mm-) **OR** 7/16-inch- (11-mm-), **as directed**, thick fiberboard backing.
   b. 1/8-inch- (3-mm-) thick, natural cork sheet factory laminated to 3/8-inch- (9.5-mm-) thick fiberboard backing.
   c. 1/4-inch- (6-mm-) thick, natural cork sheet factory laminated to 1/4-inch- (6-mm-) thick hardboard **OR** particleboard, **as directed**, backing.
2. Plastic-Impregnated-Cork Tackboard:
   a. 1/8-inch- (3-mm-) thick, plastic-impregnated cork sheet factory laminated to 3/8-inch- (9.5-mm-) thick fiberboard backing.
   b. 1/4-inch- (6-mm-) thick, plastic-impregnated cork sheet factory laminated to 1/4-inch- (6-mm-) thick hardboard **OR** particleboard, **as directed**, backing.
3. Vinyl-Fabric-Faced Tackboard:
   a. Vinyl fabric factory laminated to 3/8-inch- (9.5-mm-) **OR** 7/16-inch- (11-mm-) **OR** 1/2-inch- (13-mm-), **as directed**, thick fiberboard backing.
   b. 1/16-inch- (1.6-mm-) thick, vinyl-fabric-faced cork sheet factory laminated to 3/8-inch- (9.5-mm-) thick fiberboard backing.

c. 1/8-inch- (3-mm-) thick, vinyl-fabric-faced cork sheet factory laminated to 3/8-inch- (9.5-mm-) thick fiberboard backing.
d. 1/4-inch- (6-mm-) thick, vinyl-fabric-faced cork sheet factory laminated to 1/4-inch- (6-mm-) thick hardboard **OR** particleboard, **as directed**, backing.

4. Polyester-Fabric-Faced Tackboard:
   a. Polyester fabric factory laminated to 3/8-inch- (9.5-mm-) **OR** 1/2-inch- (13-mm-), **as directed**, thick fiberboard backing.
   b. 1/16-inch- (1.6-mm-) thick, polyester-fabric-faced cork sheet factory laminated to 3/8-inch- (9.5-mm-) thick fiberboard backing.
   c. 1/8-inch- (3-mm-) thick, polyester-fabric-faced cork sheet factory laminated to 3/8-inch- (9.5-mm-) thick fiberboard backing.
   d. 1/4-inch- (6-mm-) thick, polyester-fabric-faced cork sheet factory laminated to 1/4-inch- (6-mm-) thick hardboard **OR** particleboard, **as directed**, backing.

E. Visual Display Rails
1. General: Manufacturer's standard, aluminum-framed, tackable cork **OR** fabric, **as directed**, visual display surface fabricated into narrow rail shape and designed for displaying material.

F. Visual Display Wall Panels
1. Marker Wall Sheets: Fabricated from 0.021-inch (0.53-mm) uncoated thickness, porcelain-enamel face sheets; for direct application to wall surface.
2. Marker Wall Panels: Fabricated from markerboard assembly indicated.
3. Tack Wall Panels: With tackable surface.
   a. Fabricated from tackboard assembly indicated.
   b. Natural Cork: 1/8-inch- (3-mm-) **OR** 1/4-inch- (6-mm-), **as directed**, thick, natural cork sheet for direct application to wall surface.
   c. Plastic-Impregnated Cork: 1/8-inch- (3-mm-) **OR** 1/4-inch- (6-mm-), **as directed**, thick, plastic-impregnated cork sheet for direct application to wall surface.
   d. Vinyl Fabric-Faced Cork: 1/4-inch- (6-mm-) thick, vinyl-fabric-faced cork sheet for direct application to wall surface.
   e. Polyester-Fabric-Faced Cork: 1/4-inch- (6-mm-) thick, polyester-fabric-faced cork sheet for direct application to wall surface.
4. Joint Accessories: Manufacturer's standard, exposed trim **OR** concealed aluminum or steel spline, **as directed**, at butt joints.
5. Adhesive: Mildew-resistant, nonstaining adhesive, for use with specific tack wall panels and substrate application, as recommended in writing by visual display surface manufacturer, and with a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Primer/Sealer: Mildew-resistant primer/sealer complying with requirements in Division 09 Section "Interior Painting" and recommended in writing by visual display surface manufacturer for intended substrate.

G. Rail Support System For Visual Display Boards
1. Support Rails: Horizontal, wall-mounted, extruded-aluminum rails designed to receive hanger clip and to support visual display boards; capable of gripping and suspending paper directly from rail.
   a. Finish: Clear anodic **OR** Color anodic **OR** Baked enamel **OR** Powder coat, **as directed**.
   b. Color and Gloss: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
2. Hanger Clips: Extruded aluminum with finish to match rails; designed to support independent visual display boards by engaging support rail and top trim of board.
3. Visual Display Panels: Fabricated from not less than 3/8-inch- (9.5-mm-) thick, kraft-paper honeycomb core; designed to be rigid and to resist warpage, and with aluminum trim designed to engage hanger clips.

H. Modular Support System For Visual Display Boards

1. Standards: 72-inch- (1829-mm-) long, extruded-aluminum slotted standards designed for supporting visual display boards on panel clips. Standards shall be punched at not less than 4 inches (100 mm) o.c.
   a. Finish: Clear anodic **OR** Color anodic **OR** Baked enamel **OR** Powder coat, **as directed**.
   b. Color and Gloss: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
2. Panel Clips: Extruded aluminum or steel with finish to match standards.

I. Sliding Visual Display Units
1. Horizontal-Sliding Visual Display Units: Factory-fabricated units consisting of extruded-aluminum tubular frame, fixed-rear visual display panel, aluminum-framed horizontal-sliding panels, and extruded-aluminum fascia that conceals overhead sliding track; designed for recessed mounting. Provide panels that operate smoothly without vibration or chatter.
   a. Two-Track Units: Fabricate unit with fixed rear panel covering entire rear surface. Provide two sliding panels, each equal to not less than one-half of overall length of unit.
   b. Three-Track Units: Fabricate unit with fixed rear panel covering entire rear surface. Provide three sliding panels, each equal to not less than one-third **OR** one-half, **as directed**, of overall length of unit.
   c. Four-Track Units: Fabricate unit with fixed rear panel centered in and covering not less than one-half of rear surface, and fixed front panel on each side of unit equal to not less than one-quarter of overall length of unit. Provide four sliding panels, each equal to not less than one-quarter of overall length of unit.
      1) Swinging Doors: Fabricated from same construction as sliding panels and supported on full-height continuous hinges. Provide visual display surface on both sides of each door.
   d. Sliding Panels: Fabricated from not less than 3/8-inch- (9.5-mm-) thick, kraft-paper honeycomb core; designed to be rigid and to resist warpage.
      1) Fabricate sliding panels with 0.021-inch (0.53-mm) uncoated thickness, porcelain-enamel face sheets.
   e. Hardware: Manufacturer's standard, extruded-aluminum overhead track and channel-shaped bottom guides; with two nylon ball-bearing carriers and two nylon rollers for each sliding panel.
2. Vertical-Sliding Visual Display Units: Factory-fabricated units consisting of extruded-aluminum tubular frame, fixed-rear visual display panel, and aluminum-framed vertical-sliding panels; designed for recessed mounting. Provide panels that operate smoothly without vibration or chatter.
   a. Type: Tubular frame on four sides **OR** top and two sides, with sides extending to floor; with kick panel to conceal sliding panels, **as directed**. Unit shall be designed to support panels independent of wall.
   b. Two-Track Units: Fabricate unit with fixed rear panel covering entire rear surface. Provide two sliding panels, each equal to not less than one-half of overall height of unit.
   c. Three-Track Units: Fabricate unit with fixed rear panel covering entire rear surface. Provide three sliding panels, each equal to not less than one-half of overall height of unit.
   d. Four-Track Units: Fabricate unit with fixed rear panel centered in and covering not less than one-half of rear surface. Provide four sliding panels, each equal to not less than one-half of overall height of unit.
   e. Sliding Panels: Fabricated from not less than 3/8-inch- (9.5-mm-) thick, kraft-paper honeycomb core; designed to be rigid and to resist warpage.
      1) Fabricate sliding panels with 0.021-inch (0.53-mm) uncoated thickness, porcelain-enamel face sheets.
   f. Hardware: Manufacturer's standard, neoprene ball-bearing end rollers, four on each side of each sliding panel. Counterbalance each sliding panel with lead counterweights supported by steel aircraft cable over ball-bearing sheaves; with removable cover plate for

access to counterweights. Provide rubber bumpers at top and bottom for each sliding panel.

g. Motorized Operation: Provide not less than one motor with gearhead reducers for each sliding panel, mounted above visual display unit and connected to sliding panels with steel aircraft cable. Provide removable cover plate for access to motor. Equip motors with limit switches to automatically stop motor at each end of travel.
   1) Electric Motors: UL approved or recognized, totally enclosed, complying with NEMA MG 1, with thermal-overload protection; 1/15 hp, single phase, 110 **OR** 220, **as directed**, V, 60 Hz.
   2) Control Station: Three-position, maintained-contact **OR** momentary-contact, **as directed**, switch-operated control station with open, close, and off functions; with NEMA ICS 6, Type 1 enclosure. Provide one control station for each sliding panel unit, unless directed otherwise.
   3) Key Switch: Provide supplementary key switch for each control station. Furnish two keys for each control station, keyed alike.

J. Visual Display Conference Units
1. Visual Display Conference Units: Factory-fabricated units consisting of hinged-door wood cabinet with perimeter face frame, sides, and back; not less than 3-inch (75-mm) interior depth and designed for surface wall mounting. Fabricate inside of cabinet and cabinet doors with fixed visual display surfaces.
   a. Wood Cabinets: Fabricated from solid wood with integral, solid-wood markertray. Fabricate hinged door panels with solid wood frame and wood-veneer exterior surface.
   b. Plastic-Laminate Cabinets: Cabinet and hinged door panels fabricated from manufacturer's standard, high-pressure, plastic-laminate-finished panels; with integral markertray.
   c. Hardware: Manufacturer's standard, full-height continuous hinges, wire door pulls, and door bumpers.
   d. Projection Screens: Manufacturer's standard, pull-down, matte, white projection screen, not less than 8 inches (200 mm) smaller in each direction than overall cabinet size, and mounted above rear visual display surface.
   e. Fluorescent Light: Manufacturer's standard, not less than 24 inches (610 mm) long, and mounted above rear visual display surface.

K. Visual Display Wall Coverings
1. Visual Display Wall Covering: Intended for use with dry-erase markers and as a projection surface, **as directed**, and consisting of low-gloss **OR** moderate-gloss **OR** high-gloss, **as directed**, plastic film bonded to fabric backing; not less than 0.012-mil (0.0003-mm) **OR** 0.020-mil (0.0005-mm), **as directed**, total thickness.
2. Surface Graphics: 2-inch- (50-mm-) square grid.
   a. Color: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
3. Magnetic Visual Display Wall Covering: Intended for use with dry-erase markers and magnetic aids and consisting of moderate-gloss plastic film bonded to ferrous-powdered fabric backing; not less than 0.025-mil (0.0006-mm) total thickness.
   a. Color: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
4. Adhesive: Mildew-resistant, nonstaining, strippable, **as directed**, adhesive, for use with specific wall covering and substrate application, as recommended in writing by wall covering manufacturer, and with a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
5. Primer/Sealer: Mildew-resistant primer/sealer complying with requirements in Division 09 Section "Interior Painting" and recommended in writing by wall covering manufacturer for intended substrate.

L. Electronic Markerboards

1. General: Provide manufacturer's standard electronic markerboard that consists of touch-sensitive writing surface connected to microcomputer via RS-232 serial cable and that electronically records writing with standard dry-erase markers. Equip unit with cables, software, pens, erasers, mounting hardware, and accessories required for a complete installation.
2. Software: Capable of real-time recording, saving, and printing of everything that is written and drawn on electronic markerboard; with Windows **OR** Macintosh, **as directed**, operating system.
   a. File Export Formats: BMP, WMF, HTML, and vector-based formats.
   b. Compatibility: Compatible with Microsoft NetMeeting or other T.120-compliant software.
   c. Features: Capable of the following:
      1) Saving directly from screen.
      2) Erasing portions of screen.
      3) Printing directly from screen.
      4) Saving individual screens as separate pages.
      5) Showing onscreen toolbar **OR** keyboard, **as directed**.
      6) Recognizing not less than four pen colors.
      7) Recognizing finger touch control for presentations.
      8) Connecting multiple electronic markerboards to a single computer.
      9) Showing online help and tutorial.
3. Overall Size: Approximately 48 inches high by 60 inches wide (1219 mm high by 1524 mm wide).
4. Mounting: Wall mounted **OR** Supported by rail support system, **as directed**.

M. Chalkboard, Markerboard, And Tackboard Accessories
1. Aluminum Frames and Trim: Fabricated from not less than 0.062-inch- (1.57-mm-) thick, extruded aluminum; standard size and shape **OR** slim size and standard shape **OR** of size and shape indicated on Drawings, **as directed**.
   a. Field-Applied Trim: Manufacturer's standard, snap-on trim with no visible screws or exposed joints **OR** slip-on trim **OR** screw-on trim with Phillips flat-head screws, **as directed**.
   b. Factory-Applied Trim: Manufacturer's standard.
2. Factory-Applied Wood Trim: Red oak **OR** Walnut **OR** Manufacturer's standard species, **as directed**, not less than 1/2 inch (13 mm) thick; standard size and shape **OR** of size and shape indicated on Drawings, **as directed**.
3. Field-Applied Wood Trim: Comply with requirements specified in Division 06 Section(s) "Finish Carpentry" OR "Interior Architectural Woodwork" **as directed**.
4. Chalktray: Manufacturer's standard, continuous.
   a. Box Type: Extruded aluminum with slanted front, grooved tray, and cast-aluminum end closures.
   b. Solid Type: Extruded aluminum with ribbed section and smoothly curved exposed ends.
5. Map Rail: Provide the following accessories:
   a. Display Rail: Continuous and integral with map rail; fabricated from cork approximately 1 to 2 inches (25 to 50 mm) wide.
   b. End Stops: Located at each end of map rail.
   c. Map Hooks: Two map hooks for every 48 inches (1219 mm) **OR** 1200 mm, **as directed**, of map rail or fraction thereof.
   d. Map Hooks and Clips: Two map hooks with flexible metal clips for every 48 inches (1219 mm) **OR** 1200 mm, **as directed**, of map rail or fraction thereof.
   e. Flag Holder: One for each room.
   f. Paper Holder: Extruded aluminum; designed to hold paper by clamping action.
6. Special-Purpose Graphics: Fuse or paint the following graphics into surface of porcelain-enamel visual display unit:
   a. Semivisible writing guidelines.
   b. Penmanship lines.
   c. Music staff lines.
   d. Grid, 1 inch (25 mm) square.
   e. Graph coordinates, rectangular.

f. Horizontal lines, 2 inches (50 mm) o.c.
g. Polar coordinates.
h. USA map.
i. World map.
j. Soccer field.
k. Football field.
l. Basketball court.

N. Fabrication
1. Porcelain-Enamel Visual Display Assemblies: Laminate porcelain-enamel face sheet and backing sheet to core material under heat and pressure with manufacturer's standard flexible, waterproof adhesive.
2. Natural-Slate Chalkboards: Surface slate panels to a natural plane. Grind and hone to smooth, uniform finish equivalent to that obtained by minimum 180 grit and maximum 220 grit.
   a. Cut joints straight and true. Space joints symmetrically. Fit and match panels before shipment to provide continuous, uniform writing surface.
   b. Length: Furnish panels approximately equal in length with permissible variation not more than 3 inches (75 mm) in either direction of equal spacing. Allow 1/4-inch (6-mm) clearance at trim in length and width for fitting. Provide lengths of panels in each space as follows:
      1) Up to 5 feet (1.5 m); one panel.
      2) More than 5 feet (1.5 m) but less than 9 feet (2.7 m); two panels.
      3) More than 9 feet (2.7 m) but less than 13.5 feet (4.1 m); three panels.
      4) More than 13.5 feet (4.1 m) but less than 18 feet (5.5 m); four panels.
      5) More than 18 feet (5.5 m) but less than 22.5 feet (6.9 m); five panels.
      6) More than 22.5 feet (6.9 m) but less than 27 feet (8.2 m); six panels.
3. Visual Display Boards: Factory **OR** Field, **as directed**, assemble visual display boards unless otherwise indicated.
   a. Where factory-applied trim is indicated, trim shall be assembled and attached to visual display boards at manufacturer's factory before shipment.
4. Factory-Assembled Visual Display Units: Coordinate factory-assembled units with trim and accessories indicated. Join parts with a neat, precision fit.
   a. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, balanced around center of board, as acceptable to the Owner **OR** as indicated on approved Shop Drawings, **as directed**.
   b. Provide manufacturer's standard vertical-joint spline **OR** H-trim, **as directed**, system between abutting sections of chalkboards **OR** markerboards, **as directed**.
   c. Provide manufacturer's standard mullion trim at joints between chalkboards **OR** markerboards **OR** tackboards, **as directed**, of combination units.
   d. Where size of visual display boards or other conditions require support in addition to normal trim, provide structural supports or modify trim as indicated or as selected by the Owner from manufacturer's standard structural support accessories to suit conditions indicated.
5. Modular Visual Display Boards: Fabricated with integral panel clips attached to core material.
6. Aluminum Frames and Trim: Fabricate units straight and of single lengths, keeping joints to a minimum. Miter corners to a neat, hairline closure.
   a. Where factory-applied trim is indicated, trim shall be assembled and attached to visual display units at manufacturer's factory before shipment.

O. General Finish Requirements
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

3. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

P. Aluminum Finishes
1. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
2. Color Anodic Finish: AAMA 611, AA-M12C22A32/A34, Class II, 0.010 mm or thicker.
3. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1.3 EXECUTION

A. Examination
1. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the Work.
2. Examine roughing-in for electrical power systems to verify actual locations of connections before installation of motor-operated, sliding visual display units.
3. Examine walls and partitions for proper preparation and backing for visual display surfaces.
4. Examine walls and partitions for suitable framing depth where sliding visual display units will be installed.
5. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Comply with manufacturer's written instructions for surface preparation.
2. Clean substrates of substances that could impair the performance of and affect the smooth, finished surfaces of visual display boards, including dirt, mold, and mildew.
3. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, projections, depressions, and substances that will impair bond between visual display surfaces and wall surfaces.
   a. Prime wall surfaces indicated to receive direct-applied, visual display tack wall panels **OR** visual display wall coverings, **as directed**, and as recommended in writing by primer/sealer manufacturer and wall covering manufacturer.
   b. Prepare surfaces to receive visual display wall coverings and test for moisture according to requirements specified in Division 09 Section "Wall Coverings".
      OR
      Prepare substrates indicated to receive visual display wall covering as required by manufacturer's written instructions to achieve a smooth, dry, clean, structurally sound surface that is uniform in color.
      1) Moisture Content: Maximum of 4 percent when tested with an electronic moisture meter.
      2) Plaster: Allow new plaster to cure. Neutralize areas of high alkalinity. Prime with primer as recommended in writing by primer/sealer manufacturer and wall covering manufacturer.
      3) Metals: If not factory primed, clean and apply metal as recommended in writing by primer/sealer manufacturer and wall covering manufacturer.
      4) Gypsum Board: Prime with primer as recommended in writing by primer/sealer manufacturer and wall covering manufacturer.
      5) Painted Surfaces: Treat areas susceptible to pigment bleeding.
4. Prepare recesses for sliding visual display units as required by type and size of unit.

C. Installation, General

1. General: Install visual display surfaces in locations and at mounting heights indicated on Drawings, or if not indicated, at heights indicated below. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.
   a. Mounting Height for Grades K through 3: 24 inches (610 mm) above finished floor to top of chalktray.
   b. Mounting Height for Grades 4 through 6: 28 inches (711 mm) above finished floor to top of chalktray.
   c. Mounting Height for Grades 7 and Higher: 36 inches (914 mm) above finished floor to top of chalktray.

   OR

   a. Mounting heights of 24 inches (610 mm) above finished floor to top of chalktray for kindergarten.
   b. Mounting heights of 26 inches (660 mm) above finished floor to top of chalktray for Grades 1 through 3.
   c. Mounting heights of 30 inches (762 mm) above finished floor to top of chalktray for Grades 4 through 6.
   d. Mounting heights of 34 inches (864 mm) above finished floor to top of chalktray for Grades 7 through 9.
   e. Mounting heights of 37 inches (940 mm) above finished floor to top of chalktray for Grades 10 and higher,

   as directed

D. Installation Of Field-Fabricated Visual Display Boards And Assemblies
   1. Field-Assembled Visual Display Units: Coordinate field-assembled units with grounds, trim, and accessories indicated. Join parts with a neat, precision fit.
      a. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, balanced around center of board, as acceptable to the Owner **OR** as indicated on approved Shop Drawings, **as directed**.
      b. Provide manufacturer's standard vertical-joint spline **OR** H-trim, **as directed**, system between abutting sections of chalkboards **OR** markerboards, **as directed**.
      c. Provide manufacturer's standard mullion trim at joints between chalkboards **OR** markerboards **OR** tackboards, **as directed**, of combination units.
      d. Where size of visual display boards or other conditions require support in addition to normal trim, provide structural supports or modify trim as indicated or as selected by the Owner from manufacturer's standard structural support accessories to suit conditions indicated.
   2. Natural-Slate Chalkboards: Align and level joints between adjoining panels and apply manufacturer's recommended joint-filler compound. Hone and finish joints to continuous even plane.

E. Installation Of Factory-Fabricated Visual Display Boards And Assemblies
   1. Visual Display Boards:
      a. Attach visual display boards to wall surfaces with egg-size adhesive gobs at 16 inches (400 mm) o.c., horizontally and vertically.

         OR

         Attach concealed clips, hangers, and grounds to wall surfaces and to visual display boards with fasteners at not more than 16 inches (400 mm) o.c. Secure both top and bottom of boards to walls.
      b. Field-Applied Aluminum Trim: Attach trim over edges of visual display boards and conceal grounds and clips. Attach trim to boards with fasteners at not more than 24 inches (610 mm) o.c.
         1) Attach chalktrays to boards with fasteners at not more than 12 inches (300 mm) o.c.
      c. Field-Applied Wood Trim: Install trim according to requirements in Division 06 Section(s) "Finish Carpentry" OR "Interior Architectural Woodwork", **as directed**.

F. Installation Of Visual Display Rails
1. Display Rails: Install rails in locations and at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Attach to wall surface with fasteners at not more than 16 inches (400 mm) o.c.
   a. Mounting Height: 48 inches (1219 mm) **OR** 60 inches (1524 mm), **as directed**, above finished floor to top of rail.

G. Installation Of Visual Display Wall Panels
1. Marker Wall Sheets: Attach wall sheets to wall surface with thin layer of adhesive over entire wall surface. Butt join adjacent panels and cover joint with matching joint strip installed with double-stick tape, **as directed**.
2. Marker Wall Panels: Attach panels to wall surface with egg-size adhesive gobs at 16 inches (400 mm) o.c., horizontally and vertically.
   a. Join adjacent wall panels with concealed steel splines for smooth alignment.
      OR
      Join adjacent wall panels with exposed, H-shaped aluminum trim painted to match wall panel.
3. Tack Wall Panels: Attach panels to wall surface with egg-size adhesive gobs at 16 inches (400 mm) o.c. horizontally and vertically.
   a. Install wrapped-edge wall panels with butt joints between adjacent wall panels.
   b. Join adjacent wall panels with exposed, H-shaped aluminum trim covered with same fabric as wall panels.

H. Installation Of Rail **OR** Modular, **as directed**, Support System
1. Rail Support System: Install horizontal support rail in locations and at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Attach to wall surface with fasteners at 12 inches (300 mm) o.c.
   a. Mounting Height: 72 inches (1829 mm) above finished floor to top of rail.
   b. Hang visual display units on rail support system.
2. Modular Support System: Install adjustable standards in locations and at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Install standards at 48 inches (1219 mm) o.c., vertically aligned and plumb, and attached to wall surface with fasteners at 12 inches (300 mm) o.c.
   a. Mounting Height: 12 inches (300 mm) above finished floor to bottom of standard.
   b. Install single-slotted standard at each end of each run of standards and double-slotted standards at intermediate locations.
   c. Provide locking screw at top corner of visual display board at each standard.
   d. Hang visual display units on modular support system.

I. Installation Of Factory-Fabricated Visual Display Units
1. Sliding Visual Display Units: Install units in recessed locations and at mounting heights indicated. Attach to wall framing with fasteners at not more than 16 inches (400 mm) o.c.
   a. Adjust panels to operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.
2. Visual Display Conference Units: Install units in locations and at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Attach to wall surface with fasteners through back of cabinet **OR** concealed brackets screwed to wall **OR** concealed wood cleats screwed to wall, **as directed**.
   a. Mounting Height: 72 inches (1829 mm) above finished floor to top of cabinet.

J. Installation Of Visual Display Wall Covering
1. General: Comply with visual display wall covering manufacturers' written installation instructions.
2. Install seams horizontal and level, with lowest seam 24 inches (610 mm) above finished floor. Railroad fabric (reverse roll direction) to ensure color matching.

3. Double cut seams, with no gaps or overlaps. Remove air bubbles, wrinkles, blisters, and other defects.
4. After installation, clean visual display wall covering according to manufacturer's written instructions. Remove excess adhesive at finished seams, perimeter edges, and adjacent surfaces.

K. Installation Of Visual Electronic Markerboards
1. Electronic Markerboards: Install units in locations and at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Attach to wall **OR** cubicle, **as directed**, surface with manufacturer's standard mounting hardware.
a. Mounting Height: 72 inches (1829 mm) above finished floor to top of markerboard.

L. Cleaning And Protection
1. Clean visual display surfaces according to manufacturer's written instructions. Attach one cleaning label to visual display surface in each room.
2. Touch up factory-applied finishes to restore damaged or soiled areas.
3. Cover and protect visual display surfaces after installation and cleaning.

M. Demonstration
1. Train Owner's maintenance personnel to adjust, operate, and maintain motor-operated, sliding visual display units.

END OF SECTION 10110

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Task	Specification	Specification Description
10115	10110	Visual Display Surfaces
10120	10110	Visual Display Surfaces

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SECTION 10160 - TOILET COMPARTMENTS

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for toilet compartments. Product shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Steel toilet compartments configured as toilet enclosures, entrance screens, and urinal screens.
   b. Stainless-steel toilet compartments configured as toilet enclosures, entrance screens, and urinal screens.
   c. Plastic-laminate-faced toilet compartments configured as toilet enclosures, entrance screens, and urinal screens.
   d. Phenolic-core toilet compartments configured as toilet enclosures, entrance screens, and urinal screens.
   e. Solid-polymer toilet compartments configured as toilet enclosures, entrance screens, and urinal screens.

C. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
   a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.
   b. Product Data for Credit EQ 4.4: For particleboard, documentation indicating that product contains no urea formaldehyde.
3. Shop Drawings: For toilet compartments. Include plans, elevations, sections, details, and attachments to other work.
4. Samples for each exposed product and for each color and texture specified.
5. Product certificates.
6. Maintenance data.

D. Quality Assurance
1. Comply with requirements in GSA's CID-A-A-60003, "Partitions, Toilets, Complete", **as directed**.
2. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84, or another standard acceptable to authorities having jurisdiction, by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   a. Flame-Spread Index: 25 **OR** 75 **OR** 200, **as directed**, or less.
   b. Smoke-Developed Index: 450 or less.
3. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities" and ICC/ANSI A117.1 for toilet compartments designated as accessible.

1.2 PRODUCTS

A. Materials

1. Aluminum Castings: ASTM B 26/B 26M.
2. Aluminum Extrusions: ASTM B 221 (ASTM B 221M).
3. Brass Castings: ASTM B 584.
4. Brass Extrusions: ASTM B 455.
5. Steel Sheet: Commercial steel sheet for exposed applications; mill phosphatized and selected for smoothness.
   a. Electrolytically Zinc Coated: ASTM A 879/A 879M, 01Z (03G).
   b. Hot-Dip Galvanized: ASTM A 653/A 653M, either hot-dip galvanized or galvannealed.
6. Stainless-Steel Sheet: ASTM A 666, Type 304, stretcher-leveled standard of flatness.
7. Stainless-Steel Castings: ASTM A 743/A 743M.
8. Zamac: ASTM B 86, commercial zinc-alloy die castings.
9. Particleboard: ANSI A208.1, Grade M-2 with 45-lb (20.4-kg) density, made with binder containing no urea formaldehyde.
10. Plastic Laminate: NEMA LD 3, general-purpose HGS grade, 0.048-inch (1.2-mm) nominal thickness.

B. Steel Units
1. Toilet-Enclosure Style: Overhead braced **OR** Floor anchored **OR** Ceiling hung **OR** Floor and ceiling anchored, **as directed**.
2. Entrance-Screen Style: Overhead braced **OR** Floor anchored **OR** Ceiling hung **OR** Floor and ceiling anchored, **as directed**.
3. Urinal-Screen Style: Wall hung, flat panel **OR** Wall hung with integral flanges **OR** Wall hung, wedge shaped **OR** Floor anchored **OR** Overhead braced **OR** Post to ceiling, **as directed**.
4. Door, Panel, and Pilaster Construction: Seamless, metal facing sheets pressure laminated to core material; with continuous, interlocking molding strip or lapped-and-formed edge closures; corners secured by welding or clips and exposed welds ground smooth. Provide with no-sightline system, **as directed**. Exposed surfaces shall be free of pitting, seam marks, roller marks, stains, discolorations, telegraphing of core material, or other imperfections.
   a. Core Material: Manufacturer's standard sound-deadening honeycomb of resin-impregnated kraft paper in thickness required to provide finished thickness of 1 inch (25 mm) for doors and panels and 1-1/4 inches (32 mm) for pilasters.
   b. Grab-Bar Reinforcement: Provide concealed internal reinforcement for grab bars mounted on units.
   c. Tapping Reinforcement: Provide concealed reinforcement for tapping (threading) at locations where machine screws are used for attaching items to units.
5. Urinal-Screen Construction:
   a. Flat-Panel Urinal Screen: Matching panel construction.
   b. Integral-Flange, Wall-Hung Urinal Screen: Similar to panel construction, with integral full-height flanges for wall attachment, and maximum 1-1/4 inches (32 mm) thick.
   c. Wedge-Shaped, Wall-Hung Urinal Screen: Similar to panels, V-shaped, fabricated for concealed wall attachment, and maximum 6 inches (152 mm) wide at wall and minimum 1 inch (25 mm) wide at protruding end.
6. Facing Sheets and Closures: Electrolytically coated steel **OR** Hot-dip galvanized-steel **OR** Electrolytically coated or hot-dip galvanized-steel, **as directed**, sheet with nominal base-metal (uncoated) thicknesses as follows:
   a. Pilasters, Braced at Both Ends (for overhead-braced and floor-and-ceiling-anchored mounting styles): Manufacturer's standard thickness, but not less than 0.036 inch (0.91 mm).
   b. Pilasters, Unbraced at One End (for floor-anchored and ceiling-hung mounting styles): Manufacturer's standard thickness, but not less than 0.048 inch (1.21 mm).
   c. Panels: Manufacturer's standard thickness, but not less than 0.030 inch (0.76 mm) **OR** 0.036 inch (0.91 mm), **as directed**.
   d. Doors: Manufacturer's standard thickness, but not less than 0.030 inch (0.76 mm).
   e. Flat-Panel Urinal Screens: Thickness matching the panels.

f. Integral-Flange, Wall-Hung Urinal Screens (for government-style metal screens): Manufacturer's standard thickness, but not less than 0.030 inch (0.76 mm).
g. Wedge-Shaped, Wall-Hung Urinal Screens: Manufacturer's standard thickness, but not less than 0.036 inch (0.91 mm).

7. Pilaster Shoes and Sleeves (Caps): Stainless-steel sheet, not less than 0.031-inch (0.79-mm) nominal thickness and 3 inches (76 mm) high, finished to match hardware.
8. Urinal-Screen Post (for floor-anchored, overhead-braced, and post-to-ceiling urinal screens): Manufacturer's standard post design of material matching the thickness and construction of pilasters **OR** 1-3/4-inch- (44-mm-) square, aluminum tube with satin finish, **as directed**; with shoe and sleeve (cap), **as directed**, matching that on the pilaster.
9. Brackets (Fittings):
   a. Stirrup Type: Ear or U-brackets; chrome-plated zamac **OR** clear-anodized aluminum **OR** stainless steel **OR** chrome-plated brass, **as directed**.
   b. Full-Height (Continuous) Type: Manufacturer's standard design; stainless steel **OR** aluminum, **as directed**.
10. Steel-Sheet Finish: Immediately after cleaning and pretreating, apply manufacturer's standard baked-on finish, including thermosetting, electrostatically applied, and powder coatings. Comply with coating manufacturer's written instructions for applying and baking. Apply one color **OR** two colors, **as directed**, in each room.
    a. Color: As selected from manufacturer's full range.

C. Stainless-Steel Units
1. Toilet-Enclosure Style: Overhead braced **OR** Floor anchored **OR** Ceiling hung **OR** Floor and ceiling anchored, **as directed**.
2. Entrance-Screen Style: Overhead braced **OR** Floor anchored **OR** Ceiling hung **OR** Floor and ceiling anchored, **as directed**.
3. Urinal-Screen Style: Wall hung flat panel **OR** Wall hung with integral flanges **OR** Wall hung, wedge shaped **OR** Floor anchored **OR** Overhead braced **OR** Post to ceiling, **as directed**.
4. Door, Panel, and Pilaster Construction: Seamless, metal facing sheets pressure laminated to core material; with continuous, interlocking molding strip or lapped-and-formed edge closures; corners secured by welding or clips and exposed welds ground smooth. Provide with no-sightline system, **as directed**. Exposed surfaces shall be free of pitting, seam marks, roller marks, stains, discolorations, telegraphing of core material, or other imperfections.
   a. Core Material: Manufacturer's standard sound-deadening honeycomb of resin-impregnated kraft paper in thickness required to provide finished thickness of 1 inch (25 mm) for doors and panels and 1-1/4 inches (32 mm) for pilasters.
   b. Grab-Bar Reinforcement: Provide concealed internal reinforcement for grab bars mounted on units.
   c. Tapping Reinforcement: Provide concealed reinforcement for tapping (threading) at locations where machine screws are used for attaching items to units.
5. Urinal-Screen Construction:
   a. Flat-Panel Urinal Screen: Matching panel construction.
   b. Integral-Flange, Wall-Hung Urinal Screen (for government-style metal screens): Similar to panel construction, with integral full-height flanges for wall attachment, and maximum 1-1/4 inches (32 mm) thick.
   c. Wedge-Shaped, Wall-Hung Urinal Screen: Similar to panels, V-shaped, fabricated for concealed wall attachment, and maximum 6 inches (152 mm) wide at wall and minimum 1 inch (25 mm) wide at protruding end.
6. Facing Sheets and Closures: Stainless-steel sheet of nominal thicknesses as follows:
   a. Pilasters, Braced at Both Ends (for overhead-braced and floor-and-ceiling-anchored mounting styles): Manufacturer's standard thickness, but not less than 0.038 inch (0.95 mm).
   b. Pilasters, Unbraced at One End (for floor-anchored and ceiling-hung mounting styles: Manufacturer's standard thickness, but not less than 0.050 inch (1.27 mm).
   c. Panels: Manufacturer's standard thickness, but not less than 0.031 inch (0.79 mm) **OR** 0.038 inch (0.95 mm), **as directed**.

d. Doors: Manufacturer's standard thickness, but not less than 0.031 inch (0.79 mm).
e. Flat-Panel Urinal Screens: Thickness matching the panels.
f. Integral-Flange, Wall-Hung Urinal Screens (for government-style metal screens: Manufacturer's standard thickness, but not less than 0.031 inch (0.79 mm).
g. Wedge-Shaped, Wall-Hung Urinal Screens: Manufacturer's standard thickness, but not less than 0.038 inch (0.95 mm).

7. Pilaster Shoes and Sleeves (Caps): Stainless-steel sheet, not less than 0.031-inch (0.79-mm) nominal thickness and 3 inches (76 mm) high, finished to match hardware.
8. Urinal-Screen Post (for floor-anchored, overhead-braced, and post-to-ceiling urinal screens): Manufacturer's standard post design of material matching the thickness and construction of pilasters **OR** 1-3/4-inch- (44-mm-) square, aluminum tube with satin finish, **as directed**; with shoe and sleeve (cap) matching that on the pilaster.
9. Brackets (Fittings):
   a. Stirrup Type: Ear or U-brackets; chrome-plated zamac **OR** clear-anodized aluminum **OR** stainless steel **OR** chrome-plated brass, **as directed**.
   b. Full-Height (Continuous) Type: Manufacturer's standard design; stainless steel **OR** aluminum, **as directed**.
10. Stainless-Steel Finish: No. 4 bright, directional polish **OR** Manufacturer's standard textured finish, **as directed**, on exposed faces. Protect exposed surfaces from damage by application of strippable, temporary protective covering before shipment.

D. Plastic-Laminate-Faced Units
1. Toilet-Enclosure Style: Overhead braced **OR** Floor anchored **OR** Ceiling hung **OR** Floor and ceiling anchored, **as directed**.
2. Entrance-Screen Style: Overhead braced **OR** Floor anchored **OR** Ceiling hung **OR** Floor and ceiling anchored, **as directed**.
3. Urinal-Screen Style: Wall hung **OR** Floor anchored **OR** Overhead braced **OR** Post to ceiling, **as directed**.
4. Door, Panel, Screen, and Pilaster Construction: One-piece, plastic-laminate facing sheets pressure laminated to core material without splices or joints in facings or cores; with laminate **OR** stainless-steel edge trim 0.050 inch (1.27 mm) thick, **as directed**, applied to edges before faces to seal edges and prevent laminate from being pried loose. Seal exposed core material at cutouts to protect core from moisture. Provide with no-sightline system, **as directed**.
   a. Core Material: Particleboard.
   b. Doors and Panels: Finished to not less than 7/8 inch (22 mm) **OR** 1 inch (25 mm), **as directed**, thick.
   c. Pilasters: Provide construction to comply with one of the following, **as directed**:
      1) Finished to not less than 1-1/4 inches (32 mm) thick and with internal, nominal 0.134-inch- (3.42-mm-) thick, steel-sheet reinforcement, **as directed**.
      2) Finished to 1-1/4 inches (32 mm) thick and with manufacturer's standard steel-sheet core laminated to both sides of honeycomb of resin-impregnated kraft paper in lieu of particleboard core.
      3) Finished to not less than 1 inch (25 mm) thick and with internal, nominal 0.120-inch- (3.04-mm-) thick, steel-sheet reinforcement.
5. Pilaster Shoes and Sleeves (Caps): Formed from stainless-steel sheet, not less than 0.031-inch (0.79-mm) nominal thickness and 3 inches (76 mm) high, finished to match hardware.
6. Urinal-Screen Post (for floor-anchored, overhead-braced, and post-to-ceiling urinal screens): Manufacturer's standard post design of material matching the thickness and construction of pilasters **OR** 1-3/4-inch- (44-mm-) square, aluminum tube with satin finish **OR** 1-1/4-inch- (32-mm-) square, stainless-steel tube 0.050 inch (1.27 mm) thick with satin finish, **as directed**; with shoe and sleeve (cap) matching that on the pilaster.
7. Brackets (Fittings):
   a. Stirrup Type: Ear or U-brackets, chrome-plated zamac **OR** clear-anodized aluminum **OR** stainless steel **OR** chrome-plated brass, **as directed**.

b. Full-Height (Continuous) Type: Manufacturer's standard design; stainless steel **OR** aluminum, **as directed**.

8. Plastic-Laminate Finish: One color and pattern **OR** Two colors and patterns, **as directed**, in each room.
   a. Color and Pattern: As selected from manufacturer's full range.

E. Phenolic-Core Units
1. Toilet-Enclosure Style: Overhead braced **OR** Floor anchored **OR** Ceiling hung **OR** Floor and ceiling anchored, **as directed**.
2. Entrance-Screen Style: Overhead braced **OR** Floor anchored **OR** Ceiling hung **OR** Floor and ceiling anchored, **as directed**.
3. Urinal-Screen Style: Wall hung **OR** Floor anchored **OR** Overhead braced **OR** Post to ceiling, **as directed**.
4. Door, Panel, Screen, and Pilaster Construction: Solid phenolic-core panel material with melamine facing on both sides fused to substrate during panel manufacture (not separately laminated), and with eased and polished edges and no-sightline system, **as directed**. Provide minimum 3/4-inch- (19-mm-) thick doors and pilasters and minimum 1/2-inch- (13-mm-) thick panels.
5. Pilaster Shoes and Sleeves (Caps): Fabricated from stainless-steel sheet, not less than 0.031-inch (0.79-mm) nominal thickness and 3 inches (76 mm) high, finished to match hardware.
6. Urinal-Screen Post (for floor-anchored, overhead-braced, and post-to-ceiling urinal screens): Manufacturer's standard post design of monolithic phenolic urinal screen cut out at bottom to form a post **OR** material matching the thickness and construction of pilasters **OR** 1-3/4-inch- (44-mm-) square, aluminum tube with satin finish, **as directed**; with shoe and sleeve (cap) matching that on the pilaster.
7. Brackets (Fittings):
   a. Stirrup Type: Ear or U-brackets, chrome-plated zamac **OR** clear-anodized aluminum **OR** stainless steel **OR** chrome-plated brass, **as directed**.
   b. Full-Height (Continuous) Type: Manufacturer's standard design; stainless steel **OR** aluminum, **as directed**.
8. Phenolic-Panel Finish:
   a. Facing Sheet Finish: One color and pattern **OR** Two colors and patterns, **as directed**, in each room.
   b. Color and Pattern: As selected from manufacturer's full range, with manufacturer's standard dark color core **OR** through-color core matching face sheet, **as directed**.

F. Solid-Polymer Units
1. Toilet-Enclosure Style: Overhead braced **OR** Floor anchored **OR** Ceiling hung **OR** Floor and ceiling anchored, **as directed**.
2. Entrance-Screen Style: Overhead braced **OR** Floor anchored **OR** Ceiling hung **OR** Floor and ceiling anchored, **as directed**.
3. Urinal-Screen Style: Wall hung **OR** Floor anchored **OR** Overhead braced **OR** Post to ceiling, **as directed**.
4. Door, Panel, Screen, and Pilaster Construction: Solid, high-density polyethylene (HDPE) **OR** polypropylene (PP), **as directed**, panel material, not less than 1 inch (25 mm) thick, seamless, with eased edges, no-sightline system, **as directed**, and with homogenous color and pattern throughout thickness of material.
   a. Integral Hinges: Configure doors and pilasters to receive integral hinges.
   b. Heat-Sink Strip: Manufacturer's standard continuous, extruded-aluminum **OR** stainless-steel, **as directed**, strip fastened to exposed bottom edges of solid-polymer components to prevent burning.
   c. Color and Pattern: One color and pattern **OR** Two colors and patterns, **as directed**, in each room as indicated by manufacturer's designations **OR** as selected from manufacturer's full range, **as directed**.
5. Pilaster Shoes and Sleeves (Caps): Manufacturer's standard design; polymer **OR** stainless steel, **as directed**.

a. Polymer Color and Pattern: Matching pilaster **OR** Contrasting with pilaster, as indicated by manufacturer's designations **OR** Contrasting with pilaster, as selected from manufacturer's full range, **as directed**.

6. Urinal-Screen Post (for floor-anchored, overhead-braced, and post-to-ceiling urinal screens): Manufacturer's standard post design of material matching the thickness and construction of pilasters **OR** 1-3/4-inch- (44-mm-) square, aluminum tube with satin finish, **as directed**; with shoe and sleeve (cap) matching that on the pilaster.
7. Brackets (Fittings):
   a. Stirrup Type: Ear or U-brackets, chrome-plated zamac **OR** clear-anodized aluminum **OR** stainless steel **OR** chrome-plated brass, **as directed**.
   b. Full-Height (Continuous) Type: Manufacturer's standard design; polymer or extruded aluminum **OR** polymer **OR** extruded aluminum **OR** stainless steel, **as directed**.
      1) Polymer Color and Pattern: Matching panel **OR** Contrasting with panel, as indicated by manufacturer's designations **OR** Contrasting with panel, as selected from manufacturer's full range, **as directed**.
8. Overhead Cross Bracing for Ceiling-Hung Units: As recommended by manufacturer and fabricated from solid polymer.

G. Accessories
1. Hardware and Accessories: Manufacturer's standard design, heavy-duty operating hardware and accessories.
   a. Material: Chrome-plated zamac **OR** Clear-anodized aluminum **OR** Stainless steel **OR** Chrome-plated brass, **as directed**.
   b. Hinges: Manufacturer's standard paired, self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees **OR** continuous, cam type that swings to a closed or partially open position **OR** continuous, spring-loaded type **OR** integral hinge for solid-polymer doors, **as directed**.
   c. Latch and Keeper: Manufacturer's standard recessed **OR** surface-mounted, **as directed**, latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible.
   d. Coat Hook: Manufacturer's standard combination hook and rubber-tipped bumper, sized to prevent in-swinging door from hitting compartment-mounted accessories.
   e. Door Bumper: Manufacturer's standard rubber-tipped bumper at out-swinging doors and entrance-screen doors, **as directed**.
   f. Door Pull: Manufacturer's standard unit at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible.
2. Overhead Bracing (for overhead-braced units): Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.
3. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel or chrome-plated steel or brass, finished to match the items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized steel, or other rust-resistant, protective-coated steel.

H. Fabrication
1. Overhead-Braced Units: Provide manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters to suit floor conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.
2. Floor-Anchored Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment nuts at pilasters for structural connection to floor. Provide shoes at pilasters to conceal anchorage.
3. Ceiling-Hung Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment nuts at pilasters for connection to structural support above finished

ceiling. Provide assemblies that support pilasters from structure without transmitting load to finished ceiling. Provide sleeves (caps) at tops of pilasters to conceal anchorage.

4. Floor-and-Ceiling-Anchored Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment at tops and bottoms of pilasters. Provide shoes and sleeves (caps) at pilasters to conceal anchorage.
5. Urinal-Screen Posts: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment at tops and bottoms, **as directed**, of posts. Provide shoes and sleeves (caps) at posts to conceal anchorage.
6. Door Size and Swings: Unless otherwise indicated, provide 24-inch- (610-mm-) wide, in-swinging doors for standard toilet compartments and 36-inch- (914-mm-) wide, out-swinging doors with a minimum 32-inch- (813-mm-) wide, clear opening for compartments designated as accessible.

1.3 EXECUTION

A. Installation
1. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.
   a. Maximum Clearances:
      1) Pilasters and Panels: 1/2 inch (13 mm).
      2) Panels and Walls: 1 inch (25 mm).
   b. Stirrup Brackets: Secure panels to walls and to pilasters with no fewer than two brackets attached **OR** three brackets attached at midpoint and, **as directed**, near top and bottom of panel.
      1) Locate wall brackets so holes for wall anchors occur in masonry or tile joints.
      2) Align brackets at pilasters with brackets at walls.
2. Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Set pilasters with anchors penetrating not less than 1-3/4 inches (44 mm) into structural floor unless otherwise indicated in manufacturer's written instructions. Secure continuous head rail to each pilaster with no fewer than two fasteners. Hang doors to align tops of doors with tops of panels, and adjust so tops of doors are parallel with overhead brace when doors are in closed position.
3. Floor-Anchored Units: Set pilasters with anchors penetrating not less than 2 inches (51 mm) into structural floor unless otherwise indicated in manufacturer's written instructions. Level, plumb, and tighten pilasters. Hang doors and adjust so tops of doors are level with tops of pilasters when doors are in closed position.
4. Ceiling-Hung Units: Secure pilasters to supporting structure and level, plumb, and tighten. Hang doors and adjust so bottoms of doors are level with bottoms of pilasters when doors are in closed position.
5. Floor-and-Ceiling-Anchored Units: Secure pilasters to supporting construction and level, plumb, and tighten. Hang doors and adjust so doors are level and aligned with panels when doors are in closed position.
6. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact.

B. Adjusting
1. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors and doors in entrance screens to return doors to fully closed position.

END OF SECTION 10160

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Task	Specification	Specification Description
10160	01352	No Specification Required
10165	01352	No Specification Required
10165	10160	Toilet Compartments

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SECTION 10170 - SOLID SURFACE MATERIAL TOILET COMPARTMENTS

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for solid surface material toilet compartments. Product shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Submittals
1. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
2. Samples:
   a. Panel: 1'-0" by 1'-0" panel showing construction with two sides and two edges, including one finished corner condition.
   b. Hardware: Actual hardware item
3. Manufacturer's installation and maintenance instructions.

C. Warranty
1. Special Warranty: Solid surface material compartment manufacturer's three year warranty against defects in fabricated products. Provide for product replacement only; labor not included. Damage caused by physical or chemical abuse is not warrantied.

1.2 PRODUCTS

A. Manufactured Units
1. Product standard of quality: E.I. DuPont de Nemours and Company, Inc.; Privacy Partitions.

B. Types:
1. Floor supported, overhead braced compartments.
2. Wall hung urinal screens.

C. Materials:
1. Partitions, panels, headrails, and doors:
   a. Material: E.I. DuPont de Nemours and Company, Inc.; Corian, or approved equivalent.
   b. Characteristics:
      1) Material type: Homogeneous filled methyl methacrylate sheet, not coated.
      2) Meet ANSI Zl24.3 and 6, Type Six.
      3) Thickness: 1/2".
         a) Partition panels and doors: 1/2".
         b) Urinal screen panels: 1/2".
   c. Colors: Selected from manufacturer's color selection.
   d. Finish: Matte.
2. Pilasters, hardware, and fittings: Note requirements in FABRICATION Article for hardware concealment.
   a. Pilaster material: Same material as panels; 1" thickness.
   b. Acceptable hardware manufacturer: Jack Knob Hardware, or approved equivalent.
   c. Hinges:
      1) ANSI Type 304 stainless steel; surface mounted; self closing pivot hinge type, two per door; matt finish.
      2) Type: Adjustable to return door by gravity to preset position when not latched.
   d. Wall brackets:

1) Material: ASTM B209-90, extruded aluminum alloy 6463-T5, mill finish, full length continuous wall brackets; extrusion weighing not less than 1.685 lbs. per LF.
2) Predrill by manufacturer; holes spaced 6" along full bracket length; tamper resistant bolt attachment.

e. Pilaster hanger:
1) Manufacturer's standard galvanized anchorage device for attachment of pilaster to structural support and for leveling compartment.
2) Hanger consists of threaded rods, saddle, lock washers, and leveling nuts.
3) Design pilaster hangers to transmit loads to above-ceiling support system, not finished ceiling.

f. Pilaster base:
1) Type: Manufacturer's standard galvanized anchorage devices for attachment of pilaster to supporting floor and for leveling of compartment. Base consists of threaded rods, saddle, lock washers, leveling nuts, and minimum of two brass or lead expansion shields per base.
2) Anchor penetration: Penetrate floor at least 1” for overhead braced compartments.

g. Latch and keeper: AISI Type 304 Type stainless steel; 360 deg. pivot on latch; ADA compatible; surface mounted.
h. Door stop/bumper: AISI Type 304 Type stainless steel; surface mounted.
i. Door pull: Same material as panels; meet ADA requirements on handicap stalls.
j. Coat hook; one per unit: Same material as panels; surface mounted.
k. Grab bar mounting plate: Same material as panels; recessed back; complete with "T" nuts and screws; one per each mounting location to divider panel.
l. Headrail for overhead braced units: ASTM B209-90, 6063-T6 extruded aluminum, satin anodized finish.

D. Accessories:
1. Exposed fasteners: Stainless steel or chrome plated brass with theft resistant one-way heads,
2. Unexposed fasteners: Galvanized steel, hot-dip coated following fabrication.
3. Inserts for door hardware, hinges, latches, and coat hooks: Threaded steel.
4. Adhesives: Type recommended by panel material manufacturer for joints.
5. Silicone sealant: Specified in Joints Sealants Section.

E. Fabrication
1. Shop assembly:
a. Fabricate components in accord with manufacturers standards, without face or edge seams in solid plastic material; bevel exposed edges.
b. Factory install metal inserts into components for screw fastened hardware; fasteners secured directly into core are prohibited.
c. Pre-notch and predrill panels for hardware at factory. Exposed hardware in completed installation includes only the following items or portion of items:
1) Door hinge barrel.
2) Door latch and keeper.
3) Door striker.
d. Cover hardware with 1/2" solid surfacing material strips, except as indicated above.
e. Secure templates and factory cut panels for installation of accessories furnished under other Sections.
f. Doors: Inswing and outswing type indicated.
g. Exposed surfaces free from marks and blemishes; completely hide through material joints.
2. Tolerances; variation in size: ±1/8"

1.3 EXECUTION

A. Installation

1. General:
   a. Erect solid surface material compartment system plumb; attach to supporting structure indicated on reviewed shop drawings.
   b. Attach solid surface material compartment system to back-up construction; use fasteners indicated on reviewed shop drawings.
   c. Secure solid surface material panels to walls with continuous mounting flanges.
   d. Locate wall brackets aligning holes for fasteners with masonry or tile joints.
   e. Floor supported, overhead braced compartments:
      1) Attach pilasters to supporting floor with pilaster base indicated on reviewed shop drawings.
      2) Level and plumb compartments. Tighten pilaster base fasteners.
      3) Secure pilaster shoes in position against finished floor.
      4) Secure headrail to panels with minimum of two fasteners per face. Provide cover plates for exposed ends.
      5) Set door tops parallel with headrail when doors are in closed position.
   f. Wall hung screens:
      1) Attach screens to wall construction with brackets and fasteners, indicated on reviewed shop drawings.
      2) Position and level units. Tighten fasteners in place.

B. Application
   1. Tolerances:
      a. Between panel and pilaster: 1/2", except where concealed fasteners are used.
      b. Between door edge and pilaster: 1/4"
      c. Between panel and wall: 1".
   2. Conceal evidence of drilling, cutting, and fitting to room finishes.

C. Adjustment And Cleaning
   1. Adjustment:
      a. Lubricate and adjust hardware. Tighten fasteners.
      b. Set hinges on in-swing doors to hold doors open approximately 15 deg. from closed position when unlatched.
      c. Set hinges on out-swing doors to return to closed position.
   2. Cleaning:
      a. Remove protective coverings from compartments and hardware.
      b. Clean exposed surfaces of compartments and hardware using materials and methods recommended by solid surface material compartment system manufacturer.

END OF SECTION 10170

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Task	Specification	Specification Description
10170	10160	Toilet Compartments
10185	10160	Toilet Compartments
10186	01352	No Specification Required
10186	10160	Toilet Compartments

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SECTION 10210 - LOUVERS AND VENTS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for louvers and vents. Product shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Fixed, extruded-aluminum and formed-metal louvers.
b. Adjustable, extruded-aluminum and formed-metal louvers.
c. Adjustable, extruded-aluminum and formed-metal insulated louvers.
d. Fixed, formed-metal acoustical louvers.
e. Wall vents (brick vents).

C. Definitions
1. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.
2. Horizontal Louver: Louver with horizontal blades; i.e., the axes of the blades are horizontal.
3. Vertical Louver: Louver with vertical blades; i.e., the axes of the blades are vertical.
4. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.
5. Storm-Resistant Louver: Louver that provides specified wind-driven rain performance, as determined by testing according to AMCA 500-L.

D. Performance Requirements
1. Delegated Design: Design louvers, including comprehensive engineering analysis by a qualified professional engineer, using structural and seismic performance requirements and design criteria indicated.
2. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors.
a. Wind Loads:
1) Determine loads based on pressures as indicated on Drawings.
OR
Determine loads based on a uniform pressure of 20 lbf/sq. ft. (957 Pa) **OR** 30 lbf/sq. ft. (1436 Pa), **as directed**, acting inward or outward.
3. Seismic Performance: Louvers, including attachments to other construction, shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
a. Design earthquake spectral response acceleration, short period (Sds) for Project is **as directed.**
b. Component Importance Factor is 1.5 **OR** 1.0, **as directed**.
4. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes, without buckling, opening of joints, overstressing of components, failure of connections, or other detrimental effects.
a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
5. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

6. Acoustic Performance: Provide acoustical louvers complying with ratings specified, as demonstrated by testing manufacturer's stock units identical to those specified, except for length and width for airborne sound-transmission loss according to ASTM E 90 **OR** outdoor-indoor sound-transmission loss according to ASTM E 966, **as directed**.

E. Submittals
1. Product Data: For each type of product indicated.
   a. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.
2. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.
3. Samples: For each type of metal finish required.
4. Delegated-Design Submittal: For louvers indicated to comply with structural and seismic performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
5. Product Test Reports: Based on tests performed according to AMCA 500-L.

F. Quality Assurance
1. Welding: Qualify procedures and personnel according to the following:
   a. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
   b. AWS D1.3, "Structural Welding Code - Sheet Steel."
   c. AWS D1.6, "Structural Welding Code - Stainless Steel."
2. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.
3. UL and NEMA Compliance: Provide motors and related components for motor-operated louvers that are listed and labeled by UL and comply with applicable NEMA standards.

1.2 PRODUCTS

A. Materials
1. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T5, T-52, or T6.
2. Aluminum Sheet: ASTM B 209 (ASTM B 209M), Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.
3. Aluminum Castings: ASTM B 26/B 26M, Alloy 319.
4. Galvanized-Steel Sheet: ASTM A 653/A 653M, G60 (Z180) **OR** G90 (Z275), **as directed**, zinc coating, mill phosphatized.
5. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304, No. 2B finish **OR** No. 2D finish **OR** No. 4 finish, with grain running parallel to length of blades and frame members **OR** No. 4 finish, with grain running perpendicular to length of blades and frame members **OR** No. 4 finish, with grain running perpendicular to length of blades and parallel to length of frame members **OR** No. 6 finish, **as directed**.
6. Fasteners: Use types and sizes to suit unit installation conditions.
   a. Use Phillips flat-head **OR** hex-head or Phillips pan-head **OR** tamper-resistant, **as directed**, screws for exposed fasteners unless otherwise indicated.
   b. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
   c. For fastening galvanized steel, use hot-dip-galvanized steel or 300 series stainless-steel fasteners.
   d. For fastening stainless steel, use 300 series stainless-steel fasteners.
   e. For color-finished louvers, use fasteners with heads that match color of louvers.
7. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
8. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

B. Fabrication, General
   1. Assemble louvers in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
   2. Vertical Assemblies: Where height of louver units exceeds fabrication and handling limitations, fabricate units to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates.
      a. Continuous Vertical Assemblies: Fabricate units without interrupting blade-spacing pattern unless horizontal mullions are indicated **OR** where indicated, **as directed**.
      b. Horizontal Mullions: Provide horizontal mullions at joints unless continuous vertical assemblies are indicated **OR** where indicated, **as directed**.
   3. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, **as directed**, to produce uniform appearance.
   4. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
      a. Frame Type: Channel **OR** Exterior flange **OR** Interior flange, **as directed**, unless otherwise indicated.
   5. Include supports, anchorages, and accessories required for complete assembly.
   6. Provide vertical mullions of type and at spacings indicated, but not more than recommended by manufacturer, or 72 inches (1830 mm) o.c., whichever is less.
      a. Fully Recessed Mullions: Where indicated, provide mullions fully recessed behind louver blades. Where length of louver exceeds fabrication and handling limitations, fabricate with close-fitting blade splices designed to permit expansion and contraction.
      b. Semirecessed Mullions: Where indicated, provide mullions partly recessed behind louver blades so louver blades appear continuous. Where length of louver exceeds fabrication and handling limitations, fabricate with interlocking split mullions and close-fitting blade splices designed to permit expansion and contraction.
      c. Exposed Mullions: Where indicated, provide units with exposed mullions of same width and depth as louver frame. Where length of louver exceeds fabrication and handling limitations, provide interlocking split mullions designed to permit expansion and contraction.
      d. Exterior Corners: Prefabricated corner units with mitered and welded blades **OR** blades with concealed close-fitting splices, **as directed**, and with fully recessed **OR** semirecessed, **as directed**, mullions at corners.
   7. Provide subsills made of same material as louvers **OR** extended sills, **as directed**, for recessed louvers.
   8. Join frame members to each other and to fixed louver blades with fillet welds concealed from view **OR** welds, threaded fasteners, or both, as standard with louver manufacturer, **as directed**, unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

C. Fixed, Extruded-Aluminum Louvers
   1. Horizontal Storm-Resistant Louver:
      a. Louver Depth: 4 inches (100 mm) **OR** 5 inches (125 mm) **OR** 7 inches (175 mm) **OR** 8 inches (200 mm) **OR** 9 inches (225 mm), **as directed**.
      b. Frame and Blade Nominal Thickness: Not less than 0.080 inch (2.03 mm) **OR** 0.060 inch (1.52 mm) for blades and 0.080 inch (2.03 mm) for frames, **as directed**.
      c. Louver Performance Ratings:
         1) Free Area: Not less than 5.0 sq. ft. (0.46 sq. m) **OR** 6.0 sq. ft. (0.56 sq. m) **OR** 7.0 sq. ft. (0.65 sq. m), **as directed**, for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
         2) Air Performance: Not more than 0.10-inch wg (25-Pa) static pressure drop at 600-fpm (3.0-m/s) **OR** 700-fpm (3.6-m/s) **OR** 800-fpm (4.1-m/s), **as directed**, free-area exhaust **OR** intake, **as directed**, velocity.

3) Wind-Driven Rain Performance: Not less than 99 **OR** 95 **OR** 80, **as directed**, percent effectiveness when subjected to a rainfall rate of 3 inches (75 mm) per hour and a wind speed of 29 mph (13 m/s) **OR** 8 inches (200 mm) per hour and a wind speed of 50 mph (22.4 m/s), **as directed**, at a core-area intake velocity of 300 fpm (1.5 m/s) **OR** 400 fpm (2.0 m/s) **OR** 500 fpm (2.5 m/s), **as directed**.

d. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2. Vertical Storm-Resistant Louver:
   a. Louver Depth: 4 inches (100 mm) **OR** 6 inches (150 mm) **OR** 8 inches (200 mm) **OR** 9 inches (225 mm) **OR** 12 inches (300 mm), **as directed**.
   b. Frame and Blade Nominal Thickness: Not less than 0.080 inch (2.03 mm) **OR** 0.060 inch (1.52 mm) for blades and 0.080 inch (2.03 mm) for frames, **as directed**.
   c. Louver Performance Ratings:
      1) Free Area: Not less than 5.0 sq. ft. (0.46 sq. m) **OR** 6.0 sq. ft. (0.56 sq. m) **OR** 7.0 sq. ft. (0.65 sq. m) **as directed**, for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
      2) Air Performance: Not more than 0.10-inch wg (25-Pa) static pressure drop at 600-fpm (3.0-m/s) **OR** 700-fpm (3.6-m/s) **OR** 800-fpm (4.1-m/s), **as directed**, free-area exhaust **OR** intake, **as directed**, velocity.
      3) Wind-Driven Rain Performance: Not less than 99 percent effectiveness when subjected to a rainfall rate of 3 inches (75 mm) per hour and a wind speed of 29 mph (13 m/s) **OR** 8 inches (200 mm) per hour and a wind speed of 50 mph (22.4 m/s), **as directed**, at a core-area intake velocity of 300 fpm (1.5 m/s) **OR** 400 fpm (2.0 m/s) **OR** 500 fpm (2.5 m/s), **as directed**.
   d. AMCA Seal: Mark units with AMCA Certified Ratings Seal.
3. Horizontal, Drainable-Blade Louver:
   a. Louver Depth: 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**.
   b. Frame and Blade Nominal Thickness: Not less than 0.080 inch (2.03 mm) **OR** 0.060 inch (1.52 mm) for blades and 0.080 inch (2.03 mm) for frames, **as directed**.
   c. Mullion Type: Exposed.
   d. Louver Performance Ratings:
      1) Free Area: Not less than 7.0 sq. ft. (0.65 sq. m) **OR** 7.5 sq. ft. (0.70 sq. m) **OR** 8.0 sq. ft. (0.74 sq. m) **OR** 8.5 sq. ft. (0.79 sq. m), **as directed**, for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
      2) Point of Beginning Water Penetration: Not less than 900 fpm (4.6 m/s) **OR** 950 fpm (4.8 m/s) **OR** 1000 fpm (5.1 m/s) **OR** 1050 fpm (5.3 m/s) **OR** 1100 fpm (5.6 m/s), **as directed**.
      3) Air Performance: Not more than 0.10-inch wg (25-Pa) static pressure drop at 700-fpm (3.6-m/s) **OR** 750-fpm (3.8-m/s) **OR** 800-fpm (4.1-m/s) **OR** 850-fpm (4.3-m/s), **as directed**, free-area exhaust **OR** intake, **as directed**, velocity.
      4) Air Performance: Not more than 0.15-inch wg (37-Pa) static pressure drop at 900-fpm (4.6-m/s) **OR** 950-fpm (4.8-m/s) **OR** 1000-fpm (5.1-m/s), **as directed**, free-area exhaust **OR** intake, **as directed**, velocity.
   e. AMCA Seal: Mark units with AMCA Certified Ratings Seal.
4. Horizontal, Continuous-Line, Drainable-Blade Louver: Drainable-blade louver with blade gutters (drains) in rear two-thirds of blades only and with semirecessed mullions capable of collecting and draining water from blades.
   a. Louver Depth: 6 inches (150 mm).
   b. Frame and Blade Nominal Thickness: Not less than 0.080 inch (2.03 mm).
   c. Louver Performance Ratings:
      1) Free Area: Not less than 7.8 sq. ft. (0.72 sq. m) for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
      2) Point of Beginning Water Penetration: Not less than 850 fpm (4.3 m/s).
      3) Air Performance: Not more than 0.10-inch wg (25-Pa) static pressure drop at 800-fpm (4.1-m/s) free-area exhaust **OR** intake, **as directed**, velocity.
5. Horizontal, Sightproof, Drainable-Blade Louver:

a. Louver Depth: 5 inches (125 mm).
b. Frame and Blade Nominal Thickness: Not less than 0.080 inch (2.03 mm) **OR** 0.060 inch (1.52 mm) for blades and 0.080 inch (2.03 mm) for frames, **as directed**.
c. Mullion Type: Exposed.
d. Louver Performance Ratings:
1) Free Area: Not less than 8.3 sq. ft. (0.77 sq. m) for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
2) Point of Beginning Water Penetration: Not less than 750 fpm (3.8 m/s) **OR** 950 fpm (4.8 m/s), **as directed**.
3) Air Performance: Not more than 0.10-inch wg (25-Pa) static pressure drop at 550-fpm (2.8-m/s) free-area exhaust **OR** intake, **as directed**, velocity.

6. Horizontal, Nondrainable-Blade Louver:
a. Louver Depth: 2 inches (50 mm) **OR** 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**.
b. Blade Profile: Plain blade without **OR** Blade with, **as directed**, center baffle.
c. Frame and Blade Nominal Thickness: Not less than 0.080 inch (2.03 mm) **OR** 0.060 inch (1.52 mm) for blades and 0.080 inch (2.03 mm) for frames, **as directed**.
d. Mullion Type: Exposed **OR** Semirecessed **OR** Fully recessed, **as directed**.
e. Louver Performance Ratings:
1) Free Area: Not less than 7.5 sq. ft. (0.70 sq. m) **OR** 8.0 sq. ft. (0.74 sq. m) **OR** 8.5 sq. ft. (0.79 sq. m), **as directed**, for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
2) Point of Beginning Water Penetration: Not less than 700 fpm (3.6 m/s) **OR** 750 fpm (3.8 m/s) **OR** 800 fpm (4.1 m/s) **OR** 850 fpm (4.3 m/s) **OR** 900 fpm (4.6 m/s) **OR** 950 fpm (4.8 m/s), **as directed**.
3) Air Performance: Not more than 0.10-inch wg (25-Pa) static pressure drop at 650-fpm (3.3-m/s) **OR** 700-fpm (3.6-m/s) **OR** 750-fpm (3.8-m/s), **as directed**, free-area exhaust **OR** intake, **as directed**, velocity.

7. Vertical, Sightproof, Louver:
a. Louver Depth: 4 inches (100 mm).
b. Blade Profile: Chevron **OR** Y **OR** Labyrinth, **as directed**,-shaped blade.
c. Frame and Blade Nominal Thickness: Not less than 0.080 inch (2.03 mm) **OR** 0.060 inch (1.52 mm) for blades and 0.080 inch (2.03 mm) for frames, **as directed**.
d. Blade Spacing: 2 inches (50 mm) **OR** 4 inches (100 mm), **as directed**, o.c.
e. Mullion Type: Exposed **OR** Semirecessed **OR** Fully recessed, **as directed**.

D. Fixed, Formed-Metal Louvers
1. Horizontal, Drainable-Blade Louver:
a. Louver Depth: 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**.
b. Frame and Blade Material and Nominal Thickness: Galvanized-steel sheet, not less than 0.052 inch (1.32 mm) for frames and 0.040 inch (1.02 mm) for blades **OR** 0.052 inch (1.32 mm) **OR** 0.064 inch (1.63 mm), **as directed**.
c. Frame and Blade Material and Nominal Thickness: Stainless-steel sheet, not less than 0.050 inch (1.27 mm) **OR** 0.062 inch (1.59 mm), **as directed**.
d. Mullion Type: Exposed.
e. Louver Performance Ratings:
1) Free Area: Not less than 7.0 sq. ft. (0.65 sq. m) **OR** 7.5 sq. ft. (0.70 sq. m) **OR** 8.0 sq. ft. (0.74 sq. m) **OR** 8.5 sq. ft. (0.79 sq. m), **as directed**, for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
2) Point of Beginning Water Penetration: Not less than 800 fpm (4.1 m/s) **OR** 850 fpm (4.3 m/s) **OR** 900 fpm (4.6 m/s) **OR** 950 fpm (4.8 m/s) **OR** 1000 fpm (5.1 m/s), **as directed**.
3) Air Performance: Not more than 0.10-inch wg (25-Pa) static pressure drop at 700-fpm (3.6-m/s) **OR** 750-fpm (3.8-m/s) **OR** 800-fpm (4.1-m/s) **OR** 850-fpm (4.3-m/s), **as directed**, free-area exhaust **OR** intake, **as directed**, velocity.

4) Air Performance: Not more than 0.15-inch wg (37-Pa) static pressure drop at 900-fpm (4.6-m/s) **OR** 950-fpm (4.8-m/s) **OR** 1000-fpm (5.1-m/s), **as directed**, free-area velocity.

f. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2. Horizontal, Nondrainable-Blade Louver:
   a. Louver Depth: 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**.
   b. Blade Profile: Plain blade without **OR** Blade with, **as directed**, center baffle.
   c. Frame and Blade Material and Nominal Thickness: Galvanized-steel sheet, not less than 0.052 inch (1.32 mm) for frames and 0.040 inch (1.02 mm) for blades **OR** 0.052 inch (1.32 mm) **OR** 0.064 inch (1.63 mm), **as directed**.
   d. Frame and Blade Material and Nominal Thickness: Stainless-steel sheet, not less than 0.050 inch (1.27 mm) **OR** 0.062 inch (1.59 mm), **as directed**.
   e. Mullion Type: Exposed **OR** Semirecessed **OR** Fully recessed, **as directed**.
   f. Louver Performance Ratings:
      1) Free Area: Not less than 6.5 sq. ft. (0.60 sq. m) **OR** 7.0 sq. ft. (0.65 sq. m) **OR** 7.5 sq. ft. (0.70 sq. m) **OR** 8.0 sq. ft. (0.74 sq. m), **as directed**, for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
      2) Point of Beginning Water Penetration: Not less than 550 fpm (2.8 m/s) **OR** 600 fpm (3.0 m/s) **OR** 650 fpm (3.3 m/s) **OR** 700 fpm (3.6 m/s), **as directed**.
      3) Air Performance: Not more than 0.10-inch wg (25-Pa) static pressure drop at 550-fpm (2.8-m/s) **OR** 600-fpm (3.0-m/s) **OR** 650-fpm (3.3-m/s) **OR** 700-fpm (3.6-m/s), **as directed**, free-area exhaust **OR** intake, **as directed**, velocity.

E. Adjustable, Extruded-Aluminum Louvers
1. Louver Construction and Operation: Provide adjustable louvers with extruded-aluminum frames and blades not less than 0.080-inch (2.03-mm) nominal thickness, and with operating mechanisms to suit louver sizes.
   a. Hand operation with push bars.
   b. Crank operation with removable-crank operator in sill or jamb.
   c. Chain operation with tension spring, wall clip, pull chain, and 160 deg F (71 deg C) fusible link.
   d. Motor operation with 2-position, spring-return application (with power on, motor opens louver; with power off, spring closes louver); 110-V, 60-Hz motor and limit switch **OR** 2-direction, 110-V, 60-Hz motor and limit switches, **as directed**; equipped with frame-mounted switch **OR** remote-mounted switch with indicator light **OR** terminals for controlling devices, **as directed**.
   e. Pneumatic piston operation for use with 80- to 100-psi (550- to 690-kPa) compressed air for 2-position **OR** modulating, **as directed**, operation; power open, power close with spring-return fail-safe, **as directed**.
2. Dual-Blade, Drainable-Blade, Adjustable Louver: Fixed drainable blades and adjustable plain blades combined in single frame.
   a. Louver Depth: 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, overall.
   b. Louver Performance Ratings:
      1) Free Area: Not less than 6.0 sq. ft. (0.56 sq. m) **OR** 6.5 sq. ft. (0.60 sq. m) **OR** 7.0 sq. ft. (0.65 sq. m) **OR** 7.5 sq. ft. (0.70 sq. m) **OR** 8.0 sq. ft. (0.74 sq. m), **as directed**, for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
      2) Point of Beginning Water Penetration: Not less than 750 fpm (3.8 m/s) **OR** 800 fpm (4.1 m/s) **OR** 850 fpm (4.3 m/s) **OR** 900 fpm (4.6 m/s) **OR** 950 fpm (4.8 m/s) **OR** 1000 fpm (5.1 m/s), **as directed**.
      3) Air Performance: Not more than 0.10-inch wg (25-Pa) static pressure drop at 750-fpm (3.8-m/s) **OR** 800-fpm (4.1-m/s) **OR** 850-fpm (4.3-m/s) **OR** 900-fpm (4.6-m/s), **as directed**, free-area exhaust **OR** intake, **as directed**, velocity.
      4) Air Leakage: Not more than 1.5 cfm/sq. ft. (7.6 L/s per sq. m) of louver gross area at a differential static pressure of 0.15-inch wg (37 Pa) with adjustable louver blades closed.

c. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

3. Single-Blade, Adjustable Louver:
   a. Louver Depth: 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**.
   b. Blade Type: Drainable **OR** Plain, **as directed**.
   c. Accessories: Equip louvers as follows:
      1) Vinyl blade-edge gaskets for each louver blade.
      2) Stainless-steel jamb seals **OR** vinyl blade-end gaskets, **as directed**.
   d. Louver Performance Ratings:
      1) Free Area: Not less than 6.5 sq. ft. (0.60 sq. m) **OR** 7.0 sq. ft. (0.65 sq. m) **OR** 7.5 sq. ft. (0.70 sq. m) **OR** 8.0 sq. ft. (0.74 sq. m), **as directed**, for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
      2) Point of Beginning Water Penetration: Not less than 500 fpm (2.5 m/s) **OR** 600 fpm (3.0 m/s) **OR** 700 fpm (3.6 m/s) **OR** 800 fpm (4.1 m/s) **OR** 900 fpm (4.6 m/s) **OR** 1000 fpm (5.1 m/s), **as directed**.
      3) Air Performance: Not more than 0.10-inch wg (25-Pa) static pressure drop at 500-fpm (2.5-m/s) **OR** 600-fpm (3.0-m/s) **OR** 700-fpm (3.6-m/s) **OR** 800-fpm (4.1-m/s) **OR** 900-fpm (4.6-m/s), **as directed**, free-area exhaust **OR** intake, **as directed**, velocity.
      4) Air Leakage: Not more than 3.5 cfm/sq. ft. (17.8 L/s per sq. m) of louver gross area at a differential static pressure of 0.15-inch wg (37 Pa) with adjustable louver blades closed.
   e. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

F. Adjustable, Formed-Metal Louvers
1. Louver Operation: Provide adjustable louvers with operating mechanisms to suit louver sizes.
   a. Hand operation with push bars.
   b. Crank operation with removable-crank operator in sill or jamb.
   c. Chain operation with tension spring, wall clip, pull chain, and 160 deg F (71 deg C) fusible link.
   d. Motor operation with 2-position, spring-return application (with power on, motor opens louver; with power off, spring closes louver); 110-V, 60-Hz motor and limit switch **OR** 2-direction, 110-V, 60-Hz motor and limit switches, **as directed**; equipped with frame-mounted switch **OR** remote-mounted switch with indicator light **OR** terminals for controlling devices, **as directed**.
   e. Pneumatic piston operation for use with 80- to 100-psi (550- to 690-kPa) compressed air for 2-position **OR** modulating, **as directed**, operation; power open, power close with spring-return fail-safe, **as directed**.
2. Dual-Blade, Drainable-Blade, Adjustable Louver: Fixed drainable blades and adjustable plain blades combined in single frame.
   a. Louver Depth: 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, overall.
   b. Frame and Blade Material and Nominal Thickness: Galvanized-steel sheet, not less than 0.052 inch (1.32 mm) for frames and 0.040 inch (1.02 mm) for blades **OR** 0.052 inch (1.32 mm) **OR** 0.064 inch (1.63 mm), **as directed**.
   c. Frame and Blade Material and Nominal Thickness: Stainless-steel sheet, not less than 0.050 inch (1.27 mm) **OR** 0.062 inch (1.59 mm), **as directed**.
   d. Louver Performance Ratings:
      1) Air Leakage: Not more than 1.5 cfm/sq. ft. (7.6 L/s per sq. m) of louver gross area at a differential static pressure of 0.15-inch wg (37 Pa) with adjustable louver blades closed.
   e. AMCA Seal: Mark units with AMCA Certified Ratings Seal.
3. Single-Blade, Adjustable Louver:
   a. Louver Depth: 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**.
   b. Blade Type: Drainable **OR** Plain, **as directed**.
   c. Frame and Blade Material and Nominal Thickness: Galvanized-steel sheet, not less than 0.052 inch (1.32 mm) for frames and 0.040 inch (1.02 mm) for blades **OR** 0.052 inch (1.32 mm) **OR** 0.064 inch (1.63 mm), **as directed**.

d. Frame and Blade Material and Nominal Thickness: Stainless-steel sheet, not less than 0.050 inch (1.27 mm) **OR** 0.062 inch (1.59 mm), **as directed**.
e. Accessories: Equip louvers as follows:
   1) Vinyl blade-edge gaskets for each louver blade.
   2) Stainless-steel jamb seals **OR** vinyl blade-end gaskets, **as directed**.
f. Louver Performance Ratings:
   1) Free Area: Not less than 6.5 sq. ft. (0.60 sq. m) **OR** 7.0 sq. ft. (0.65 sq. m) **OR** 7.5 sq. ft. (0.70 sq. m) **OR** 8.0 sq. ft. (0.74 sq. m), **as directed**, for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
   2) Point of Beginning Water Penetration: Not less than 500 fpm (2.5 m/s) **OR** 600 fpm (3.0 m/s) **OR** 700 fpm (3.6 m/s) **OR** 800 fpm (4.1 m/s) **OR** 900 fpm (4.6 m/s) **OR** 1000 fpm (5.1 m/s), **as directed**.
   3) Air Performance: Not more than 0.10-inch wg (25-Pa) static pressure drop at 500-fpm (2.5-m/s) **OR** 600-fpm (3.0-m/s) **OR** 700-fpm (3.6-m/s) **OR** 800-fpm (4.1-m/s) **OR** 900-fpm (4.6-m/s), **as directed**, free-area exhaust **OR** intake, **as directed**, velocity.
   4) Air Leakage: Not more than 3.5 cfm/sq. ft. (17.8 L/s per sq. m) of louver gross area at a differential static pressure of 0.15-inch wg (37 Pa) with adjustable louver blades closed.
g. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

G. Adjustable, Insulated Louvers
1. Louver Operation: Provide adjustable louvers with operating mechanisms to suit louver sizes.
   a. Hand operation with push bars.
   b. Crank operation with removable-crank operator in sill or jamb.
   c. Chain operation with tension spring, wall clip, pull chain, and 160 deg F (71 deg C) fusible link.
   d. Motor operation with 2-position, spring-return application (with power on, motor opens louver; with power off, spring closes louver); 110-V, 60-Hz motor and limit switch **OR** 2-direction, 110-V, 60-Hz motor and limit switches, **as directed**; equipped with frame-mounted switch **OR** remote-mounted switch with indicator light **OR** terminals for controlling devices, **as directed**.
   e. Pneumatic piston operation for use with 80- to 100-psi (550- to 690-kPa) compressed air for 2-position **OR** modulating, **as directed**, operation; power open, power close with spring-return fail-safe, **as directed**.
2. Adjustable, Insulated, Extruded-Aluminum Louver: Single-blade, adjustable louver with gasketed, insulated blades. Frames and blade frames have urethane thermal break. Frames are extruded aluminum, not less than 0.080-inch (2.03-mm) nominal thickness. Blade facings are aluminum sheet, not less than 0.032-inch (0.81-mm) nominal thickness.
   a. Louver Depth: 6 inches (150 mm) **OR** 9 inches (225 mm), **as directed**.
   b. Insulation: Extruded-polystyrene foam, 2 inches (50 mm) thick **OR** Foamed-in-place polyurethane, **as directed**.
3. Adjustable, Insulated, Formed-Metal Louver: Single-blade, adjustable louver with gasketed, insulated blades.
   a. Louver Depth: 6 inches (150 mm) **OR** 8 inches (200 mm), **as directed**.
   b. Frame Material and Nominal Thickness: Galvanized-steel sheet, not less than 0.052 inch (1.32 mm) **OR** 0.064 inch (1.63 mm), **as directed**.
   c. Frame Material and Nominal Thickness: Stainless-steel sheet, not less than 0.050 inch (1.27 mm) **OR** 0.062 inch (1.59 mm), **as directed**.
   d. Blade Material and Nominal Thickness: Galvanized-steel sheet, not less than 0.028 inch (0.71 mm) **OR** 0.040 inch (1.02 mm) **OR** 0.052 inch (1.32 mm) **OR** 0.064 inch (1.63 mm), **as directed**.
   e. Blade Material and Nominal Thickness: Stainless-steel sheet, not less than 0.025 inch (0.64 mm) **OR** 0.038 inch (0.95 mm) **OR** 0.050 inch (1.27 mm) **OR** 0.062 inch (1.59 mm), **as directed**.

f. Insulation: Extruded-polystyrene foam, 1 inch (25 mm) thick **OR** Rigid, glass-fiber-board insulation, 1 inch (25 mm) thick **OR** Foamed-in-place polyurethane, 1/2 inch (13 mm) thick, **as directed**.

H. Fixed, Acoustical Louvers

1. Fixed, Formed-Metal Acoustical Louver: Louver with formed-metal blades filled on interior with mineral-fiber, rigid-board, acoustical insulation retained by perforated metal sheet of same material and finish as blade.
   a. Louver Depth: 6 inches (150 mm) **OR** 8 inches (200 mm) **OR** 12 inches (300 mm), **as directed**.
   b. Frame Material: Extruded-aluminum or aluminum sheet, not less than 0.080-inch (2.03-mm) nominal thickness.
   c. Frame Material: Galvanized-steel sheet, not less than 0.052-inch (1.32-mm) **OR** 0.064-inch (1.63-mm), **as directed**, nominal thickness.
   d. Blade Material: Aluminum sheet, not less than 0.063-inch (1.60-mm) **OR** 0.080-inch (2.03-mm), **as directed**, nominal thickness.
   e. Blade Material: Galvanized-steel sheet, not less than 0.034-inch (0.86-mm) **OR** 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
   f. Blade Shape: Straight **OR** Airfoil **OR** Chevron, **as directed**.
   g. Blade Angle: 45 degrees unless otherwise indicated.
   h. Blade Spacing: 6 inches (150 mm) o.c. for 6-inch- (150-mm-) deep louvers.
   i. Blade Spacing: 6 inches (150 mm) **OR** 8 inches (200 mm), **as directed**, o.c. for 8-inch- (200-mm-) deep louvers.
   j. Blade Spacing: 9 inches (225 mm) **OR** 12 inches (300 mm), **as directed**, o.c. for 12-inch- (300-mm-) deep louvers.
   k. Free Area: Not less than 4 sq. ft. (0.37 sq. m) for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
   l. Airborne Sound-Transmission Loss: STC 10 per ASTM E 413, determined by testing per ASTM E 90.
   m. Outdoor-Indoor Sound-Transmission Loss: OITC 10 per ASTM E 1332, determined by testing per ASTM E 966.

I. Louver Screens

1. General: Provide screen at each exterior louver **OR** louvers indicated, **as directed**.
   a. Screen Location for Fixed Louvers: Interior face.
   b. Screen Location for Adjustable Louvers: Interior **OR** Exterior, **as directed**, face unless otherwise indicated.
   c. Screening Type: Bird screening **OR** Bird screening except where insect screening is indicated **OR** Insect screening, **as directed**.
2. Secure screen frames to louver frames with stainless-steel machine screws **OR** machine screws with heads finished to match louver, **as directed**, spaced a maximum of 6 inches (150 mm) from each corner and at 12 inches (300 mm) o.c.
3. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.
   a. Metal: Same kind and form of metal as indicated for louver to which screens are attached. Reinforce extruded-aluminum screen frames at corners with clips, **as directed**.
   b. Finish: Same finish as louver frames to which louver screens are attached **OR** Mill finish unless otherwise indicated, **as directed**.
   c. Type: Rewirable frames with a driven spline or insert **OR** Non-rewirable, U-shaped frames, **as directed**.
4. Louver Screening for Aluminum Louvers:
   a. Bird Screening: Aluminum, 1/2-inch- (13-mm-) square mesh, 0.063-inch (1.60-mm) wire.
   b. Bird Screening: Stainless steel, 1/2-inch- (13-mm-) square mesh, 0.047-inch (1.19-mm) wire.
   c. Bird Screening: Flattened, expanded aluminum, 3/4 by 0.050 inch (19 by 1.27 mm) thick.
   d. Insect Screening: Aluminum, 18-by-16 (1.4-by-1.6-mm) mesh, 0.012-inch (0.30-mm) wire.

e. Insect Screening: Stainless steel, 18-by-18 (1.4-by-1.4-mm) mesh, 0.009-inch (0.23-mm) wire.

5. Louver Screening for Galvanized-Steel Louvers:
   a. Bird Screening: Galvanized steel, 1/2-inch- (13-mm-) square mesh, 0.041-inch (1.04-mm) wire.
   b. Bird Screening: Stainless steel, 1/2-inch- (13-mm-) square mesh, 0.047-inch (1.19-mm) wire.
   c. Insect Screening: Galvanized steel, 18-by-14 (1.4-by-1.8-mm) mesh, 0.011-inch (0.28-mm) wire.
   d. Insect Screening: Stainless steel, 18-by-18 (1.4-by-1.4-mm) mesh, 0.009-inch (0.23-mm) wire.
6. Louver Screening for Stainless-Steel Louvers:
   a. Bird Screening: Stainless steel, 1/2-inch- (13-mm-) square mesh, 0.047-inch (1.19-mm) wire.
   b. Insect Screening: Stainless steel, 18-by-18 (1.4-by-1.4-mm) mesh, 0.009-inch (0.23-mm) wire.

J. Blank-Off Panels
1. Uninsulated, Blank-Off Panels: Metal sheet attached to back of louver.
   a. Aluminum sheet for aluminum louvers, not less than 0.050-inch (1.27-mm) nominal thickness.
   b. Galvanized-steel sheet for galvanized-steel louvers, not less than 0.040-inch (1.02-mm) **OR** 0.052-inch (1.32-mm), **as directed**, nominal thickness.
   c. Stainless-steel sheet for stainless-steel louvers, not less than 0.038-inch (0.95-mm) **OR** 0.050-inch (1.27-mm), **as directed**, nominal thickness, with grain running in same direction as grain of louver blades.
   d. Panel Finish: Same finish applied to louvers **OR** Same type of finish applied to louvers, but black color, **as directed**.
   e. Attach blank-off panels with clips **OR** sheet metal screws, **as directed**.
2. Insulated, Blank-Off Panels: Laminated panels consisting of insulating core surfaced on back and front with metal sheets and attached to back of louver.
   a. Thickness: 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**.
   b. Metal Facing Sheets: Aluminum sheet, not less than 0.032-inch (0.81-mm) nominal thickness.
   c. Metal Facing Sheets: Galvanized-steel sheet, not less than 0.028-inch (0.71-mm) nominal thickness.
   d. Metal Facing Sheets: Stainless-steel sheet, not less than 0.031-inch (0.79-mm) nominal thickness.
   e. Insulating Core: Rigid, glass-fiber-board insulation **OR** extruded-polystyrene foam, **as directed**.
   f. Edge Treatment: Trim perimeter edges of blank-off panels with louver manufacturer's standard extruded-aluminum-channel frames, not less than 0.080-inch (2.03-mm) nominal thickness **OR** channel frames, **as directed**, with corners mitered and with same finish as panels.
   g. Seal perimeter joints between panel faces and louver frames with gaskets or sealant.
   h. Panel Finish: Same finish applied to louvers **OR** Same type of finish applied to louvers, but black color, **as directed**.
   i. Attach blank-off panels with clips **OR** sheet metal screws, **as directed**.

K. Wall Vents (Brick Vents)
1. Extruded-Aluminum Wall Vents:
   a. Extruded-aluminum louvers and frames, not less than 0.125-inch (3.18-mm) nominal thickness, assembled by welding; with 18-by-14- (1.4-by-1.8-mm-) mesh, aluminum insect screening on inside face; incorporating weep holes, continuous drip at sill, and integral waterstop on inside edge of sill; of load-bearing design and construction.

b. Dampers: Aluminum blades and frames mounted on inside of wall vents; operated from exterior with Allen wrench in socket-head cap screw. Fabricate operating mechanism from Type 304 stainless-steel components.
c. Finish: Mill finish.

2. Cast-Aluminum Wall Vents:
a. One-piece, cast-aluminum louvers and frames; with 18-by-14- (1.4-by-1.8-mm-) mesh, aluminum insect screening on inside face; incorporating integral waterstop on inside edge of sill; of load-bearing design and construction.
b. Dampers: Aluminum blades and frames mounted on inside of wall vents; operated from exterior with Allen wrench in socket-head cap screw. Fabricate operating mechanism from Type 304 stainless-steel components.
c. Finish: Mill finish.

L. Finishes, General
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

M. Aluminum Finishes
1. Finish louvers after assembly.
2. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
3. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
a. Color: As selected from full range of industry colors and color densities.
4. Conversion-Coated Finish: AA-C12C42 (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating).
5. Conversion-Coated and Factory-Primed Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below).
a. Organic Coating: Air-dried primer of not less than 2-mil (0.05-mm) dry film thickness.
6. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
7. High-Performance Organic Finish: 2-coat fluoropolymer finish complying with AAMA 2604 **OR** AAMA 2605, **as directed**, and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
8. High-Performance Organic Finish: 3 **OR** 4, **as directed**,-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

N. Galvanized-Steel Sheet Finishes
1. Finish louvers after assembly.
2. Surface Preparation: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas and repair according to ASTM A 780.
3. Baked-Enamel or Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard 2-coat, baked-on finish consisting of prime coat and thermosetting

topcoat, with a minimum dry film thickness of 1 mil (0.025 mm) for topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils (0.05 mm).

a. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

O. Stainless-Steel Sheet Finishes

1. Repair sheet finish by grinding and polishing irregularities, weld spatter, scratches, and forming marks to match surrounding finish.

1.3 EXECUTION

A. Installation

1. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent work.
2. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
3. Form closely fitted joints with exposed connections accurately located and secured.
4. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
5. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.
6. Protect unpainted galvanized and nonferrous-metal surfaces that will be in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.
7. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Division 07 Section "Joint Sealants" for sealants applied during louver installation.

B. Adjusting And Cleaning

1. Test operation of adjustable louvers and adjust as needed to produce fully functioning units that comply with requirements.
2. Clean exposed surfaces of louvers and vents that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.
3. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
4. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by the Owner, remove damaged units and replace with new units.
   a. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 10210

Task	Specification	Specification Description
10210	01352	No Specification Required
10210	05720	Ornamental Metal
10210	05730	Ornamental Formed Metal
10230	01352	No Specification Required
10230	05500	Metal Fabrications
10230	05720a	Miscellaneous Ornamental Metals

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SECTION 10261 - IMPACT-RESISTANT WALL PROTECTION

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for impact-resistant wall protection. Product shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Wall guards.
b. Impact-resistant handrails.
c. Bed locators.
d. Corner guards.
e. Impact-resistant wall coverings.
f. Door protection systems.

C. Performance Requirements
1. Structural Performance: Provide handrails capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
a. Uniform load of 50 lbf/ft. (0.73 kN/m) applied in any direction.
b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
c. Uniform and concentrated loads need not be assumed to act concurrently.

D. Submittals
1. Product Data: Include construction details, material descriptions, impact strength, fire-test-response characteristics, dimensions of individual components and profiles, and finishes for each impact-resistant wall protection unit.
2. LEED Submittals:
a. Certificates for Credit MR 7: Chain-of-custody certificates certifying that wood rails comply with forest certification requirements. Include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
1) Include statement indicating costs for each certified wood product.
b. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content.
c. Product Data for Credit EQ 4.4: For particleboard, documentation indicating that products contain no urea formaldehyde.
3. Shop Drawings: For each impact-resistant wall protection unit showing locations and extent. Include sections, details, and attachments to other work.
a. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
4. Samples: For each type of exposed finish required, prepared on Samples of size indicated below. Include Samples of accent strips to verify color selected.
a. Wall and Corner Guards: 12 inches (300 mm) long. Include examples of joinery, corners, end caps, top caps, and field splices.
b. Handrails: 12 inches (300 mm) long. Include examples of joinery, corners, and field splices.
c. Impact-Resistant Wall Covering: 6 by 6 inches (150 by 150 mm) square.
d. Door-Surface Protection: 6 by 6 inches (150 by 150 mm) square.
e. Door-Edge and -Frame Protectors: 12 inches (300 mm) long.
f. Door-Knob and -Lever Protectors: Full-size unit of each type.

5. Qualification Data: For qualified Installer and testing agency.
6. Material Certificates: For each impact-resistant plastic material, from manufacturer.
7. Material Test Reports: For each impact-resistant plastic material.
8. Maintenance Data: For each impact-resistant wall protection unit to include in maintenance manuals.
   a. Include recommended methods and frequency of maintenance for maintaining optimum condition of plastic covers under anticipated traffic and use conditions. Include precautions against using cleaning materials and methods that may be detrimental to plastic finishes and performance.
9. Warranty: Sample of special warranty.

E. Quality Assurance
1. Installer Qualifications: An employer of workers trained and approved by manufacturer.
2. Source Limitations: Obtain impact-resistant wall protection units from single source from single manufacturer.
3. Product Options: Drawings indicate size, profiles, and dimensional requirements of impact-resistant wall protection units and are based on the specific system indicated.
   a. Do not modify intended aesthetic effects, as judged solely by the Owner, except with the Owner's approval. If modifications are proposed, submit comprehensive explanatory data to the Owner for review.
4. Forest Certification: Fabricate wood rails from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
5. Surface-Burning Characteristics: Provide impact-resistant, plastic wall protection units with surface-burning characteristics as determined by testing identical products per ASTM E 84, NFPA 255, or UL 723 by UL or another qualified testing agency.
6. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.
7. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Store impact-resistant wall protection units in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.
   a. Maintain room temperature within storage area at not less than 70 deg F (21 deg C) during the period plastic materials are stored.
   b. Keep plastic sheet material out of direct sunlight.
   c. Store plastic wall protection components for a minimum of 72 hours, or until plastic material attains a minimum room temperature of 70 deg F (21 deg C).
      1) Store corner-guard covers in a vertical position.
      2) Store wall-guard, bed-locator and handrail covers in a horizontal position.

G. Project Conditions
1. Environmental Limitations: Do not deliver or install impact-resistant wall protection units until building is enclosed and weatherproof, wet work is complete and dry, and HVAC system is operating and maintaining temperature at 70 deg F (21 deg C) for not less than 72 hours before beginning installation and for the remainder of the construction period.

H. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of impact-resistant wall protection units that fail in materials or workmanship within specified warranty period.
   a. Failures include, but are not limited to, the following:
      1) Structural failures.

2) Deterioration of plastic and other materials beyond normal use.

b. Warranty Period: Five years from date of Substantial Completion.

1.2 PRODUCTS

A. Materials

1. PVC Plastic: ASTM D 1784, Class 1, textured, chemical- and stain-resistant, high-impact-resistant PVC or acrylic-modified vinyl plastic with integral color throughout; extruded and sheet material, thickness as indicated.
   a. Impact Resistance: Minimum 25.4 ft-lbf/in. (1356 J/m) of notch when tested according to ASTM D 256, Test Method A.
   b. Chemical and Stain Resistance: Tested according to ASTM D 543 **OR** ASTM D 1308.
   c. Self-extinguishing when tested according to ASTM D 635.
   d. Flame-Spread Index: 25 or less.
   e. Smoke-Developed Index: 450 or less.
2. Polycarbonate Plastic Sheet: ASTM D 6098, S-PC01, Class 1 or 2, abrasion resistant; with a minimum impact-resistance rating of 15 ft-lbf/in. (800 J/m) of notch when tested according to ASTM D 256, Test Method A.
3. Aluminum Extrusions: Alloy and temper recommended by manufacturer for type of use and finish indicated, but with not less than strength and durability properties specified in ASTM B 221 (ASTM B 221M) for Alloy 6063-T5.
4. Stainless-Steel Sheet: ASTM A 240/A 240M.
5. Brass: ASTM B 249/B 249M for extruded shapes and ASTM B 36/B 36 M for sheet.
6. Solid Wood: Clear hardwood lumber of species indicated, free of appearance defects, and selected for compatible grain and color.
7. Particleboard: ANSI A208.1, Grade M-2; made with binder containing no urea formaldehyde.
8. Fasteners: Aluminum, nonmagnetic stainless-steel, or other noncorrosive metal screws, bolts, and other fasteners compatible with items being fastened. Use security-type fasteners where exposed to view.
9. Adhesive: As recommended by impact-resistant plastic wall protection manufacturer and with a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Wall Guards

1. Crash Rail: Heavy-duty assembly consisting of continuous snap-on plastic cover installed over concealed retainer system; designed to withstand impacts.
   a. Cover: Extruded rigid plastic, minimum 0.100-inch (2.5-mm) wall thickness; as follows: **OR** in dimensions and profiles indicated on Drawings, **as directed**.
      1) Profile: Flat **OR** Convex, **as directed**.
         a) Dimensions: Nominal 6 inches high by 1 inch deep (150 mm high by 25 mm deep) **OR** 8 inches high by 1 inch deep (200 mm high by 25 mm deep), **as directed**.
         b) Surface: Uniform **OR** Uniform with coextruded accent inlay strip in contrasting color **OR** Grooved, **as directed**.
            i. Accent Inlay Strip: Nominal 2 inches (50 mm) high by length of rail.
      2) Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   b. Continuous Retainer: Minimum 0.080-inch- (2.0-mm-) thick, one-piece, extruded aluminum.

      OR

      Retainer Clips: Manufacturer's standard impact-absorbing clips designed for heavy-duty performance.
   c. Bumper: Continuous rubber or vinyl bumper cushion(s).

d. End Caps and Corners: Prefabricated, injection-molded plastic; matching color **OR** contrasting with color, **as directed**, cover; field adjustable for close alignment with snap-on cover.
e. Accessories: Concealed splices and mounting hardware.
f. Mounting: Surface mounted directly to wall **OR** Reveal mounted on bumper cushion(s) **OR** Extended mounting on injection-molded plastic mounting brackets, **as directed**.

2. Bumper Rail: Assembly consisting of continuous snap-on plastic cover installed over concealed, continuous retainer; designed to withstand impacts.
   a. Cover: Extruded rigid plastic, minimum 0.078-inch (2.0-mm) wall thickness; as follows: **OR** in dimensions and profiles indicated on Drawings, **as directed**.
      1) Profile: Half round profile, nominal 1 inch high by 1 inch deep (25 mm high by 25 mm deep) **OR** Rounded bullnose profile, nominal 4 inches high by 2 inches deep (100 mm high by 50 mm deep) **OR** Angled profile with rounded-bullnose front edge, nominal 4 inches high by 2 inches deep (100 mm high by 50 mm deep) **OR** Flat profile, nominal 4 inches high by 1 inch deep (100 mm high by 25 mm deep), **as directed**.
      2) Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   b. Continuous Retainer: Minimum 0.080-inch- (2.0-mm-) thick, one-piece, extruded aluminum.
      OR
      Retainer Clips: Manufacturer's standard impact-absorbing clips.
   c. Bumper: Continuous rubber or vinyl bumper cushion(s).
   d. End Caps and Corners: Prefabricated, injection-molded plastic; matching color **OR** contrasting with color, **as directed**, cover; field adjustable for close alignment with snap-on cover.
   e. Accessories: Concealed splices and mounting hardware.
   f. Mounting: Surface mounted directly to wall **OR** Reveal mounted on bumper cushions **OR** Extended mounting on injection-molded plastic mounting brackets, **as directed**.

3. Rub Rail: Assembly consisting of continuous snap-on cover installed over concealed, continuous retainer.
   a. Cover: Extruded rigid plastic **OR** flexible PVC, **as directed**, minimum 0.078-inch (2.0-mm) wall thickness; as follows: **OR** in dimensions and profiles indicated on Drawings, **as directed**.
      1) Profile: Half-round profile, nominal 1-1/8 inches high by 1-1/8 inches deep (30 mm high by 30 mm deep) **OR** Rounded bullnose profile, nominal 2 inches high by 1 inch deep (50 mm high by 25 mm deep), **as directed**.
      2) Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   b. Retainer: Minimum 0.0625-inch- (1.6-mm-) thick, one-piece, extruded aluminum.
   c. End Caps and Corners: Prefabricated, injection-molded plastic; color matching cover; field adjustable for close alignment with snap-on cover.
   d. Accessories: Concealed splices and mounting hardware.
   e. Mounting: Surface mounted directly to wall **OR** Reveal mounted on bumper cushions, **as directed**.

4. Wood Chair Rail with Bumper: Assembly consisting of continuous sculpted, solid-wood rail, with continuous bumper insert installed in continuous recessed retainer.
   a. Wood Rail: 3-1/2 inches high by 7/8 inch deep (89 mm high by 22 mm deep) **OR** 5-1/2 inches high by 1-1/2 inches deep (140 mm high by 38 mm deep) **OR** Size and profile indicated on Drawings, **as directed**.
      1) Wood Species: Red oak **OR** Maple **OR** Ash **OR** Beech, **as directed**.
      2) Finish: Clear **OR** Stained, **as directed**.
      3) Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

b. Bumper: Extruded rigid plastic **OR** flexible vinyl, **as directed**, minimum 0.078-inch (2.0-mm) wall thickness; as follows: **OR** in dimensions and profiles indicated on Drawings, **as directed**.
   1) Profile: Half-round profile, nominal 2 inches high by 1 inch deep (50 mm high by 25 mm deep) **OR** Small rounded profile, nominal 1-1/8 inches high by 1-1/8 inches deep (30 mm high by 30 mm deep), **as directed**.
   2) Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   3) End Caps and Corners: Prefabricated, injection-molded plastic; color matching bumper; field adjustable for close alignment with snap-on bumper.

c. Retainer: Minimum 0.0625-inch- (1.6-mm-) thick, one-piece, extruded aluminum.
   1) Finish: Mill **OR** Brass colored, **as directed**.

d. Accessories: Concealed splices and mounting hardware.

e. Mounting: Surface mounted directly to wall.

5. Wood Chair Rail: Assembly consisting of continuous sculpted, solid-wood rail.
   a. Rail: 3-1/2 inches high by 7/8 inch deep (89 mm high by 22 mm deep) **OR** 5-1/2 inches high by 1-1/2 inches deep (140 mm high by 38 mm deep) **OR** As indicated on Drawings, **as directed**.
      1) Wood Species: Red oak **OR** Maple **OR** Ash **OR** Bamboo, **as directed**.
      2) Finish: Clear **OR** Stained, **as directed**.
      3) Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   b. Accessories: Concealed splices and mounting hardware.
   c. Mounting: Surface mounted directly to wall.
6. Opaque-Plastic Chair Rail: Assembly consisting of continuous snap-on cover installed over continuous retainer.
   a. Cover: Extruded rigid plastic, minimum 0.070-inch (1.8-mm) wall thickness; as follows: **OR** in dimensions and profiles indicated on Drawings, **as directed**.
      1) Profile: Rounded bullnose profile, nominal 2 inches high by 1 inch deep (50 mm high by 25 mm deep) **OR** Half-round profile, nominal 1-1/8 inches high by 1-1/8 inches deep (30 mm high by 30 mm deep), **as directed**.
      2) Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   b. Retainer: Minimum 0.060-inch- (1.5-mm-) thick, one-piece, extruded aluminum.
   c. Bumper: Continuous rubber or vinyl bumper cushion(s).
   d. End Caps and Corners: Prefabricated, injection-molded plastic; color matching cover; field adjustable for close alignment with snap-on cover.
   e. Accessories: Concealed splices and mounting hardware.
   f. Mounting: Surface mounted directly to wall **OR** Reveal mounted on bumper cushions, **as directed**.
7. Transparent-Plastic Chair Rail: Consisting of clear polycarbonate plastic sheet.
   a. Height: 3 inches (75 mm) nominal **OR** 4 inches (100 mm) nominal **OR** As indicated on Drawings, **as directed**.
   b. Mounting: Surface mounted using flat-head countersunk screws through factory-drilled mounting holes.
8. Rub Strip: Consisting of minimum 0.040-inch- (1.0-mm-) **OR** 0.060-inch- (1.5-mm-), **as directed**, thick, plastic sheet wall-covering material.
   a. Height: 8 inches (200 mm) nominal.
   b. Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   c. Mounting: Surface mounted with adhesive or double-faced adhesive tape.

C. Handrails
1. Impact-Resistant Plastic Handrails: Assembly consisting of snap-on plastic cover installed over continuous retainer.

a. Cover: Minimum 0.078-inch- (2.0-mm-) **OR** 0.100-inch- (2.5-mm-), **as directed**, thick, extruded rigid plastic; as follows: **OR** in dimensions and profiles indicated on Drawings, **as directed**.
   1) Single Handrail: Cylindrical tube profile cover with continuous retainer; with mounting brackets supporting bottom of rail.
      a) Tube Diameter: as directed by the Owner.
   2) Bumper Rail: Cover with flat **OR** sculpted with contoured thumb recess on, **as directed**, front side; with 1-1/2-inch- (38-mm-) diameter gripping surface and finger recess on back side; supported by concealed, continuous retainer and extended mounting brackets.
      a) Bumper-Rail Dimensions: Nominal 5-1/2 inches high by 1-1/2 inches deep (140 mm high by 38 mm deep) **OR** 5-1/2 inches high by 2 inches deep (140 mm high by 50 mm deep), **as directed**.
      b) Bumper Surface: Smooth **OR** Smooth with coextruded accent inlay strip in contrasting color **OR** Grooved, **as directed**.
      c) Accent Inlay Strip: Nominal 2 inches (50 mm) high by length of rail.
   3) Double Handrail with Bumper-Rail Profile: Two tubes mounted above and below nominal, flat-faced bumper rail; each tube with 1-1/2-inch- (38-mm-) diameter gripping surface and finger recess on back side; supported by concealed, continuous retainer and extended mounting brackets.
      a) Bumper-Rail Dimensions: Nominal 4 inches high by 1-1/2 inches deep (100 mm high by 38 mm deep).
      b) Bumper Surface: Smooth **OR** Smooth with coextruded accent inlay strip in contrasting color **OR** Grooved, **as directed**.
      c) Accent Inlay Strip: Nominal 2 inches (50 mm) high by length of rail.
   4) Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
b. Retainer: Minimum 0.080-inch- (2.0-mm-) thick, one-piece, extruded aluminum.
c. Mounting Bracket: Extended mounting on injection-molded plastic **OR** anodized-aluminum, **as directed**, mounting brackets.
d. End Caps and Corners: Prefabricated, injection-molded plastic; matching color **OR** contrasting with color, **as directed**, cover; field adjustable for close alignment with snap-on cover.
e. Accessories: Concealed splices, cushions, and mounting hardware.

2. Combination Wood-Plastic Bumper Handrail: Assembly consisting of solid-wood handrail mounted above plastic bumper rail, both mounted on continuous retainer; with reveal between handrail and bumper serving as thumb recess on front side; with 1-1/2-inch- (38-mm-) diameter gripping surface and finger recess on back side.
   a. Wood Handrail: 1-1/2 inches (38 mm) in diameter; with matching end caps and corners.
      1) Wood Species: Red oak **OR** Maple **OR** Ash **OR** Beech, **as directed**.
      2) Finish: Clear **OR** Stained, **as directed**.
      3) Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   b. Bumper: Extruded rigid plastic, minimum 0.078-inch- (2.0-mm-) **OR** 0.100-inch- (2.5-mm-), **as directed**, wall thickness; as follows: **OR** in dimensions and profiles indicated on Drawings, **as directed**.
      1) Profile: Flat **OR** Convex, **as directed**, profile, nominal 4 inches high by 1 inch deep (100 mm high by 25 mm deep).
      2) Accent Inlay Strip: Nominal 2 inches (50 mm) high by length of rail.
      3) Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
      4) End Caps and Corners: Prefabricated, injection-molded plastic; color matching bumper; field adjustable for close alignment with snap-on bumper.
   c. Retainer: Minimum 0.0625-inch- (1.6-mm-) thick, one-piece, extruded aluminum.
   d. Reveal: Extruded rigid plastic or vinyl over aluminum retainer.

1) Color: Brass **OR** Chrome **OR** As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

e. Accessories: Concealed splices, cushion(s), and mounting hardware.

3. Wood Handrail with Bumper: Assembly consisting of continuous sculpted, solid-wood handrail, with bumper insert installed in continuous retainer recessed into the face of the wood.
   a. Wood Handrail: As indicated on Drawings with 1-1/2-inch- (38-mm-) diameter gripping surface.
      1) End Caps, Returns, Corners, and Mounting Brackets: Solid wood that matches rail.
      2) Wood Species: Red oak **OR** Maple **OR** Ash **OR** Beech **OR** Bamboo, **as directed**.
      3) Finish: Clear **OR** Stained, **as directed**.
      4) Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   b. Bumper: Extruded rigid plastic **OR** flexible vinyl, **as directed**, minimum 0.078-inch (2.0-mm) wall thickness; as follows: **OR** in dimensions and profiles indicated on Drawings, **as directed**.
      1) Profile: Half-round profile, nominal 2 inches high by 1 inch deep (50 mm high by 25 mm deep) **OR** Small rounded profile, nominal 1-1/8 inches high by 1-1/8 inches deep (30 mm high by 30 mm deep), **as directed**.
      2) Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
      3) End Caps and Corners: Prefabricated, injection-molded plastic; color matching bumper; field adjustable for close alignment with snap-on bumper.
   c. Retainer: Minimum 0.0625-inch- (1.6-mm-) thick, one-piece, extruded aluminum.
      1) Finish: Mill **OR** Brass colored, **as directed**.
   d. Accessories: Concealed splices and mounting hardware.
4. Solid-Wood Handrail: Assembly consisting of continuous sculpted, solid-wood handrail.
   a. Handrail: 5-1/2 inches high by 1-1/2 inches deep (140 mm high by 38 mm deep) **OR** As indicated on Drawings, **as directed**, with 1-1/2-inch- (38-mm-) diameter gripping surface.
      1) End Caps, Returns, Corners, and Mounting Brackets: Solid wood that matches rail.
      2) Wood Species: Red oak **OR** Maple **OR** Ash **OR** Beech, **as directed**.
      3) Finish: Clear **OR** Stained, **as directed**.
      4) Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

D. Bed Locators
1. Bed Locators: Assembly consisting of continuous snap-on plastic cover installed over continuous retainer; with two bed-locator end caps and mounting hardware; cover designed to spring back when hit.
   a. Cover: Extruded rigid plastic, minimum 0.078-inch (2.0-mm) wall thickness.
      1) Profile: Large rounded angled **OR** bullnose, **as directed**, profile, nominal 4 inches high by 2 inches deep (100 mm high by 50 mm deep).
      2) Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   b. Retainer: Minimum 0.080-inch- (2.0-mm-) thick, one-piece, extruded aluminum.
   c. Bed-Locator End Caps: Prefabricated, injection-molded plastic; color matching cover; field adjustable for close alignment with snap-on cover.
   d. Mounting Type: Surface mounted on 1/2-inch- (13-mm-) thick cushion spacers **OR** Extended mounting on injection-molded plastic mounting brackets **OR** Extended mounting on aluminum mounting brackets, **as directed**.

E. Corner Guards
1. Surface-Mounted, Resilient, Plastic Corner Guards: Assembly consisting of snap-on plastic cover installed over continuous retainer; including mounting hardware; fabricated with 90- or 135-degree turn to match wall condition.

a. Cover: Extruded rigid plastic, minimum 0.078-inch (2.0-mm) **OR** 0.100-inch (2.5-mm), **as directed**, wall thickness; as follows: **OR** in dimensions and profiles indicated on Drawings, **as directed**.
   1) Profile: Nominal 2-inch- (50-mm-) long leg and 1/4-inch (6-mm) corner radius **OR** 3-inch- (75-mm-) long leg and 1/4-inch (6-mm) corner radius **OR** 3-inch- (75-mm-) long leg and 1-1/4-inch (32-mm) corner radius, **as directed**.
   2) Height: 4 feet (1.2 m) **OR** 8 feet (2.4 m), **as directed**.
   3) Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

b. Retainer: Minimum 0.060-inch- (1.5-mm-) thick, one-piece, extruded aluminum **OR** One-piece extruded plastic, **as directed**.
   OR
   Retainer Clips: Manufacturer's standard impact-absorbing clips.

c. Top and Bottom Caps: Prefabricated, injection-molded plastic; color matching cover; field adjustable for close alignment with snap-on cover.

2. Flush-Mounted, Resilient, Plastic Corner Guards: Assembly consisting of snap-on plastic cover that is flush with adjacent wall surface, installed over continuous retainer; including mounting hardware; fabricated with 90- or 135-degree turn to match wall condition; full wall height.
   a. Cover: Extruded rigid plastic, minimum 0.078-inch (2.0-mm) **OR** 0.100-inch (2.5-mm), **as directed**, wall thickness; as follows: **OR** in dimensions and profiles indicated on Drawings, **as directed**.
      1) Profile: Nominal 2-inch- (50-mm-) long leg and 1/4-inch (6-mm) corner radius **OR** 3-inch- (75-mm-) long leg and 1/4-inch (6-mm) corner radius **OR** 3-inch- (75-mm-) long leg and 1-1/4-inch (32-mm) corner radius, **as directed**.
      2) Height: 4 feet (1.2 m) **OR** 8 feet (2.4 m), **as directed**.
      3) Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   b. Retainer: Minimum 0.060-inch- (1.5-mm-) thick, one-piece, extruded aluminum.
      OR
      Retainer Clips: Manufacturer's standard impact-absorbing clips.
   c. Aluminum Cove Base: Nominal 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, high.

3. Fire-Rated, Resilient, Plastic Corner Guards: Assembly consisting of snap-on plastic cover that is flush with adjacent wall surface, installed over continuous retainer and intumescent fire barrier; including mounting hardware; fabricated with 90- or 135-degree turn to match wall condition; full wall height.
   a. Fire Rating: 1 hour **OR** 2 hours **OR** Same rating as wall in which corner guard is installed, **as directed**; UL listed and labeled according to UL 2079.
   b. Cover: Extruded rigid plastic, minimum 0.078-inch (2.0-mm) **OR** 0.100-inch (2.5-mm), **as directed**, wall thickness; as follows: **OR** in dimensions and profiles indicated on Drawings, **as directed**.
      1) Leg: Nominal 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**.
      2) Corner Radius: 1/4 inch (6 mm) **OR** 1-1/4 inches (32 mm), **as directed**.
      3) Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   c. Retainer: Minimum 0.070-inch- (1.8-mm-) thick, one-piece, extruded aluminum.
   d. Aluminum Cove Base: Nominal 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, high.

4. Surface-Mounted, Opaque-Plastic Corner Guards: Fabricated from PVC plastic, acrylic-modified vinyl sheet or opaque polycarbonate sheet; with formed edges; fabricated with 90- or 135-degree turn to match wall condition.
   a. Wing Size: Nominal 3/4 by 3/4 inch (20 by 20 mm) **OR** 1-1/8 by 1-1/8 inches (30 by 30 mm) **OR** 2-1/2 by 2-1/2 inches (65 by 65 mm), **as directed**.
   b. Mounting: Countersunk screws through factory-drilled mounting holes **OR** Adhesive **OR** Double-faced adhesive foam tape, **as directed**.

c. Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

5. Surface-Mounted, Transparent-Plastic Corner Guards: Fabricated from clear polycarbonate plastic sheet; with formed edges; fabricated with 90- or 135-degree turn to match wall condition.
   a. Wing Size: Nominal 3/4 by 3/4 inch (20 by 20 mm) **OR** 1-1/8 by 1-1/8 inches (30 by 30 mm) **OR** 2-1/2 by 2-1/2 inches (65 by 65 mm), **as directed**.
   b. Thickness: Minimum 0.050 inch (1.3 mm) **OR** 0.075 inch (1.9 mm) **OR** 0.100 inch (2.5 mm), **as directed**.
   c. Mounting: Countersunk screws through factory-drilled mounting holes **OR** Corner clips, **as directed**.
6. Surface-Mounted, Metal Corner Guards: Fabricated from one-piece, formed or extruded metal with formed edges; with 90- or 135-degree turn to match wall condition.
   a. Material: Stainless steel, Type 304 **OR** Type 430, **as directed**.
      1) Thickness: Minimum 0.0500 inch (1.3 mm) **OR** 0.0625 inch (1.6 mm) **OR** 0.0781 inch (2.0 mm), **as directed**.
      2) Finish: Directional satin, No. 4 **OR** Bright annealed, **as directed**.

      OR

      Material: Extruded aluminum, minimum 0.0625 inch (1.6 mm) thick, with clear anodic finish.

      OR

      Material: Brass sheet, minimum 0.0500 inch (1.3 mm) thick, with buffed, smooth specular **OR** fine satin, **as directed**, finish.
   b. Wing Size: Nominal 1-1/2 by 1-1/2 inches (38 by 38 mm) **OR** 2-1/2 by 2-1/2 inches (65 by 65 mm) **OR** 3-1/2 by 3-1/2 inches (90 by 90 mm), **as directed**.
   c. Corner Radius: 1/8 inch (3 mm) **OR** 3/4 inch (19 mm), **as directed**.
   d. Mounting: Flat-head, countersunk screws through factory-drilled mounting holes **OR** Oval head, countersunk screws through factory-drilled mounting holes **OR** Double-faced, adhesive foam tape **OR** Adhesive, **as directed**.

F. End-Wall Guards
1. Surface-Mounted, Resilient, Plastic End-Wall Guard: Assembly consisting of snap-on plastic cover installed over continuous retainer **OR** continuous retainer at each corner, with end of wall covered by semirigid, impact-resistant sheet wall covering, **as directed**; including mounting hardware.
   a. Cover: Extruded rigid plastic, minimum 0.078-inch (2.0-mm) **OR** 0.100-inch (2.5-mm), **as directed**, wall thickness; as follows: **OR** in dimensions and profiles indicated on Drawings, **as directed**.
      1) Profile: Nominal 2-inch- (50-mm-) long leg and 1/4-inch (6-mm) corner radius **OR** 3-inch- (75-mm-) long leg and 1/4-inch (6-mm) corner radius **OR** 3-inch- (75-mm-) long leg and 1-1/4-inch (32-mm) corner radius, **as directed**.
      2) Height: 4 feet (1.2 m) **OR** 8 feet (2.4 m), **as directed**.
      3) Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **a directed**.
   b. Retainer: Minimum 0.060-inch- (1.5-mm-) thick, one-piece, extruded aluminum.
   c. Top and Bottom Caps: Prefabricated, injection-molded plastic; color matching cover; field adjustable for close alignment with snap-on cover.
2. Flush-Mounted, Resilient, Plastic End-Wall Guard: Assembly consisting of snap-on plastic cover that is flush with adjacent wall surface and that covers entire end of wall, installed over continuous retainer **OR** continuous retainer at each corner, with end of wall covered by semirigid, impact-resistant sheet wall covering, **as directed**; including mounting hardware.
   a. Cover: Extruded rigid plastic, minimum 0.078-inch (2.0-mm) **OR** 0.100-inch (2.5-mm), **as directed**, wall thickness; as follows: **OR** in dimensions and profiles indicated on Drawings, **as directed**.
      1) Profile: Nominal 2-inch- (50-mm-) long leg and 1/4-inch (6-mm) corner radius **OR** 3-inch- (75-mm-) long leg and 1/4-inch (6-mm) corner radius **OR** 3-inch- (75-mm-) long leg and 1-1/4-inch (32-mm) corner radius, **as directed**.

2) Height: 4 feet (1.2 m) **OR** 8 feet (2.4 m), **as directed**.
3) Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

b. Retainer: Minimum 0.060-inch- (1.5-mm-) thick, one-piece, extruded aluminum.
c. Aluminum Cove Base: Nominal 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, high.

3. Fire-Rated, Resilient, Plastic End-Wall Guard: Assembly consisting of snap-on plastic cover that is flush with adjacent wall surface and that covers entire end of wall, installed over continuous retainer and intumescent fire barrier; including mounting hardware; full wall height.
a. Fire Rating: 1 hour **OR** 2 hours **OR** Same rating as wall in which end guard is installed, **as directed**; UL listed and labeled according to UL 2079.
b. Cover: Extruded rigid plastic, minimum 0.078-inch (2.0-mm) **OR** 0.100-inch (2.5-mm), **as directed**, wall thickness; as follows: **OR** in dimensions and profiles indicated on Drawings, **as directed**.
1) Leg: Nominal 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**.
2) Corner Radius: 1/4 inch (6 mm) **OR** 1-1/4 inches (32 mm), **as directed**.
3) Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
c. Retainer: Minimum 0.070-inch- (1.8-mm-) thick, one-piece, extruded aluminum.
d. Aluminum Cove Base: Nominal 4 inches (100 mm) **OR** 6 inches (150 mm), **as directed**, high.

4. Surface-Mounted, Metal, End-Wall Guards: Fabricated from one-piece, formed or extruded metal that covers entire end of wall; with formed edges.
a. Material: Stainless steel, Type 304 **OR** Type 430 **as directed**.
1) Thickness: Minimum 0.0500 inch (1.3 mm) **OR** 0.0625 inch (1.6 mm) **OR** 0.0781 inch (2.0 mm), **as directed**.
2) Finish: Directional satin, No. 4 **OR** Bright annealed, **as directed**.

OR

Material: Extruded aluminum, minimum 0.0625 inch (1.6 mm) thick, with clear anodic finish.

OR

Material: Brass sheet, minimum 0.0500 inch (1.3 mm) thick, with buffed, smooth specular **OR** fine satin, **as directed**, finish.

b. Wing Size: Nominal 1-1/2 by 1-1/2 inches (38 by 38 mm) **OR** 2-1/2 by 2-1/2 inches (65 by 65 mm) **OR** 3-1/2 by 3-1/2 inches (90 by 90 mm), **as directed**.
c. Corner Radius: 1/8 inch (3 mm) **OR** 3/4 inch (19 mm), **as directed**.
d. Mounting: Flat-head, countersunk screws through factory-drilled mounting holes **OR** Oval head, countersunk screws through factory-drilled mounting holes **OR** Double-faced, adhesive foam tape **OR** Adhesive, **as directed**.

G. Impact-Resistant Wall Coverings
1. Impact-Resistant Sheet Wall Covering: Fabricated from plastic sheet wall-covering material.
a. Size: 48 by 96 inches (1219 by 2438 mm) for sheet **OR** 48 by 120 inches (1219 by 3048 mm) for roll **OR** As indicated, **as directed**.
b. Sheet Thickness: 0.022 inch (0.56 mm) **OR** 0.028 inch (0.7 mm) **OR** 0.040 inch (1.0 mm) **OR** 0.060 inch (1.5 mm) **OR** 0.080 inch (2.0 mm) **OR** 0.093 inch (2.4 mm) **OR** 0.125 inch (3.0 mm), **as directed**.
c. Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
d. Height: Full wall **OR** Wainscot **OR** As indicated, **as directed**.
e. Trim and Joint Moldings: Extruded rigid plastic that matches sheet wall covering color.
f. Mounting: Adhesive.

2. Prelaminated, Impact-Resistant Wall Panels: Rigid wall panels consisting of impact-resistant plastic sheet wall covering material factory laminated to high-impact-resistant core, with moisture-resistant vapor barrier factory laminated to reverse side of panel for stability.

a. Composition: 0.028-inch- (0.70-mm-) thick plastic sheet laminated to 3/8-inch- (9.5-mm-) thick, particleboard core **OR** 0.04-inch- (1.02-mm-) thick plastic sheet laminated to 3/8-inch- (9.5-mm-) thick, particleboard core, **as directed**.
b. Sheet Size: 48 by 96 inches (1219 by 2438 mm) **OR** 48 by 108 inches (1219 by 2743 mm) **OR** 48 by 120 inches (1219 by 3048 mm) **OR** As indicated, **as directed**.
c. Height: Full wall **OR** Wainscot **OR** As indicated, **as directed**.
d. Sheet Edge: Square **OR** Beveled, **as directed**.
e. Trim and Joint Moldings: Extruded rigid plastic that matches sheet wall covering color.
f. Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
g. Mounting: Adhesive.

H. Door Protection Systems
1. General: Comply with BHMA A156.6.
a. For fire-rated doors, provide door protection systems that are UL listed and labeled.
2. Protection Plates: Fabricated from extruded rigid plastic, of thickness indicated.
3. Full-Height Door-Surface Protection: Minimum 0.040-inch (1.0-mm) **OR** 0.060-inch (1.5-mm) **OR** 0.080-inch (2.0-mm), **as directed**, wall thickness; with 90-degree bend for door-edge protection.
a. Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
b. Mounting: Adhesive **OR** Countersunk screws through factory-drilled mounting holes **OR** Double-faced adhesive foam tape, **as directed**.
4. Armor Plates: Minimum 0.040-inch (1.0-mm) **OR** 0.060-inch (1.5-mm) **OR** 0.080-inch (2.0-mm), **as directed**, wall thickness; beveled four sides.
a. Size: 32 inches (813 mm) **OR** 36 inches (914 mm) **OR** 40 inches (1016 mm) **OR** 42 inches (1067 mm), **as directed**, high by door width, with allowance for frame stops.
b. Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
c. Mounting: Adhesive **OR** Countersunk screws through factory-drilled mounting holes **OR** Double-faced adhesive foam tape, **as directed**.
5. Kick Plates: Minimum 0.040-inch (1.0-mm) **OR** 0.060-inch (1.5-mm) **OR** 0.080-inch (2.0-mm), **as directed** wall thickness; beveled four sides.
a. Size: 8 inches (203 mm) **OR** 10 inches (254 mm) **OR** 12 inches (305 mm), **as directed**, high by door width, with allowance for frame stops.
b. Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
c. Mounting: Adhesive **OR** Countersunk screws through factory-drilled mounting holes **OR** Double-faced adhesive foam tape, **as directed**.
6. Mop Plates: Minimum 0.040-inch (1.0-mm) **OR** 0.060-inch (1.5-mm) **OR** 0.080-inch (2.0-mm), **as directed**, wall thickness; beveled four sides.
a. Size: 4 inches (102 mm) **OR** 6 inches (152 mm), **as directed**, high by 1 inch (25 mm) less than door width.
b. Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
c. Mounting: Adhesive **OR** Countersunk screws through factory-drilled mounting holes **OR** Double-faced adhesive foam tape, **as directed**.
7. Stretcher Plates: Minimum 0.040-inch (1.0-mm) **OR** 0.060-inch (1.5-mm) **OR** 0.080-inch (2.0-mm), **as directed**, wall thickness; beveled four sides.
a. Size: 6 inches (152 mm) **OR** 8 inches (203 mm), **as directed**, high by door width, with allowance for frame stops.
b. Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
c. Mounting: Adhesive **OR** Countersunk screws through factory-drilled mounting holes **OR** Double-faced adhesive foam tape, **as directed**.
8. Push Plates: Minimum 0.040-inch (1.0-mm) **OR** 0.060-inch (1.5-mm) **OR** 0.080-inch (2.0-mm), **as directed**, wall thickness; beveled four sides.

a. Size: 12 inches high by 4 inches wide (305 mm high by 102 mm wide) **OR** 16 inches high by 4 inches wide (406 mm high by 102 mm wide), **as directed**.
b. Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
c. Mounting: Adhesive **OR** Countersunk screws through factory-drilled mounting holes **OR** Double-faced adhesive foam tape, **as directed**.

9. Door-Edge Protection: Fabricated from extruded rigid plastic, minimum 0.040-inch (1.0-mm) **OR** 0.060-inch (1.5-mm), **as directed**, wall thickness; formed to fit over door edge without mortising.
   a. Shape: L **OR** U, **as directed**.
   b. Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   c. Mounting: Adhesive **OR** Countersunk screws through factory-drilled mounting holes **OR** Double-faced adhesive foam tape, **as directed**.
10. Door-Frame Protector: Fabricated from extruded rigid plastic, minimum 0.040-inch (1.0-mm) **OR** 0.050-inch (1.3-mm) **OR** 0.060-inch (1.5-mm), **as directed**, wall thickness; formed to fit entire door-frame profile.
   a. Height: 36 inches (914 mm) **OR** 48 inches (1219 mm), **as directed**.
   b. Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   c. Mounting: Adhesive **OR** Countersunk screws through factory-drilled mounting holes **OR** Double-faced adhesive foam tape, **as directed**.
11. Door-Frame Protector: Assembly consisting of snap-on plastic cover installed over continuous retainer; formed to fit door frame on opposite side of door swing.
   a. Cover: Extruded rigid plastic, minimum 0.080-inch (2.0-mm) wall thickness; in dimensions and profiles indicated.
      1) Height: 36 inches (914 mm) **OR** 48 inches (1219 mm), **as directed**.
      2) Corner Radius: 1/4 inch (6 mm) **OR** 1-1/4 inches (32 mm), **as directed**.
      3) Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   b. Retainer: Minimum 0.080-inch- (2.0-mm-) thick, one-piece, extruded aluminum.
12. Door-Knob **OR** Door-Lever, **as directed**, Protector: Fabricated from injection-molded plastic, minimum 0.060-inch (1.5-mm) wall thickness.
   a. Color and Texture: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   b. Mounting: Countersunk screws through factory-drilled mounting holes.

I. Fabrication
1. Fabricate impact-resistant wall protection units to comply with requirements indicated for design, dimensions, and member sizes, including thicknesses of components.
2. Preform curved semirigid, impact-resistant sheet wall covering in factory for radius and sheet thickness as follows:
   a. Sheet Thickness of 0.040 Inch (1.0 mm): 24-inch (610-mm) radius.
   b. Sheet Thickness of 0.060 Inch (1.5 mm): 36-inch (914-mm) radius.
3. Assemble components in factory to greatest extent possible to minimize field assembly. Disassemble only as necessary for shipping and handling.
4. Fabricate components with tight seams and joints with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.
5. Miter corners and ends of wood handrails for returns.

J. Metal Finishes
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   a. Remove tool and die marks and stretch lines, or blend into finish.
   b. Grind and polish surfaces to produce uniform finish, free of cross scratches.

c. Run grain of directional finishes with long dimension of each piece.
d. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

2. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

1.3 EXECUTION

A. Examination
1. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances, fire rating, and other conditions affecting performance of work.
2. Examine walls to which impact-resistant wall protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.
a. For impact-resistant wall protection units attached with adhesive or foam tape, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation
1. Complete finishing operations, including painting, before installing impact-resistant wall protection system components.
2. Before installation, clean substrate to remove dust, debris, and loose particles.

C. Installation
1. General: Install impact-resistant wall protection units level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.
a. Install impact-resistant wall protection units in locations and at mounting heights indicated on Drawings or, if not indicated, at heights indicated on Drawings **OR** as directed.
b. Provide splices, mounting hardware, anchors, and other accessories required for a complete installation.
1) Provide anchoring devices to withstand imposed loads.
2) Where splices occur in horizontal runs of more than 20 feet (6.1 m), splice aluminum retainers and plastic covers at different locations along the run, but no closer than 12 inches (305 mm).
3) Adjust end and top caps as required to ensure tight seams.
2. Impact-Resistant Wall Covering: Install top and edge moldings, corners, and divider bars as required for a complete installation.

D. Cleaning
1. Immediately after completion of installation, clean plastic covers and accessories using a standard, ammonia-based, household cleaning agent.
2. Remove excess adhesive using methods and materials recommended in writing by manufacturer.

END OF SECTION 10261

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Task	Specification	Specification Description
10261	05500	Metal Fabrications
10263	10261	Impact-Resistant Wall Protection

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SECTION 10271 - ACCESS FLOORING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for access flooring. Product shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Access flooring panels and understructure.
b. Floor panel coverings.

C. Definition
1. ESD: Electrostatic discharge. The transfer of electric charge between bodies at different potentials.

D. System Description
1. Access Flooring System: Assemblies composed of modular floor panels on pedestals with or without stringers.

E. Performance Requirements
1. Structural Performance: Provide access flooring systems capable of withstanding the following loads and stresses within limits and under conditions indicated, as determined by testing manufacturer's current standard products according to referenced procedures in CISCA A/F, "Recommended Test Procedures for Access Floors":
a. Concentrated Loads: Provide floor panels, including those with cutouts, capable of withstanding a concentrated design load of 1000 lbf (4448 N) **OR** 1250 lbf (5560 N) **OR** 1500 lbf (6672 N) **OR** 2000 lbf (8896 N), **as directed**, with a top-surface deflection under load and a permanent set not to exceed, respectively, 0.10 and 0.010 inch (2.54 and 0.25 mm) **OR** 0.080 inch and 0.010 inch (2.03 and 0.25 mm), **as directed**, according to CISCA A/F, Section I, "Concentrated Loads."
OR
Concentrated Loads: Provide floor panels, including those with cutouts, capable of withstanding a concentrated design load of 1000 lbf (4448 N) **OR** 1250 lbf (5560 N) **OR** 1500 lbf (6672 N) **OR** 2000 lbf (8896 N), **as directed**, with a bottom-surface deflection under load and a permanent set not to exceed, respectively, 0.10 and 0.010 inch (2.54 and 0.25 mm) **OR** 0.13 inch and 0.010 inch (3.30 and 0.25 mm), **as directed**, measured below each applied-load location at horizontal surface of nearest composite beam according to CISCA A/F, Section I, "Concentrated Loads."
b. Ultimate Loads: Provide access flooring systems capable of withstanding a minimum ultimate concentrated load of 2000 lbf (8896 N) **OR** 2500 lbf (11 121 N) **OR** 2600 lbf (11 565 N) **OR** 3000 lbf (13 345 N) **OR** 4000 lbf (17 793 N), **as directed**, without failing, according to CISCA A/F, Section II, "Ultimate Loading."
c. Rolling Loads: Provide access flooring systems capable of withstanding rolling loads of the following magnitude, with a combination of local and overall deformation not to exceed 0.040 inch (1.02 mm) after exposure to rolling load over CISCA A/F Path A or B, whichever path produces the greatest top-surface deformation, according to CISCA A/F, Section III, "Rolling Loads."
1) CISCA A/F Wheel 1 Rolling Load: 600 lbf (2669 N) **OR** 800 lbf (3559 N) **OR** 1000 lbf (4448 N) **OR** 1200 lbf (5338 N), **as directed**.

2) CISCA A/F Wheel 2 Rolling Load: 500 lbf (2224 N) **OR** 600 lbf (2669 N) **OR** 800 lbf (3559 N) **OR** 1000 lbf (4448 N), **as directed**.

d. Stringer Load Testing: Provide stringers, without panels in place, capable of withstanding a concentrated load of 75 lbf (334 N) **OR** 225 lbf (1001 N) **OR** 450 lbf (2002 N) **OR** 850 lbf (3781 N), **as directed**, at center of span with a permanent set not to exceed 0.010 inch (0.25 mm), as determined per CISCA A/F, Section IV, "Stringer Load Testing."

e. Pedestal Axial Load Test: Provide pedestal assemblies, without panels or other supports in place, capable of withstanding a 5000 lbf (22 240 N) **OR** 6000 lbf (26 690 N), **as directed**, axial load per pedestal, according to CISCA A/F, Section V, "Pedestal Axial Load Test."

f. Pedestal Overturning Moment Test: Provide pedestal assemblies, without panels or other supports in place, capable of withstanding an overturning moment per pedestal of 1000 lbf x inches (113 N x meters), according to CISCA A/F, Section VI, "Pedestal Overturning Moment Test."

2. Floor Panel Impact-Load Performance: Provide access flooring system capable of withstanding an impact load of 75 lb (34.0 kg) **OR** 100 lb (45.5 kg) **OR** 125 lb (56.7 kg) **OR** 150 lb (68.0 kg) **OR** 175 lbs (79.4 kg), **as directed**, when dropped from 36 inches (914 mm) onto a 1-sq. in. (6.5-sq. cm) area located anywhere on panel, without failing. Failure is defined as collapse of access flooring system.

3. Seismic Performance: Provide access flooring system capable of withstanding the effects of seismic motions determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."

4. ESD-Control Properties: Provide floor coverings with ESD-control properties indicated as determined by testing identical products per test method indicated by an independent testing and inspecting agency.

a. Static-Dissipative Floor Covering Properties:

1) Electrical Resistance: Test per ASTM F 150 with 100-V applied voltage **OR** ESD STM 7.1, **as directed**.

a) Average greater than 1 megohm and less than or equal to 1000 megohms when test specimens are tested surface to ground.

b) Average no less than 1 megohm and less than or equal to 1000 megohms when installed floor coverings are tested surface to ground.

2) Static Generation: Less than 300 V when tested per AATCC-134 at 20 percent relative humidity with conductive footwear.

3) Static Decay: 5000 to 0 V in less than 0.25 seconds when tested per FED-STD-101C/4046.1.

b. Static-Conductive Floor Covering Properties:

1) Electrical Resistance: Test per ASTM F 150 with 500-V applied voltage **OR** ESD STM 7.1 **OR** NFPA 99, Annex 2 **OR** UL 779, **as directed**.

a) Average greater than 25,000 ohms and less than 1 megohm when test specimens and installed floor coverings are tested surface to surface (point to point).

b) Average no less than 25,000 ohms with no single measurement less than 10,000 ohms when installed floor coverings are tested surface to ground.

2) Static Generation: Less than 100 V when tested per AATCC-134 at 20 percent relative humidity with conductive footwear.

3) Static Decay: 5000 to 0 V in less than 0.03 **OR** 0.01, **as directed**, seconds when tested per FED-STD-101C/4046.1.

c. Antistatic Floor Covering Properties:

1) Electrical Resistance: Test per ESD STM 7.1.

a) Average greater than 25,000 ohms and less than 1,000 megohm when test specimens and installed floor coverings are tested surface to surface (point to point).

2) Static Generation: Less than 100 V when tested per AATCC-134 at 20 percent relative humidity with conductive footwear.

d. Panel-to-Understructure Resistance: Not more than 10 ohms as measured without floor coverings.

F. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Include layout of access flooring system and relationship to adjoining Work based on field-verified dimensions.
3. Shop Drawings: Include layout, details, sections, and relationship to adjoining Work.
4. LEED Submittals:
a. Product Data for Credit EQ 4.1: For pedestal installation adhesive, including printed statement of VOC content.
b. Product Data for Credit EQ 4.3: For carpet and installation adhesive, documentation indicating compliance with specified requirements.
c. Product Data for Credit EQ 4.4: For particleboard used in steel-encapsulated, wood core panels, documentation indicating that particleboard contains no urea formaldehyde.
5. Product test reports.

G. Quality Assurance
1. Regulatory Requirements: Fabricate and install access flooring to comply with NFPA 75 requirements for raised flooring.
2. Preinstallation Conference: Conduct conference at Project site.

1.2 PRODUCTS

A. Floor Panels And Understructure
1. Floor Panels, General: Provide modular panels complying with the following requirements that one person, using a portable lifting device, can interchange with other field panels without disturbing adjacent panels or understructure:
a. Nominal Panel Size: 24 by 24 inches (610 by 610 mm) **OR** 600 by 600 mm, **as directed**.
b. Fabrication Tolerances: Fabricate panels to the following tolerances with squareness tolerances expressed as the difference between diagonal measurements from corner to corner:
1) Size and Squareness: Plus or minus 0.015 inch (0.38 mm) of required size, with a squareness tolerance of plus or minus 0.015 inch (0.38 mm), unless tolerances are otherwise indicated for a specific panel type.
2) Flatness: Plus or minus 0.020 inch (0.50 mm), measured on a diagonal on top of panel.
c. Panel Attachment to Understructure: By gravity.
d. Panel Attachment to Understructure: By bolting to pedestal head. Provide panels with holes drilled in corners to align precisely with threaded holes in pedestal heads and to accept countersunk screws with heads flush with top of panel.
1) Provide fasteners held captive to panels.
2. Steel-Encapsulated, Wood-Core Panels: Fabricated with 1-inch- (25-mm-) thick, particleboard core, made without urea formaldehyde laminated to top and bottom steel face sheets, with metal surfaces protected against corrosion by manufacturer's standard factory-applied finish, and with a flame-spread index of 25 or less per ASTM E 84. Provide core edges enclosed with upturned, die-formed edge of bottom sheet or with perimeter steel channel welded to top sheet and welded or bonded to bottom sheet.
3. Formed-Steel Panels: Fabricated with die-cut flat top sheet and die-formed and stiffened steel bottom pan formed from cold-rolled steel sheet and joined together by resistance welding, with metal surfaces protected against corrosion by manufacturer's standard factory-applied finish to produce units of the following type:
a. Solid Panels: Flat, solid top surface.

b. Perforated Panels: Perforated top surface with holes **OR** slots, **as directed**, of number, spacing, and size standard with manufacturer to produce a nominal open area of 25 percent. Provide mechanical dampers with each panel unit, **as directed**.
   1) Quantity: As directed.
   2) Finish: Manufacturer's standard **OR** To match solid panels, **as directed**.

c. Grates: Grating ribs arranged in manufacturer's standard pattern to produce a nominal open area of 56 percent. Provide mechanical dampers with each panel unit, **as directed**.
   1) Quantity: As directed.
   2) Finish: Manufacturer's standard **OR** To match solid panels, **as directed**.

4. Cementitious-Filled, Formed-Steel Panels: Fabricated with die-cut flat top sheet and die-formed and stiffened bottom pan formed from cold-rolled steel sheet joined together by resistance welding to form an enclosed assembly, with metal surfaces protected against corrosion by manufacturer's standard factory-applied finish. Fully grout internal spaces of completed units with manufacturer's standard cementitious fill.
5. Die-Cast Aluminum Panels: Fabricated from manufacturer's standard aluminum alloy but not less than the strength and corrosion resistance of Alloy UNS No. A03830 or UNS No. A03840 per ASTM B 85, to produce units of the following type and with the following finish:
   a. Solid Panels: Flat, solid surface on top and symmetrical crossing ribs on bottom; edge machined after casting to specified tolerances.
   b. Perforated Panels: Perforated top surface with holes **OR** slots, **as directed**, of number, spacing, and size standard with manufacturer to produce a nominal open area of 25 percent. Provide mechanical dampers with each panel unit, **as directed**.
      1) Quantity: As directed.
      2) Finish: Manufacturer's standard **OR** To match solid panels, **as directed**.
   c. Grates: Grating ribs arranged in manufacturer's standard pattern to produce a nominal open area of 56 percent. Provide mechanical dampers with each panel unit, **as directed**.
      1) Quantity: As directed.
      2) Finish: Manufacturer's standard **OR** To match solid panels, **as directed**.
   d. Epoxy Finish: Epoxy **OR** Conductive epoxy, **as directed**, powder coating with a minimum average thickness of 2.5 mils (0.064 mm) and in color selected from manufacturer's full range.
   e. Plated Finish: Nickel-chrome electrodeposited plating, 0.000005-inch (0.000127-mm) chrome over 0.0008-inch (0.02-mm) nickel, without copper or brass strike, to produce complete coverage over significant surfaces with a matte metallic appearance.
6. Concrete-Filled, Steel Pan Panels: Fabricated with bottom pan die-formed from electrolytic-zinc-coated steel sheet and filled with lightweight concrete that is reinforced and bonded to pan by shear ties.
7. Pedestals: Assembly consisting of base, column with provisions for height adjustment, and head (cap); made of steel **OR** aluminum, **as directed**.
   a. Provide pedestals designed for use in seismic applications.
   b. Base: Square or circular base with not less than 16 sq. in. (103 sq. cm) of bearing area.
   c. Column: Of height required to bring finished floor to elevations indicated. Weld to base plate.
   d. Provide vibration-proof leveling mechanism for making and holding fine adjustments in height over a range of not less than 2 inches (51 mm) and for locking at a selected height, so deliberate action is required to change height setting and vibratory displacement is prevented.
   e. Head: Designed to support understructure system indicated.
      1) Provide sound-deadening pads or gaskets at contact points between heads and panels.
      2) Provide head with four holes aligned with holes in floor panels for bolting of panels to pedestals.
8. Stringer Systems: Modular steel **OR** aluminum, **as directed**, stringer systems made to interlock with pedestal heads and form a grid pattern placing stringers under each edge of each floor panel

and a pedestal under each corner of each floor panel. Protect steel components with manufacturer's standard galvanized or corrosion-resistant paint finish.

a. Bolted Stringers: System of main and cross stringers connected to pedestals with threaded fasteners accessible from above.
b. Snap-on Stringers: System of stringers attached to pedestals with nonbolted interlocking connections to provide a stable understructure and to prevent accidental disengagement.
c. Provide continuous gasket at contact surfaces between panel and stringers to deaden sound, to seal off underfloor cavity from above, and to maintain panel alignment and position.
d. Provide stringers that support each edge of each panel where required to meet design-load criteria.

B. Floor Panel Coverings

1. Provide bare panels without factory-applied floor coverings on traffic surfaces.
2. General: Provide factory-applied floor coverings of type indicated that are laminated by access flooring manufacturer to tops of floor panels including perforated panels, **as directed**.
3. Colors, Textures, and Patterns: As selected from manufacturer's full range.
4. Standard Plastic Laminate: NEMA LD 3, High-Wear type, Grade HWH **OR** HDS, **as directed**; fabricated in one piece to cover each panel face within perimeter plastic **OR** with integral trim serving as, **as directed**, edging.
5. Static-Conductive Plastic Laminate: NEMA LD 3, High-Wear type, Grade CHWH **OR** CHDS, **as directed**, fabricated in one piece to cover each panel face within perimeter plastic edging or with integral trim serving as edging.
6. Solid Vinyl Tile: Static-Conductive **OR** Static-Dissipative, **as directed**, ASTM F 1700, Class I (Monolithic Vinyl Tile), Type A (Smooth Surface), fabricated in one piece to cover panel face within plastic edging.
7. Low-Emissivity, Solid Vinyl Tile: Static-Conductive **OR** Static-Dissipative, **as directed**, ASTM F 1700, Class I (Monolithic Vinyl Tile), Type A (Smooth Surface), with minimum 50 percent reduction in outgasing **OR** total mass loss of 1 percent and minimum 98 percent reduction in collected volatile condensable materials, **as directed**, compared to products with dioctyl phthalate as determined by testing per ASTM E 595.
8. Standard Commercial Carpet: Die cut and adhesively bonded to top surface of panel.
   a. Provide factory-applied carpet with the following characteristics:
      1) Style: Passport.
      2) Fiber Type: 100% BCF nylon.
      3) Pile Characteristics: Level loop.
      4) Pile Thickness: 0.130 inch (3.30 mm).
      5) Stitches: 10.0/inch (10.0/2.54 cm).
      6) Surface Pile Weight: 26 oz./sq. yd. (881 g/sq. m).
      7) Total Weight: 56 oz./sq. yd. (1899 g/sq. m).
      8) Backing: Woven polypropylene.
      9) Critical Radiant Flux Rating: Minimum of 0.45 W/sq. cm per ASTM E 648.
   b. Environmental Requirements: Provide carpet that complies with testing and product requirements of Carpet and Rug Institute's "Green Label Plus" program. Bond carpet to panels with adhesives with VOC content not more than 50g/L when calculated according to 40 CFR 59, Subpart D (EPA method 24).
9. Antistatic Carpet: Antistatic modular carpet tile bonded with conductive adhesive to **OR** with buttons that engage into positioning holes in, **as directed**, top surface of panel.
   a. Provide carpet with the following characteristics:
      1) Style: Classic **OR** Contempo, **as directed**.
      2) Fiber Type: Solutia LXI nylon **OR** Performa SD Type 6 nylon, **as directed**
      3) Pile Characteristics: Textured loop **OR** Textured graphic loop, **as directed**.
      4) Pile Thickness: 0.125 and 0.188 inch (3.18 and 4.78 mm).
      5) Stitches: 11.0/inch (11.0/2.54 cm) **OR** 10.0/inch (10.0/ 2.54 cm), **as directed**.
      6) Surface Pile Weight: 24 oz./sq. yd. (814 g/sq. m).
      7) Total Weight: 148 oz./sq. yd. (5018 g/sq. m).

8) Backing: Static-dissipative, unitary PVC backing with conductive additive.
9) Critical Radiant Flux Rating: Minimum of 0.45 W/sq. cm per ASTM E 648.

b. Environmental Requirements: Provide carpet that complies with testing and product requirements of Carpet and Rug Institute's "Green Label Plus" program. Bond carpet to panels with adhesives with VOC content not more than 50g/L when calculated according to 40 CFR 59, Subpart D (EPA method 24), **as directed**.

10. Edging: Manufacturer's standard applied **OR** integral, **as directed**, edge trim. Provide size and profile of applied edge trim that fits floor coverings selected.
11. Resilient Wall Base: ASTM F 1861, Type TS (rubber, vulcanized thermoset) **OR** TV (vinyl, thermoplastic), **as directed**, Group 1 (solid), Style B (cove), 0.080 inch (2.03 mm) **OR** 0.125 inch (3.18 mm), **as directed**, thick and 2-1/2 inches (63.5 mm) **OR** 4 inches (102 mm) **OR** 6 inches (152 mm), **as directed**, high, with matching end stops and factory-made corner units, **as directed**.

C. Accessories
1. Adhesives: Manufacturer's standard adhesive for bonding pedestal bases to subfloor.
   a. Provide adhesive with a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Post-Installed Anchors: For anchoring pedestal bases to subfloor, provide 2 **OR** 4, **as directed**, post-installed expansion anchors **OR** threaded concrete screws, **as directed**, made from carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (5 microns) for Class SC 1 service condition (mild), with the capability to sustain, without failure, a load equal to 1.5 times the loads imposed by pedestal overturning moment on fasteners, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
3. Cutouts: Provide cutouts in floor panels for cable penetrations and service outlets. Provide reinforcement or additional support, if needed, to make panels with cutouts comply with standard performance requirements.
   a. Number, Size, Shape, and Location: As directed.
   b. Trim edge of cutouts with manufacturer's standard plastic molding.
   c. Fit cutouts with manufacturer's standard grommets in sizes indicated or, if size of cutouts exceeds maximum grommet size available, trim edge of cutouts with manufacturer's standard plastic molding having tapered top flange. Furnish removable covers for grommets, **as directed**.
   d. Provide foam-rubber pads for sealing annular space formed in cutouts by cables.
4. Service Outlets: Standard UL-listed and -labeled assemblies, for recessed mounting flush with top of floor panels, for power, communication, and signal services, and complying with the following requirements:
   a. Structural Performance: Cover capable of supporting a 1000-lbf (4448-N) concentrated load.
   b. Cover and Box Type: Hinged polycarbonate cover with opening for passage of cables when cover is closed and including frame and steel box or formed-steel plate for mounting electrical receptacles.
      OR
      Cover and Box Type: Grommet with twist-close cover and including steel junction box for electrical receptacle with provision for telephone Amphenol connectors and signal cables.
   c. Location: In center of panel quadrant, unless otherwise indicated.
   d. Receptacles and Wiring: Electrical receptacles and wiring for service outlets are specified in Division 15.
      OR
      Receptacles and Wiring: Equip each service outlet with power receptacles to comply with the following requirements:
      1) Type of Receptacle: Heavy-duty duplex, 2-pole, 3-wire grounding, 20 A, 125 V, NEMA WD 6, Configuration 5-20R, unless otherwise indicated.
      2) Number of Receptacles for Outlet: One **OR** Two **OR** Four, **as directed**.

3) Wiring Method: Factory wired for hard wiring in field with armored cable, containing 3 insulated No. 12 AWG solid-copper conductors, terminated with a 6-inch- (152-mm-) long pigtail.
OR
Wiring Method: Power-in connectors, built into outlet housing, of type to fit power-in and power-out connectors of branch-circuit cables supplied with building electrical system.

5. Diffusers: Manufacturer's standard round diffusers, 4 inches (102 mm) **OR** 8 inches (203 mm), **as directed**, in diameter, formed from aluminum **OR** polycarbonate plastic, **as directed**, to produce a removable 1-piece unit complete with diffuser, manually adjustable flow regulator, dirt and dust receptacle, trim ring, and underfloor compression mounting ring; precisely fitted in factory-prepared openings of standard field panels, and complying with the following requirements:
   a. Air-Distribution Characteristics: 100 cfm (47 L/s) at 0.096-inch (24-Pa) static pressure and a maximum noise criterion rating of 15, **as directed**.
   b. Structural Performance: Capable of supporting a 600-lbf (2669-N) concentrated load, **as directed**.
   c. Fire-Test-Response Characteristics: Classified 94V-0 per UL 94.
6. Floor Grilles: Standard load-bearing grilles formed from aluminum **OR** polycarbonate plastic, **as directed**, to produce removable one-piece unit precisely fitted in factory-prepared openings of standard field panels, with adjustable/removable **OR** without, **as directed**, dampers and complying with the following requirements:
   a. Air-Distribution Characteristics: 468 cfm at 0.10-inch wg (221 L/s at 25-Pa) static pressure.
   b. Structural Performance: Capable of supporting a 1000-lbf (4448-N) concentrated load.
   c. Fire-Test-Response Characteristics: Classified 94V-0 per UL 94.
7. Cavity Dividers: Provide manufacturer's standard metal dividers located where indicated to divide underfloor cavities.
8. Vertical Closures (Fasciae): Where underfloor cavity is not enclosed by abutting walls or other construction, provide metal-closure plates with manufacturer's standard finish.
9. Ramps: Manufacturer's standard ramp construction of width and slope indicated but not steeper than 1:12, with raised-disc or textured rubber or vinyl floor coverings, and of same materials, performance, and construction requirements as access flooring.
10. Steps: Provide steps of size and arrangement indicated with floor coverings to match access flooring. Apply nonslip aluminum nosings to treads, unless otherwise indicated.
11. Railings: Standard extruded-aluminum railings, at ramps and open-sided perimeter of access flooring where indicated. Include handrail, intermediate rails, posts, brackets, end caps, wall returns, wall and floor flanges, plates, and anchorages where required.
    a. Provide railings that comply with structural performance requirements specified in Division 05 Section(s) "Pipe And Tube Railings" OR "Ornamental Metal", **as directed**.
12. Panel Lifting Device: Manufacturer's standard portable lifting device of type required for specified panels. Provide one lifting devices per room of each type required.
13. Perimeter Support: Where indicated, provide manufacturer's standard method for supporting panel edge and forming transition between access flooring and adjoining floor coverings at same level as access flooring.

1.3 EXECUTION

A. Preparation
   1. Lay out floor panel installation to keep the number of cut panels at floor perimeter to a minimum. Avoid using panels cut to less than 6 inches (152 mm).
   2. Locate each pedestal, complete any necessary subfloor preparation, and vacuum clean subfloor to remove dust, dirt, and construction debris before beginning installation.

B. Installation

1. Install access flooring system and accessories under supervision of access flooring manufacturer's authorized representative to produce a rigid, firm installation that complies with performance requirements and is free of instability, rocking, rattles, and squeaks.
2. Set pedestals in adhesive as recommended in writing by access flooring manufacturer to provide full bearing of pedestal base on subfloor.
3. Attach pedestals to subfloor by post-installed mechanical anchors.
4. Adjust pedestals to permit top of installed panels to be set flat, level, and to proper height.
5. Secure stringers to pedestal heads according to access flooring manufacturer's written instructions.
6. Install flooring panels securely in place, properly seated with panel edges flush. Do not force panels into place.
   a. Carpeted Panels: Install panels with carpet pile in same direction.
7. Scribe perimeter panels to provide a close fit with adjoining construction with no voids greater than 1/8 inch (3 mm) where panels abut vertical surfaces.
   a. To prevent dusting, seal cut edges of steel-encapsulated, wood-core panels with sealer recommended in writing by panel manufacturer.
8. Cut and trim access flooring and perform other dirt-or-debris-producing activities at a remote location or as required to prevent contamination of subfloor under access flooring already installed.
9. Ground flooring system as recommended by manufacturer and as needed to comply with performance requirements for electrical resistance of floor coverings.
10. Scribe and install underfloor-cavity dividers to closely fit against subfloor surfaces, and seal with mastic.
11. Scribe vertical closures to closely fit against subfloor and adjacent finished-floor surfaces. Set in mastic and seal to maintain plenum effect within underfloor cavity.
12. Clean dust, dirt, and construction debris caused by floor installation, and vacuum subfloor area, as installation of floor panels proceeds.
13. Seal underfloor air cavities at construction seams, penetrations, and perimeter to control air leakage as recommended in writing by manufacturer.
14. Install access flooring without change in elevation between adjacent panels and within the following tolerances:
    a. Plus or minus 1/16 inch (1.5 mm) **OR** 1/8 inch (3 mm), **as directed**, in any 10-foot (3-m) distance.
    b. Plus or minus 1/8 inch (3 mm) **OR** 1/4 inch (6.5 mm), **as directed**, from a level plane over entire access flooring area.

C. Adjusting, Cleaning, And Protection
1. Prohibit traffic on access flooring for 24 hours and removal of floor panels for 72 hours after installation to allow pedestal adhesive to set.
2. After completing installation, vacuum clean access flooring and cover with continuous sheets of reinforced paper or plastic. Maintain protective covering until time of Substantial Completion.
3. Replace access flooring panels that are stained, scratched, or otherwise damaged or that do not comply with specified requirements.

END OF SECTION 10271

Task	Specification	Specification Description
10291	02244a	Termite Control

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SECTION 10292 - ORIENTED FLEXIBLE NETTING BIRD BARRIER

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of oriented flexible netting bird barrier. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

1.2 PRODUCTS

A. Material
1. Polyethylene twine netting attached to pre-installed cable system and steel installation hardware.
2. Netting shall be high density polyethylene knitted into sheets with mesh sizes of 3/4" **OR** 1-1/8" **OR** 2", **as directed.** Polyethylene shall be UV treated, color stable, and flame-retardant.
3. Color shall be selected from manufacturer's standard colors.
4. Installation hardware shall include corner and intermediate attachments, perimeter cable, turnbuckles, ferrules or clamps and net rings.

1.3 EXECUTION

A. Installation
1. Comply with manufacturer's printed instructions.

END OF SECTION 10292

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SECTION 10351 - FLAGPOLES

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for flagpoles. Product shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section includes ground-mounted, wall-mounted, and roof-mounted flagpoles made from aluminum, copper alloy (bronze), fiberglass, stainless steel, and steel.

C. Performance Requirements
1. Structural Performance: Flagpole assemblies, including anchorages and supports, shall withstand the effects of gravity loads, and the following loads and stresses within limits and under conditions indicated according to the following design criteria:
   a. Seismic Loads: <**Insert seismic criteria**> according to SEI/ASCE 7.
   b. Wind Loads: <**Insert wind speed and exposure factor**> according to NAAMM FP 1001, "Guide Specifications for Design of Metal Flagpoles" **OR** SEI/ASCE 7, **as directed**.
   c. Base flagpole design on polyester **OR** nylon or cotton, **as directed**, flags of maximum standard size suitable for use with flagpole or flag size indicated, whichever is more stringent.

D. Submittals
1. Product Data: For each type of product indicated.
2. Delegated-Design Submittal: For flagpole assemblies indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   a. Include loads, point reactions, and locations for attachment of flagpoles to building's structure.
3. Operation and Maintenance Data: For flagpoles to include in operation and maintenance manuals.

E. Delivery, Storage, And Handling
1. General: Spiral wrap flagpoles with heavy paper and enclose in a hard fiber tube or other protective container.

1.2 PRODUCTS

A. Flagpoles
1. Flagpole Construction, General: Construct flagpoles in one piece if possible. If more than one piece is necessary, comply with the following:
   a. Fabricate shop and field joints without using fasteners, screw collars, or lead calking.
   b. Provide flush hairline joints using self-aligning, snug-fitting, internal sleeves.
      OR
      Provide self-aligning, snug-fitting joints.
2. Exposed Height: 20 feet (6 m) **OR** 25 feet (7.5 m) **OR** 30 feet (9 m) **OR** 35 feet (11 m) **OR** 40 feet (12 m) **OR** 45 feet (13.5 m) **OR** 50 feet (15 m) **OR** 60 feet (18 m) **OR** 70 feet (21 m) **OR** 80 feet (24 m), **as directed**.

3. Aluminum Flagpoles: Provide cone **OR** entasis, **as directed**,-tapered flagpoles fabricated from seamless extruded tubing complying with ASTM B 241/B 241M, Alloy 6063, with a minimum wall thickness of 3/16 inch (4.8 mm).
4. Copper-Alloy (Bronze) Flagpoles: Provide cone **OR** entasis, **as directed**,-tapered flagpoles fabricated from seamless pipe or tube complying with ASTM B 43 or ASTM B 135 (ASTM B 135M), Alloy UNS C23000 (red brass, 85 percent copper).
5. Fiberglass Flagpoles: Provide cone **OR** entasis, **as directed**,-tapered flagpoles fabricated from polyester resin reinforced with woven glass-fiber roving with 75 percent of glass fibers parallel to length of flagpole.
6. Stainless-Steel Flagpoles: Provide cone **OR** entasis, **as directed**,-tapered flagpoles fabricated from pipe, tube, or plate complying with ASTM A 312/A 312M, ASTM A 269, or ASTM A 666, Alloy UNS S30400 **OR** Alloy UNS S31603, **as directed**.
7. Steel Flagpoles: Provide cone-tapered **OR** stepped-sectional, **as directed**, flagpoles fabricated from standard-weight, seamless steel pipe complying with ASTM A 53/A 53M, Type S, Grade B or steel tube complying with ASTM A 513.
8. Metal Foundation Tube: Manufacturer's standard corrugated-steel foundation tube, not less than 0.064-inch- (1.6-mm-) nominal wall thickness. Provide with 3/16-inch (4.8-mm) steel bottom plate and support plate; 3/4-inch- (19-mm-) diameter, steel ground spike; and steel centering wedges welded together. Galvanize steel after assembly. Provide loose hardwood wedges at top of foundation tube for plumbing pole.
   a. Provide flashing collar of same material and finish as flagpole.
   b. Provide steel ground protectors extending 12 inches (300 mm) aboveground and 6 inches (150 mm) belowground for steel flagpoles where flashing collars are not provided.
9. Sleeve for Fiberglass **OR** Aluminum, **as directed**, Flagpole: Fiberglass or PVC pipe foundation sleeve, made to fit flagpole, for casting into concrete foundation.
   a. Provide flashing collar of same material and finish as flagpole.
10. Cast-Metal Shoe Base: For anchor-bolt mounting; provide with anchor bolts.
   a. Provide units made from aluminum **OR** steel, **as directed**, with same finish and color as flagpoles.
   b. Provide ground spike at grade-mounted flagpoles for metal flagpoles or fiberglass flagpoles with metal halyards.
   c. Provide connector to building's lightning protection system conductor at roof-mounted flagpoles for metal flagpoles or fiberglass flagpoles with metal halyards.
11. Hinged Baseplate: Cast-metal tilting hinged base and anchored plate joined by permanently secured pivot rod for aluminum and fiberglass flagpoles 30 to 40 feet (9 to 12 m) or less in height. Provide with stainless-steel screws for securing tilting base to anchored plate when not tilted; provide with anchor bolts.
   a. Finish base to match flagpole.
   b. Provide aluminum base or aluminum flashing collar finished to match flagpole.
   c. Provide ground spike at grade-mounted flagpoles for metal flagpoles or fiberglass flagpoles with metal halyards.
   d. Provide connector to building's lightning protection system conductor at roof-mounted metal flagpoles for metal flagpoles or fiberglass flagpoles with metal halyards.
12. Pivoting Tilt Base: Steel baseplate with channel or rectangular tube uprights, pivot bolt, and locking device for tilting flagpole. Provide tilting flagpole with steel counterweight box and weights, or provide with internal counterweight. Provide base with anchor bolts.
   a. Finish base to match flagpole.
   b. Provide ground spike at grade-mounted flagpoles.
      OR
      Provide connector to building's lightning protection system conductor at roof-mounted metal flagpoles.
13. Vertical Wall Mount: Cast-aluminum **OR** Cast-copper-alloy (bronze), **as directed**, mounting bracket complete with escutcheon, **as directed**, mounting plate and through-wall anchorage.
   a. Provide units with same finish as flagpole for copper-alloy (bronze) or aluminum units.

b. Provide units with gold anodic **OR** bronze powder-coated **OR** black powder-coated, **as directed**, finish for aluminum units.

14. Outrigger Wall Mount: Aluminum **OR** Copper-alloy (bronze), **as directed**, mounting bracket complete with escutcheon, **as directed**, mounting plate and through-wall anchorage.
    a. Provide units with same finish as flagpole for copper-alloy (bronze) or aluminum units.
    b. Provide units with gold anodic **OR** bronze powder-coated **OR** black powder-coated, **as directed**, finish for aluminum units.
15. Braced Roof Mount: Roof-mounted flagpole socket and either rod or tubular braces with turnbuckles and mounting bases. Provide as a complete assembly with anchor bolts and connector for lightning protection system.
    a. Provide braces, turnbuckles, and connectors made from same metal and with same finish as flagpoles.

B. Fittings
1. Finial Ball: Manufacturer's standard flush-seam ball, sized as indicated or, if not indicated, to match flagpole-butt diameter.
    a. 0.063-inch (1.6-mm) spun aluminum, finished to match flagpole **OR** with gold anodic finish, **as directed**.
    b. 20-oz. (0.70-mm) copper with 23-karat gold leaf finish.
    c. Spun stainless steel, finished to match flagpole.
    d. Spun copper alloy, finished to match flagpole.
2. Finial Eagle: Manufacturer's standard, sized as indicated **OR** as standard with manufacturer for flagpole size indicated, **as directed**.
    a. Cast aluminum, finished to match flagpole **OR** with gold anodic finish, **as directed**.
       OR
       20-oz. (0.70-mm) copper with 23-karat gold leaf finish.
3. Internal Halyard, Winch System: Manually operated winch with control stop device and removable handle, stainless-steel cable halyard, and concealed revolving truck assembly with plastic-coated counterweight and sling. Provide flush access door secured with cylinder lock. Finish truck assembly to match flagpole.
    a. Halyard Flag Snaps: Provide two chromium-plated bronze **OR** stainless-steel **OR** bronze **OR** nylon, **as directed**, swivel snap hooks per halyard.
       1) Provide with neoprene or vinyl covers.
    b. Plastic Halyard Flag Clips: Made from injection-molded, UV-stabilized, acetal resin (Delrin). Clips attach to flag and have two eyes for inserting both runs of halyards. Provide two flag clips per halyard.
4. Internal Halyard, Cam Cleat System (for flagpoles 40 feet (12 m) or less in height): 5/16-inch- (8-mm-) diameter, braided polypropylene halyard; cam cleat; and concealed revolving truck assembly with plastic-coated counterweight and sling. Provide flush access door secured with cylinder lock. Finish truck assembly to match flagpole.
    a. Halyard Flag Snaps: Provide two chromium-plated bronze **OR** stainless-steel **OR** bronze **OR** nylon, **as directed**, swivel snap hooks per halyard.
       1) Provide with neoprene or vinyl covers.
    b. Plastic Halyard Flag Clips: Made from injection-molded, UV-stabilized, acetal resin (Delrin). Clips attach to flag and have two eyes for inserting both runs of halyards. Provide two flag clips per halyard.
5. External Halyard: Ball-bearing, nonfouling, revolving truck assembly of cast metal with continuous 5/16-inch- (8-mm-) diameter, braided polypropylene halyard and 9-inch (228-mm) cast-metal cleats with fasteners. Finish exposed metal surfaces to match flagpole.
    a. Provide one halyard and one cleat **OR** two halyards and two cleats, **as directed**, at each flagpole.
    b. Provide cast-metal cleat covers, finished to match flagpole, secured with cylinder locks.
    c. Provide halyard covers consisting of a 2-inch (50-mm) channel, 60 inches (1500 mm) long, finished to match flagpole.
    d. Halyard Flag Snaps: Provide two chromium-plated bronze **OR** stainless-steel **OR** bronze **OR** nylon, **as directed**, swivel snap hooks per halyard.

1) Provide with neoprene or vinyl covers.

e. Plastic Halyard Flag Clips: Made from injection-molded, UV-stabilized, acetal resin (Delrin). Clips attach to flag and have two eyes for inserting both runs of halyards. Provide two flag clips per halyard.

C. Miscellaneous Materials

1. Nonshrink, Nonmetallic Grout (for baseplate-mounted flagpoles): Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107.
2. Drainage Material (for ground-set flagpoles with foundations): Crushed stone, or crushed or uncrushed gravel; coarse aggregate.
3. Sand (for ground-set, foundation-tube-mounted flagpoles): ASTM C 33, fine aggregate.
4. Elastomeric Joint Sealant (for ground-set, foundation-tube-mounted flagpoles): Multicomponent nonsag urethane **OR** Single-component nonsag urethane **OR** Single-component neutral- and basic-curing silicone **OR** Single-component neutral-curing silicone, **as directed**, joint sealant complying with requirements in Division 07 Section "Joint Sealants" for Use NT (nontraffic) and for Use M, G, A, and, as applicable to joint substrates indicated, for Use O.
5. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

D. General Finish Requirements

1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

E. Aluminum Finishes

1. Natural Satin Finish: AA-M32, fine, directional, medium satin polish; buff complying with AA-M20; seal aluminum surfaces with clear, hard-coat wax.
2. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
3. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
   a. Color: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black, **as directed**.
   b. Color: Match sample **OR** As selected from full range of industry colors and color densities, **as directed**.
4. Gold Anodic Finish: AAMA 611, AA-M32C22A43 Class I, 0.018 mm or thicker; gold color.
5. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
6. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 **OR** AAMA 2605, **as directed**, and containing not less than 50 **OR** 70, **as directed**, percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   a. Color and Gloss: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.

F. Steel Finishes

1. Flagpole Interior Finish: Apply one coat of bituminous paint on interior of flagpole or otherwise treat to prevent corrosion.
2. Galvanized Finish: Hot-dip galvanize after fabrication to comply with ASTM A 123/A 123M.
3. Surface Preparation: Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning" **OR** SSPC-SP 8, "Pickling," **as**

directed. After cleaning, apply a conversion coating suited to the organic coating to be applied over it, **as directed**.

4. Polyurethane Enamel Finish: Immediately after cleaning, apply manufacturer's standard primer and two-coat, high-gloss, high-build polyurethane-enamel finish.
   a. Color: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.
5. Baked-Enamel or Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils (0.05 mm).
   a. Color and Gloss: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.

G. Stainless-Steel Finishes
1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
   a. Run grain of directional finishes with long dimension of each piece.
   b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
   c. Directional Satin Finish: No. 4.

H. Copper-Alloy Finishes
1. Buffed Finish, Lacquered: M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear organic, air drying, as specified below).
   a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
2. Medium Satin Finish, Lacquered: M32-O6x (Mechanical Finish: medium satin; Coating: clear organic, air drying, as specified below).
   a. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of 1 mil (0.025 mm).
3. Statuary Conversion Coating over Satin Finish: M31-C55 (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide).
   a. Color: Match sample.

I. Fiberglass Finishes
1. Fiberglass: UV-light stable, hard, high-gloss gel coat or high-gloss, high-build polyurethane or polyester coating.
   a. Color: As indicated by manufacturer's designations **OR** Match sample **OR** As selected from manufacturer's full range, **as directed**.

1.3 EXECUTION

A. Preparation
1. Prepare uncoated metal flagpoles that are set in foundation tubes by painting below-grade portions with a heavy coat of bituminous paint.
2. Foundation Excavation: Excavate to neat clean lines in undisturbed soil. Remove loose soil and foreign matter from excavation and moisten earth before placing concrete. Place and compact drainage material at excavation bottom.
3. Provide forms where required due to unstable soil conditions and for perimeter of flagpole base at grade. Secure and brace forms to prevent displacement during concreting.
4. Place concrete, as specified in Division 03 Section "Cast-in-place Concrete". Compact concrete in place by using vibrators. Moist-cure exposed concrete for not less than seven days or use nonstaining curing compound.

5. Trowel exposed concrete surfaces to a smooth, dense finish, free of trowel marks, and uniform in texture and appearance. Provide positive slope for water runoff to perimeter of concrete base.

B. Flagpole Installation
   1. General: Install flagpoles where shown and according to Shop Drawings and manufacturer's written instructions.
   2. Ground Set: Place foundation tube, sleeve, center, and brace to prevent displacement during concreting. Place concrete. Plumb and level foundation tube **OR** sleeve, **as directed**, and allow concrete to cure. Install flagpole, plumb, in foundation tube **OR** sleeve, **as directed**.
      a. Foundation Tube: Place tube seated on bottom plate between steel centering wedges and install hardwood wedges to secure flagpole in place. Place and compact sand in foundation tube and remove hardwood wedges. Seal top of foundation tube with a 2-inch (50-mm) layer of elastomeric joint sealant and cover with flashing collar.
   3. Baseplate: Cast anchor bolts in concrete foundation. Install baseplate on washers placed over leveling nuts on anchor bolts and adjust until flagpole is plumb. After flagpole is plumb, tighten retaining nuts and fill space under baseplate solidly with nonshrink, nonmetallic grout. Finish exposed grout surfaces smooth and slope 45 degrees away from edges of baseplate.
   4. Mounting Brackets and Bases: Anchor brackets and bases securely through to structural support with fasteners as indicated on Shop Drawings.

END OF SECTION 10351

Task	Specification	Specification Description
10351	01352	No Specification Required
10410	10110	Visual Display Surfaces
10431	01352	No Specification Required
10501	01352	No Specification Required
10502	01352	No Specification Required

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SECTION 10503 - METAL LOCKERS

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for metal lockers. Product shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. Standard metal lockers.
   b. Heavy-duty metal lockers.
   c. Athletic metal lockers.
   d. Open-front athletic metal lockers.
   e. Coin-operated metal lockers.
   f. Locker benches.

C. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: For metal lockers. Include plans, elevations, sections, details, and attachments to other work.
3. Samples: For units with factory-applied color finishes.
4. Maintenance data.
5. Warranty: Sample of special warranty.

D. Quality Assurance
1. Regulatory Requirements: Where metal lockers and benches are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities" and ICC/ANSI A117.1.

E. Preinstallation Conference: Conduct conference at Project site.
1. Delivery, Storage, And Handling
2. Do not deliver metal lockers until spaces to receive them are clean, dry, and ready for their installation.
3. Deliver master and control keys **OR** combination control charts, **as directed**, to Owner by registered mail or overnight package service.

F. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal lockers that fail in materials or workmanship, excluding finish, within specified warranty period.
   a. Warranty Period for Knocked-Down Metal Lockers: Two years from date of Substantial Completion.
   b. Warranty Period for All-Welded Metal Lockers: Lifetime **OR** 10 years, **as directed**, from date of Substantial Completion.

1.2 PRODUCTS

A. Materials

1. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
2. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with A60 (ZF180) zinc-iron, alloy (galvannealed) coating designation.
3. Expanded Metal: ASTM F 1267, Type II (flattened), Class I, 3/4-inch (19-mm) steel mesh, with at least 70 percent open area.
4. Stainless-Steel Sheet: ASTM A 666, Type 304.
5. Plastic Laminate: NEMA LD 3, Grade HGP.
6. Extruded Aluminum: ASTM B 221 (ASTM B 221M), alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated.
7. Steel Tube: ASTM A 500, cold rolled.
8. Particleboard: ANSI A208.1, Grade M-2.
9. Fasteners: Zinc- or nickel-plated steel, slotless-type, exposed bolt heads; with self-locking nuts or lock washers for nuts on moving parts.
10. Anchors: Material, type, and size required for secure anchorage to each substrate.
    a. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls, and elsewhere as indicated, for corrosion resistance.
    b. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

B. Standard Metal Lockers
1. Locker Arrangement: Single tier **OR** Double tier **OR** Triple tier **OR** Box **OR** Two person **OR** Duplex **OR** 16 person **OR** As indicated on Drawings, **as directed**.
2. Material: Cold-rolled **OR** Metallic-coated, **as directed**, steel sheet.
3. Body: Assembled by riveting or bolting body components together. Fabricate from unperforated steel sheet as follows:
    a. Tops, Bottoms, and Intermediate Dividers: 0.024-inch (0.61-mm) nominal thickness, with single bend at sides.
    b. Backs and Sides: 0.024-inch (0.61-mm) nominal thickness, with full-height, double-flanged connections.
    c. Shelves: 0.024-inch (0.61-mm) nominal thickness, with double bend at front and single bend at sides and back.
4. Frames: Channel formed; fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames. Form continuous, integral door strike full height on vertical main frames.
    a. Cross Frames between Tiers: Channel formed and fabricated from same material as main frames; welded to vertical main frames.
    b. Frame Vents: Fabricate face frames with vents.
5. Doors: One piece; fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet; formed into channel shape with double bend at vertical edges and with right-angle single bend at horizontal edges.
    a. Doors less than 12 inches (305 mm) wide may be fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.
    b. Doors for box lockers less than 15 inches (381 mm) wide may be fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.
    c. Reinforcement: Manufacturer's standard reinforcing angles, channels, or stiffeners for doors more than 15 inches (381 mm) wide; welded to inner face of doors.
    d. Stiffeners: Manufacturer's standard full-height stiffener fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet; welded to inner face of doors.
    e. Sound-Dampening Panels: Manufacturer's standard, designed to stiffen doors and reduce sound levels when doors are closed, of die-formed metal with full perimeter flange and sound-dampening material; welded to inner face of doors.
    f. Door Style: Unperforated panel. **OR** Vented panel as follows:, **as directed**,
        1) Louvered Vents: No fewer than six louver openings at top and bottom for single-tier **OR** three louver openings at top and bottom for double-tier **OR** two louver openings

at top and bottom, or three louver openings at top or bottom, for triple-tier, **as directed**, lockers.
2) Security Vents: Manufacturer's standard, stamped horizontal or vertical.
3) Perforated Vents: Manufacturer's standard shape and configuration.
4) Concealed Vents: Slotted perforations in top and bottom horizontal return flanges of doors.

6. Hinges: Welded to door and attached to door frame with no fewer than two factory-installed rivets per hinge that are completely concealed and tamper resistant when door is closed; fabricated to swing 180 degrees; self-closing, **as directed**.
   a. Knuckle Hinges: Steel, full loop, five or seven knuckles, tight pin; minimum 2 inches (51 mm) high. Provide no fewer than three hinges for each door more than 42 inches (1067 mm) high.
   b. Continuous Hinges: Manufacturer's standard, steel, full height.
7. Projecting Door Handle and Latch: Finger-lift latch control designed for use with either built-in combination locks or padlocks; positive automatic latching, chromium plated; pry and vandal resistant.
   a. Latch Hooks: Equip doors 48 inches (1219 mm) and higher with three latch hooks and doors less than 48 inches (1219 mm) high with two latch hooks; fabricated from 0.105-inch (2.66-mm) nominal-thickness steel sheet; welded or riveted to full-height door strikes; with resilient silencer on each latch hook.
   b. Latching Mechanism: Manufacturer's standard, rattle-free latching mechanism and moving components isolated to prevent metal-to-metal contact, and incorporating a prelocking device that allows locker door to be locked while door is open and then closed without unlocking or damaging lock or latching mechanism.
8. Recessed Door Handle and Latch: Stainless-steel cup with integral door pull, recessed so locking device does not protrude beyond face of door; pry and vandal resistant.
   a. Multipoint Latching: Finger-lift latch control designed for use with built-in combination locks, built-in key locks, or padlocks; positive automatic latching and prelocking.
      1) Latch Hooks: Equip doors 48 inches (1219 mm) and higher with three latch hooks and doors less than 48 inches (1219 mm) high with two latch hooks; fabricated from 0.105-inch (2.66-mm) nominal-thickness steel sheet; welded or riveted to full-height door strikes; with resilient silencer on each latch hook.
      2) Latching Mechanism: Manufacturer's standard, rattle-free latching mechanism and moving components isolated with vinyl or nylon to prevent metal-to-metal contact, and incorporating a prelocking device that allows locker door to be locked while door is open and then closed without unlocking or damaging lock or latching mechanism.
   b. Single-Point Latching: Nonmoving latch hook designed to engage bolt of built-in combination or cylinder lock **OR** with steel padlock loop that projects through recessed cup and is finished to match metal locker body, **as directed**.
      1) Latch Hook: Equip each door with one latch hook, fabricated from 0.105-inch (2.66-mm) nominal-thickness steel sheet; welded midway up full-height door strike; with resilient silencer.
9. Door Handle and Latch for Box **OR** 16-Person, **as directed**, Lockers: Stainless-steel strike plate with integral pull; with steel padlock loop that projects through metal locker door.
10. Combination Padlocks: Key-controlled, three-number dialing combination locks; capable of five combination changes **OR** Provided by Owner, **as directed**.
11. Built-in Combination Locks: Key-controlled, three-number dialing combination locks; capable of at least five combination changes made automatically with a control key.
    a. Bolt Operation: Manually locking deadbolt **OR** automatically locking spring bolt, **as directed**.
12. Cylinder Locks: Built-in, flush, cam locks with five-pin tumbler keyway, keyed separately and master keyed. Furnish two change keys for each lock and two, **as directed**, master keys.
    a. Key Type: Flat **OR** Grooved, **as directed**, with minimum 2- by 2.68-inch (51- by 68.3-mm) key head for accessible lockers, **as directed**.
    b. Bolt Operation: Manually locking deadbolt **OR** automatically locking spring bolt, **as directed**.