Building knowledge

Job Order Contract Technical Specifications

Book 1 of 5 CSI Divisions 01 - 07 November 2018

Los Angeles Community Development Center

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SECTION 01 22 16 00 - 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 01 22 16 00

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Task	Specification	Specification Description
01 22 20 00	01 22 16 00	No Specification Required
01 22 23 00	01 22 16 00	No Specification Required

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SECTION 01 52 13 00 - 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, the Owner's construction forces, the Owner, occupants of Project, testing agencies, and authorities having jurisdiction.
2. Water Service: Water from the 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 the 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 the Owner's acceptance, regardless of previously assigned responsibilities.

1.2 PRODUCTS

A. Materials
1. Pavement: Comply with Division 32 Section(s) "Asphalt Paving" OR "Concrete Paving", **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 Rough 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 the 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 the 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, the 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 the Owner's existing water service facilities will be permitted, as long as facilities are cleaned and maintained in a condition acceptable to the Owner. At Final 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 the Owner's existing toilet facilities will be permitted, as long as facilities are cleaned and maintained in a condition acceptable to the Owner. At Final 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 the Owner's existing electric power service will be permitted, as long as equipment is maintained in a condition acceptable to the 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 the Owner's existing power source, as directed by the 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) the 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 Final Completion. Remove before Final Completion. Personnel remaining after Final Completion will be permitted to use permanent facilities, under conditions acceptable to the 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 31 Section "Earth Moving".
   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 Final Completion. Repair hot-mix asphalt base-course pavement before installation of final course according to Division 32 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 the 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 the Owner's existing elevators will be permitted, as long as elevators are cleaned and maintained in a condition acceptable to the Owner. At Final 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 the Owner's existing stairs will be permitted, as long as stairs are cleaned and maintained in a condition acceptable to the Owner. At Final 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 Final Completion. Obtain extended warranty for the 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 the 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 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 the 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 Final 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 Final 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. the 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 Final Completion, clean and renovate permanent facilities used during construction period. Comply with final cleaning requirements specified in General Requirements

END OF SECTION 01 52 13 00

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Task	Specification	Specification Description
01 52 13 00	01 22 16 00	No Specification Required
01 52 19 00	01 22 16 00	No Specification Required
01 52 19 00	01 52 13 00	Temporary Facilities and Controls

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SECTION 01 54 23 00 - 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 01 54 23 00

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SECTION 01 54 23 00a - 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** Tables 2105.2 in the International Building Code, **as directed**.
OR
Determine net-area compressive strength (f'_m) of masonry by testing masonry prisms according to ASTM C 1314 **OR** IBC Standard, **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: Engage a qualified independent testing agency to perform preconstruction testing indicated below.
   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** IBC Standard, **as directed**.
   d. Grout Test (Compressive Strength): For each mix required, per ASTM C 1019 **OR** IBC Standard, **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 International 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** IBC Standard, **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** IBC Standard, **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** IBC Standard, **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** IBC Standard, **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** IBC Standard, **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** IBC Standard, **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** IBC Standard, **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** IBC Standard, **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** IBC Standard, **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** IBC , **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** IBC Standard, **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** IBC Standard, **as directed**.
5. Mortar Cement: ASTM C 1329 **OR** IBC Standard, **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** IBC Standard, **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** IBC Standard, **as directed,** Proportion Specification.
4. Mortar for Unit Masonry: Comply with ASTM C 270 **OR** BIA Technical Notes 8A **OR** IBC Standard, **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** IBC Standard, **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 International 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 International 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 International 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: 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: Engage a qualified independent testing and inspecting agency to perform field tests and inspections indicated below and prepare test reports:
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** IBC Standard, **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** IBC Standard, **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 the Owner's property.

END OF SECTION 01 54 23 00a

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Task	Specification	Specification Description
01 54 23 00	01 22 16 00	No Specification Required
01 54 26 00	01 22 16 00	No Specification Required
01 54 29 00	01 22 16 00	No Specification Required
01 55 23 00	01 22 16 00	No Specification Required
01 55 26 00	01 22 16 00	No Specification Required
01 56 16 00	01 22 16 00	No Specification Required

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SECTION 01 56 26 00 - SEDIMENT REMOVAL

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing of labor and equipment for sediment removal.

1.2 PRODUCTS - (Not Used)

1.3 EXECUTION

A. The Contractor shall remove all material from areas as required to meet project requirements. Water and sediment removed from these areas shall be discharged to a sedimentation basin constructed and maintained by the Contractor. All work shall be in strict compliance with Pollution Control requirements and Dewatering requirements. All material removed shall be disposed of in an approved landfill in accordance with all State and Federal Regulations.

END OF SECTION 01 56 26 00

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SECTION 01 56 26 00a - 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 01 56 26 00a

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Task	Specification	Specification Description
01 56 26 00	01 22 16 00	No Specification Required
01 56 29 00	01 22 16 00	No Specification Required
01 56 33 00	01 22 16 00	No Specification Required
01 56 39 00	01 22 16 00	No Specification Required
01 57 13 00	01 56 26 00	Sediment Removal

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SECTION 01 58 13 00 - SIGNAGE

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for signage. 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. Plaques.
b. Dimensional illuminated and non-illuminated characters.
c. Panel signs.
d. Illuminated panel signs.
e. Photoluminescent markings and signs.

C. Definitions
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. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Show fabrication and installation details for signs.
a. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.
b. Provide message list, typestyles, graphic elements, including tactile characters and Braille, and layout for each sign.
c. Wiring Diagrams: Power, signal, and control wiring.
3. Samples: For each sign type and for each color and texture required.

E. Quality Assurance
1. Regulatory Requirements: Comply with applicable provisions in ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.
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. Provide exit signs in accordance with NFPA 101, Building Code, and Fire Code.
4. Comply with National Fire Protection Association (NFPA) 101 - Life Safety Code.
5. Comply with Underwriters Laboratories, Inc. (UL) - 924 - Standard for Emergency Lighting and Power Equipment.

F. Field Quality Control
1. With room light fixtures illuminated, measure amount of illumination on face of each exit sign using handheld light meter.
2. Ensure that each location has minimum of 5 foot-candles of illumination.

G. Warranty
1. Manufacturer's standard form in which manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within Five years from date of Final Completion.

1.2 PRODUCTS

A. Materials
1. Aluminum Castings: ASTM B 26/B 26M, of alloy and temper recommended by sign manufacturer for casting process used and for use and finish indicated.
2. Aluminum Sheet and Plate: ASTM B 209 (ASTM B 209M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with at least the strength and durability properties of Alloy 5005-H32.
3. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with at least the strength and durability properties of Alloy 6063-T5.
4. Brass Castings: ASTM B 584, Alloy UNS No. C85200 (high-copper yellow brass).
5. Brass, Yellow, Sheet: ASTM B 36/B 36M, Alloy UNS No. C26000.
6. Bronze Castings: ASTM B 584, Alloy UNS No. C86500 (No. 1 manganese bronze).
7. Bronze Plate: ASTM B 36/B 36M.
8. Copper Sheet: ASTM B 152/B 152M.
9. Steel:
    a. Galvanized Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating, either commercial or forming steel.
    b. Steel Sheet: Uncoated, cold-rolled, ASTM A 1008/A 1008M, commercial steel, Type B, exposed **OR** Electrolytic zinc-coated, ASTM A 591/A 591M, with steel sheet substrate complying with ASTM A 1008/A 1008M, commercial steel, exposed, **as directed**.
    c. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304 **OR** 316, **as directed**, stretcher-leveled standard of flatness.
    d. Steel Members Fabricated from Plate or Bar Stock: ASTM A 529/A 529M or ASTM A 572/A 572M, 42,000-psi (290-MPa) minimum yield strength.
    e. For steel exposed to view on completion, provide materials having flat, smooth surfaces without blemishes. Do not use materials whose surfaces exhibit pitting, seam marks, roller marks, rolled trade names, or roughness.
10. Fiberglass Sheet: Molded, seamless, thermosetting, glass-fiber-reinforced polyester panels with a minimum tensile strength of 15,000 psi (103 MPa) when tested according to ASTM D 638 and with a minimum flexural strength of 30,000 psi (207 MPa) when tested according to ASTM D 790.
11. Acrylic Sheet: ASTM D 4802, Category A-1 (cell-cast sheet), Type UVA (UV absorbing).
12. Polycarbonate Sheet: Of thickness indicated, manufactured by extrusion process, coated on both surfaces with abrasion-resistant coating:
    a. Impact Resistance: 16 ft-lbf/in. (854 J/m) per ASTM D 256, Method A.
    b. Tensile Strength: 9000 lbf/sq. in. (62 MPa) per ASTM D 638.
    c. Flexural Modulus of Elasticity: 340,000 lbf/sq. in. (2345 MPa) per ASTM D 790.
    d. Heat Deflection: 265 deg F (129 deg C) at 264 lbf/sq. in. (1.82 MPa) per ASTM D 648.
    e. Abrasion Resistance: 1.5 percent maximum haze increase for 100 revolutions of a Taber abraser with a load of 500 g per ASTM D 1044.
13. Applied Vinyl: Die-cut characters from vinyl film of nominal thickness of 3 mils (0.076 mm) with pressure-sensitive adhesive backing, suitable for exterior applications.

B. Plaques
1. Cast Plaques: Provide castings free of pits, scale, sand holes, and other defects, as follows:
    a. Plaque Material: Aluminum **OR** Bronze, **as directed**.
    b. Background Texture: Manufacturer's standard pebble **OR** leatherette **OR** matte **OR** stipple, **as directed**, texture.
    c. Border Style: Square, polished **OR** Plain bevel **OR** Projected bevel **OR** Raised flat band **OR** Double-raised line border, **as directed**.
    d. Mounting: Rosettes and fasteners matching plaque finish **OR** Concealed studs, **as directed**, noncorroding, **as directed**, for substrates encountered.
2. Etched Plaques: Provide metal sheet or plate for etching, as follows:
    a. Plaque Material: Aluminum **OR** Brass **OR** Bronze, **as directed**.

b. Custom Paint Colors: Match Pantone, **as directed**, color matching system.
c. Color(s): As indicated **OR** As selected from manufacturer's full range, **as directed**.
d. Edge Style: Square, polished **OR** Plain bevel, **as directed**.
e. Mounting: Concealed studs **OR** Exposed fasteners, **as directed**, noncorroding, **as directed**, for substrates encountered.
f. Thickness: 0.125 inch (3.18 mm) **OR** 0.250 inch (6.35 mm), **as directed**, thick.

C. Dimensional Characters
1. Cast Characters: Produce characters with smooth flat faces, sharp corners, and precisely formed lines and profiles, free of pits, scale, sand holes, and other defects. Cast lugs into back of characters and tap to receive threaded mounting studs. Alloy and temper recommended by sign manufacturer for casting process used and for use and finish indicated. Comply with the following requirements.
a. Character Material: Aluminum **OR** Brass **OR** Bronze, **as directed**.
b. Thickness: As indicated.
c. Color(s): As indicated **OR** As selected from manufacturer's full range, **as directed**.
d. Mounting: Rosettes and fasteners matching character finish **OR** Concealed studs, **as directed**, noncorroding, **as directed**, for substrates encountered.
2. Aluminum Extrusions: Comply with the following requirements:
a. Finish: Anodized **OR** Painted, **as directed**.
b. Thickness: As indicated.
c. Custom Paint Colors: Match Pantone, **as directed**, color matching system.
d. Color(s): As indicated **OR** As selected from manufacturer's full range, **as directed**.
e. Mounting: Concealed studs, noncorroding, **as directed**, for substrates encountered.
3. Fabricated Channel Characters: Form exposed faces and sides of characters to produce surfaces free from warp and distortion. Include internal bracing for stability and attachment of mounting accessories. Comply with the following requirements:
a. Illuminated Backlighted **OR** Frontlighted, **as directed**, Channel Characters: Manufacturer's standard fluorescent tube **OR** fiber-optic **OR** LED **OR** neon tube, **as directed**, lighting including transformers, insulators, and other components. Make provisions for servicing and concealing connections to building electrical system.
b. Aluminum Sheet: Not less than 0.090 inch (2.29 mm) thick.
1) Finish: Anodized **OR** Painted, **as directed**.
2) Custom Paint Colors: Match Pantone, **as directed**, color matching system.
3) Color: As indicated **OR** As selected from manufacturer's full range, **as directed**.
c. Bronze Sheet: Not less than 0.032 inch (0.81 mm) thick.
d. Brass Sheet: Not less than 0.032 inch (0.81 mm) thick.
e. Copper Sheet: Not less than 0.032 inch (0.81 mm) **OR** 0.048 inch (1.22 mm), **as directed**, thick.
f. Steel Sheet: Painted, not less than 0.050 inch (1.27 mm) thick for face and 0.031 inch (0.78 mm) thick for returns.
1) Color: As indicated **OR** As selected from manufacturer's full range, **as directed**.
g. Stainless-Steel Sheet: Not less than 0.050 inch (1.27 mm) thick for face and 0.031 inch (0.78 mm) thick for returns.
1) Finish: No. 4 **OR** No. 8, **as directed**.
h. Provide manufacturer's hardware for projection mounting of backlighted, **as directed**, channel characters at distance from wall surface indicated.
i. Provide translucent acrylic face sheet of thickness indicated. Attach characters to sheet metal back channels. Provide required to illuminate sign faces evenly.
1) Color: As indicated **OR** As selected from manufacturer's full range, **as directed**.
j. Provide open-front, sheet metal channel characters.
4. Molded Plastic Characters: Thermoformed **OR** Injection molded, **as directed**, and as follows:
a. Illuminated Characters: Manufacturer's standard fluorescent tube **OR** fiber-optic **OR** LED **OR** neon tube, **as directed**, lighting including transformers, insulators, and other components. Make provisions for servicing and concealing connections to building electrical system.

b. Integral Color **OR** Painted Finish, **as directed**: As indicated **OR** As selected from manufacturer's full range, **as directed**.

5. Cutout Characters: Provide characters with square-cut, smooth, eased, **as directed**, edges. Comply with the following requirements:
   a. Acrylic: 0.25 inch (6.35 mm) **OR** 0.50 inch (12.7 mm), **as directed**, thick.
      1) Metal face laminated to acrylic base with painted edges, **as directed**.
         a) Brass Face: Satin **OR** Polished, **as directed**, finish.
         b) Stainless-Steel Face: No. 4 **OR** No. 8, **as directed**, finish.
         c) Metal Thickness: 0.030 inch (0.76 mm).
      2) Custom Paint Colors: Match Pantone, **as directed**, color matching system.
      3) Color: As indicated **OR** As selected from manufacturer's full range, **as directed**.
   b. Aluminum Sheet: 0.125 inch (3.18 mm) **OR** 0.25 inch (6.35 mm), **as directed**, thick.
      1) Finish: Anodized **OR** Painted, **as directed**.
      2) Custom Paint Colors: Match Pantone, **as directed**, color matching system.
      3) Color: As indicated **OR** As selected from manufacturer's full range, **as directed**.
   c. Brass Sheet, Yellow: 0.125 inch (3.18 mm) **OR** 0.25 inch (6.35 mm), **as directed,** thick.
   d. Bronze Sheet: 0.125 inch (3.18 mm) **OR** 0.25 inch (6.35 mm), **as directed**, thick.
   e. Vinyl: Pressure sensitive, 3.5 mils (0.09 mm) thick.
      1) Custom Paint Colors: Match Pantone, **as directed**, color matching system.
      2) Color: As indicated **OR** As selected from manufacturer's full range, **as directed**.
   f. Mounting: Adhesive **OR** Flush **OR** Projected **OR** Back bar **OR** Bracket, **as directed**, with concealed noncorroding studs, **as directed**, for substrates encountered.

D. panel signs
   1. Interior Panel Signs: Provide smooth sign panel surfaces constructed to remain flat under installed conditions within a tolerance of plus or minus 1/16 inch (1.5 mm) measured diagonally from corner to corner, complying with the following requirements:
      a. Aluminum Sheet: 0.050 inch (1.27 mm) **OR** 0.080 inch (2.03 mm), **as directed**, thick.
      b. Laminated, Aluminum-Faced Sheet: 0.020-inch- (0.51-mm-) thick aluminum sheet laminated to each side of 0.197-inch- (5.0-mm-) **OR** 0.394-inch- (10.0-mm-), **as directed**, thick, corrugated **OR** phenolic **OR** acrylic, **as directed**, backing with painted edges, **as directed**.
      c. Laminated, Polycarbonate-Faced Sheet: 0.060-inch- (1.52-mm-) thick, polycarbonate face sheet laminated to each side of 0.197-inch- (5.0-mm) **OR** 0.394-inch- (10.0-mm-), **as directed**, thick phenolic backing.
      d. Acrylic Sheet: 0.060 inch (1.52 mm) **OR** 0.080 inch (2.03 mm), **as directed**, thick.
      e. PVC Sheet: 0.060-inch- (1.52-mm-) **OR** 0.080-inch- (2.03-mm-), **as directed**, thick, extruded, high-impact PVC plastic in color to match face color **OR** with painted finish, **as directed**.
      f. High-Pressure Decorative Laminate: 0.048 inch (1.21 mm) thick.
      g. Phenolic-Backed Photopolymer Sheet: Provide light-sensitive, water-wash photopolymer face layer bonded to a phenolic base layer to produce a composite sheet with overall, face layer, and base-layer thicknesses, respectively, of 0.120, 0.040, and 0.080 inch (3.0, 1.0, and 2.03 mm) **OR** 0.160, 0.040, and 0.120 inch (4.06, 1.0, and 3.04 mm), **as directed**.
      h. Laminated Sheet: High-pressure engraved stock with contrasting color, **as directed**, face laminated to acrylic core in finishes and color combinations indicated **OR** as selected from manufacturer's full range, **as directed**.
      i. Laminated, Etched Photopolymer: Raised graphics with Braille, **as directed**, 1/32 inch (0.8 mm) above surface with contrasting colors in finishes and color combinations indicated **OR** as selected from manufacturer's full range, **as directed**, and laminated to acrylic back.
      j. Laminated, Sandblasted Polymer: Raised graphics with Braille, **as directed**, 1/32 inch (0.8 mm) above surface with contrasting colors in finishes and color combinations indicated **OR** as selected from manufacturer's full range, **as directed**, and laminated to acrylic back.
      k. Edge Condition: Square cut **OR** Beveled **OR** Bullnose, **as directed**.
      l. Corner Condition: Square **OR** Rounded to radius indicated, **as directed**.

m. Mounting: Framed **OR** Unframed **OR** As indicated, **as directed**.
   1) Wall **OR** Ceiling **OR** Projection, **as directed**, mounted with concealed anchors **OR** magnetic tape **OR** two-face tape, **as directed**.
   2) Manufacturer's standard anchors for substrates encountered.
n. Custom Paint Colors: Match Pantone, **as directed**, color matching system.
o. Color: As indicated **OR** As selected from manufacturer's full range, **as directed**.
p. Tactile Characters: Characters and Grade 2 Braille raised 1/32 inch (0.8 mm) above surface with contrasting colors.

2. Exterior Panel Signs: Provide smooth sign panel surfaces constructed to remain flat under installed conditions within a tolerance of plus or minus 1/16 inch (1.5 mm) measured diagonally from corner to corner, complying with the following requirements:
   a. Aluminum Sheet: 0.050 inch (1.27 mm) **OR** 0.080 inch (2.03 mm), **as directed**, thick.
   b. Laminated, Aluminum-Faced Sheet: 0.020-inch- (0.51-mm-) thick aluminum sheet laminated to each side of 0.197-inch- (5.0-mm-) **OR** 0.394-inch- (10.0-mm-), **as directed**, thick, corrugated **OR** phenolic **OR** acrylic, **as directed**, backing with painted edges, **as directed**.
   c. Acrylic Sheet: 0.060 inch (1.52 mm) **OR** 0.080 inch (2.03 mm), **as directed,** thick.
   d. Fiberglass Sheet: 0.090-inch- (2.29-mm-) **OR** 0.125-inch- (3.18-mm-), **as directed**, thick sheet.
   e. Edge Condition: Square cut **OR** Beveled **OR** Bullnose, **as directed**.
   f. Corner Condition: Square **OR** Rounded to radius indicated, **as directed**.
   g. Mounting: Framed **OR** Unframed **OR** As indicated, **as directed**.
      1) Wall **OR** Soffit **OR** Projection, **as directed**, mounted.
      2) Manufacturer's standard noncorroding, **as directed**, anchors for substrates encountered.
   h. Custom Paint Colors: Match Pantone, **as directed**, color matching system.
   i. Color: As indicated **OR** As selected from manufacturer's full range, **as directed**.
3. Laminated Interior **OR** Exterior, **as directed**, Signs: Solid phenolic panel core with graphic image covered with thermosetting resin face layer.
   a. Surface Finish: Mat **OR** Beaded **OR** Gloss **OR** UV resistant, outdoor, **as directed**.
   b. Edge Condition: Square cut **OR** Beveled **OR** Bullnose, **as directed**.
   c. Corner Condition: Square **OR** Rounded to radius indicated, **as directed**.
   d. Thickness: 1/8 inch (3 mm) **OR** 1/4 inch (6 mm), **as directed**.
4. Brackets: Fabricate brackets and fittings for bracket-mounted signs from extruded aluminum to suit panel sign construction and mounting conditions indicated. Factory paint brackets in color matching background color of panel sign **OR** matching sample, **as directed**.
5. Panel Sign Frames:
   a. PVC Frames: Extruded, high-impact PVC plastic.
      1) Color: As indicated **OR** As selected from manufacturer's full range **OR** Match face color, **as directed**.
      2) Depth: As indicated.
      3) Profile: Square **OR** Beveled **OR** Rounded, **as directed**.
      4) Corner Condition: Square **OR** Rounded to radius indicated, **as directed**.
      5) Mounting: As indicated.
         a) Wall **OR** Ceiling **OR** Projection, **as directed**, mounted with concealed anchors **OR** magnetic tape **OR** two-face tape, **as directed**.
         b) Manufacturer's standard noncorroding, **as directed**, anchors for substrates encountered.
   b. Extruded-Aluminum Frames: Mitered with concealed anchors and welded, **as directed**.
      1) Color: As indicated **OR** As selected from manufacturer's full range, **as directed**.
      2) Depth: As indicated.
      3) Profile: Square **OR** Beveled **OR** Rounded, **as directed**.
      4) Corner Condition: Square **OR** Rounded to radius indicated, **as directed**.
      5) Mounting: As indicated.
         a) Wall **OR** Ceiling **OR** Projection, **as directed**, mounted with concealed anchors **OR** magnetic tape **OR** two-face tape, **as directed**.

b) Manufacturer's standard noncorroding, **as directed**, anchors for substrates encountered.

c. Metal Frames:
1) Bronze Plate: Not less than 0.032 inch (0.81 mm) thick.
2) Brass Plate: Not less than 0.032 inch (0.81 mm) thick.
3) Steel Sheet: Painted, not less than 0.050 inch (1.27 mm) thick for face and 0.031 inch (0.78 mm) thick for returns.
a) Color: As indicated **OR** As selected from manufacturer's full range, **as directed**.
4) Stainless-Steel Sheet: Not less than 0.050 inch (1.27 mm) thick for face and 0.031 inch (0.78 mm) thick for returns.
5) Depth: As indicated.
6) Corner Condition: Square **OR** Rounded to radius indicated, **as directed**.
7) Mounting: As indicated.
a) Wall **OR** Ceiling **OR** Projection, **as directed**, mounted with concealed anchors **OR** magnetic tape **OR** two-face tape, **as directed**.
b) Manufacturer's standard noncorroding, **as directed**, anchors for substrates encountered.

6. Changeable Message Inserts: Fabricate signs to allow insertion of changeable messages in the form of slide-in inserts **OR** transparent covers with paper inserts printed by the Owner **OR** changeable panel inserts for use in fixed frames, **as directed**.
a. Furnish insert material and software for creating text and symbols for PC-Windows **OR** Macintosh, **as directed**, computers for the Owner production of paper inserts.
b. Furnish insert material cut-to-size for changeable message insert.

7. Tactile and Braille Sign: Manufacturer's standard process for producing text and symbols complying with ADA-ABA Accessibility Guidelines and with ICC/ANSI A117.1. Text shall be accompanied by Grade 2 Braille. Produce precisely formed characters with square-cut edges free from burrs and cut marks; Braille dots with domed or rounded shape.
a. Panel Material: Opaque acrylic sheet **OR** Photopolymer **OR** Clear acrylic sheet with opaque color coating, subsurface applied, **as directed**.
b. Raised-Copy Thickness: Not less than 1/32 inch (0.8 mm).

8. Engraved Copy: Machine engrave letters, numbers, symbols, and other graphic devices into panel sign on face indicated to produce precisely formed copy, incised to uniform depth.
a. Engraved Plastic Laminate: Engrave through exposed face ply of plastic-laminate sheet to expose contrasting core ply.
b. Engraved Metal: Fill engraved copy with enamel.
c. Engraved Opaque Acrylic Sheet: Fill engraved copy with enamel.
d. Face-Engraved Clear Acrylic Sheet: Fill engraved copy with enamel. Apply opaque background color coating to back face of acrylic sheet.

9. Subsurface Copy: Apply minimum 4-mil- (0.10-mm-) thick vinyl copy to back face of clear acrylic sheet forming panel face to produce precisely formed opaque image. Image shall be free of rough edges.

10. Subsurface Engraved Acrylic Sheet: Reverse-engrave back face of clear acrylic sheet. Fill resulting copy with enamel. Apply opaque background color coating over enamel-filled copy.

11. Applied Vinyl: Die-cut characters from vinyl film of nominal thickness of 3 mils (0.076 mm) with pressure-sensitive adhesive backing. Apply copy to exposed face of panel sign **OR** glass **OR** doors **OR** wall surfaces, **as directed**.
a. Panel Material: Opaque acrylic sheet **OR** Clear acrylic sheet with opaque color coating, subsurface applied, **as directed**.

12. Colored Coatings for Acrylic Sheet: For copy and background and frame colors, provide colored coatings, including inks, dyes, and paints, that are recommended by acrylic manufacturers for optimum adherence to acrylic surface and are UV and water resistant for three **OR** five, **as directed**, years for application intended.
a. Custom Paint Colors: Match Pantone, **as directed**, color matching system.
b. Color: As indicated **OR** As selected from manufacturer's full range, **as directed**.

E. Photoluminescent Markings and Signs
1. All photoluminescent exit path markings, signs and materials shall be approved by Authorities having jurisdiction and meet minimum performance requirements.
2. Photoluminescent Signs: Self-contained, single **OR** double, **as directed**, face, as follows:
a. Manufacturer's standard aluminum **OR** plastic, **as directed**, frame with translucent lettering and transparent polycarbonate face.
b. Exit sign, UL 924.
c. Mounting: As indicated.
1) Wall **OR** Ceiling **OR** Projection, **as directed**, mounted with concealed anchors.
d. Face Color: Red **OR** Green **OR** Black, **as directed**.
e. Frame Color: As indicated **OR** As selected from manufacturer's full range, **as directed**.
f. Service Life: 10 **OR** 15 **OR** 20, **as directed**, years.
g. New Buildings.
1) All new buildings of three or more stories in height shall be provided with approved photoluminescent exit path markings in all enclosed exit stairwells.
h. Existing buildings.
1) All Group E, I, R-1 and R-2 occupancies in buildings of three or more stories in height shall be provided with approved photoluminescent exit path markings in all enclosed exit stairwells.
i. All other occupancies in buildings four or more stories in height shall be provided with approved photoluminescent exit path markings in all enclosed exit stairwells.
j. Exception: Exit path markings in existence at the time of the adoption and or at the time of this ordinance may continue to exist as installed as long as they are in proper working order.

F. Accessories
1. Anchors and Inserts: Provide nonferrous-metal or hot-dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or lead expansion-bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete or masonry work.
2. Fasteners: Stainless or corrosion-resistant; type best suited to application.

G. Fabrication
1. General: Provide manufacturer's standard signs of configurations indicated.
a. Welded Connections: Comply with AWS standards for recommended practices in shop welding. Provide welds behind finished surfaces without distortion or discoloration of exposed side. Clean exposed welded surfaces of welding flux and dress exposed and contact surfaces.
b. Mill joints to tight, hairline fit. Form joints exposed to weather to exclude water penetration.
c. Preassemble signs in the shop to greatest extent possible. Disassemble signs only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation, in location not exposed to view after final assembly.
d. Conceal fasteners if possible; otherwise, locate fasteners where they will be inconspicuous.

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.

I. Aluminum Finishes
1. Clear Anodic Finish: Manufacturer's standard Class 1 clear anodic coating, 0.018 mm or thicker, over a satin (directionally textured) **OR** polished (buffed) **OR** nonspecular as fabricated, **as directed**, mechanical finish, complying with AAMA 611.
2. Color Anodic Finish: Manufacturer's standard Class 1 integrally colored or electrolytically deposited color anodic coating, 0.018 mm or thicker, in light bronze **OR** medium bronze **OR** dark bronze **OR** gold **OR** black, **as directed**, applied over a satin (directionally textured) **OR** polished (buffed) **OR** nonspecular as fabricated, **as directed**, mechanical finish, complying with AAMA 611.
3. 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 enamel primer/topcoat system complying with AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm), medium gloss.

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."
2. Factory Priming for Painted Finish: Apply shop primer specified below immediately after surface preparation and pretreatment.
    a. 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.
3. 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).

K. Stainless-Steel Finishes
1. Remove tool and die marks and stretch lines or blend into finish. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
2. Directional Satin Finish: No. 4 finish.
3. Mirrorlike Reflective, Nondirectional Polish: No. 8 finish.
4. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

L. Copper-Alloy Finishes
1. Sheet or Plate Finish: Medium satin (directionally textured) **OR** Smooth specular (mirrorlike), buffed, **as directed**, finish.
    a. Raised Finish: Satin **OR** Polished **OR** Painted, **as directed**.
    b. Recessed Finish: Etched, painted, **as directed**.
2. Cast-Bronze **OR** Cast-Brass, **as directed**, Character Finishes: Manufacturer's standard satin finish, **as directed**, with exposed surfaces free from porosity, burrs, and rough spots; with returns finished with fine-grain air blast.
3. Cast-Bronze Plaque Finishes: Exposed surfaces free of porosity, burrs, and rough spots; with returns finished with fine-grain air blast.
    a. Raised Areas: Hand-tool and buff borders and raised copy to produce manufacturer's standard satin **OR** polished, **as directed**, finish.
    b. Background Finish: Painted **OR** Dark oxidized **OR** Green patina, **as directed**.
4. Clear Protective Coating: Coat exposed surfaces of copper alloys with manufacturer's standard, clear organic coating specially designed for coating copper-alloy products.

M. Acrylic Sheet Finishes
1. Colored Coatings for Acrylic Sheet: For copy and background and frame colors, provide colored coatings, including inks, dyes, and paints, that are recommended by acrylic manufacturers for optimum adherence to acrylic surface and that are UV and water resistant for three **OR** five, **as directed**, years for application intended.

1.3 EXECUTION

A. Installation
1. Locate signs and accessories where indicated, using mounting methods of types described and complying with manufacturer's written instructions.
a. Install signs level, plumb, and at heights indicated, with sign surfaces free of distortion and other defects in appearance.
b. Interior Wall Signs: Install signs on walls adjacent to latch side of door where applicable. Where not indicated or possible, such as double doors, install signs on nearest adjacent walls. Locate to allow approach within 3 inches (75 mm) of sign without encountering protruding objects or standing within swing of door.
2. Wall-Mounted Signs: Comply with sign manufacturer's written instructions except where more stringent requirements apply.
a. Two-Face Tape: Mount signs to smooth, nonporous surfaces. Do not use this method for vinyl-covered or rough surfaces.
b. Hook-and-Loop Tapes: Mount signs to smooth, nonporous surfaces.
c. Magnetic Tape: Mount signs to smooth, nonporous surfaces.
d. Silicone-Adhesive Mounting: Attach signs to irregular, porous, or vinyl-covered surfaces.
e. Shim Plate Mounting: Provide 1/8-inch- (3-mm-) thick, concealed aluminum shim plates with predrilled and countersunk holes, at locations indicated, and where other mounting methods are not practicable. Attach plate with fasteners and anchors suitable for secure attachment to substrate. Attach panel signs to plate using method specified above.
f. Mechanical Fasteners: Use nonremovable mechanical fasteners placed through predrilled holes. Attach signs with fasteners and anchors suitable for secure attachment to substrate as recommended in writing by sign manufacturer.
g. Signs Mounted on Glass: Provide matching opaque plate on opposite side of glass to conceal mounting materials.
3. Bracket-Mounted Signs: Provide manufacturer's standard brackets, fittings, and hardware for mounting signs that project at right angles from walls and ceilings. Attach brackets and fittings securely to walls and ceilings with concealed fasteners and anchoring devices to comply with manufacturer's written instructions.
4. Dimensional Characters: Mount characters using standard fastening methods to comply with manufacturer's written instructions for character form, type of mounting, wall construction, and condition of exposure indicated. Provide heavy paper template to establish character spacing and to locate holes for fasteners.
a. Flush Mounting: Mount characters with backs in contact with wall surface.
b. Projected Mounting: Mount characters at projection distance from wall surface indicated.
5. Cast-Metal Plaques: Mount plaques using standard fastening methods to comply with manufacturer's written instructions for type of wall surface indicated.
a. Concealed Mounting: Mount plaques by inserting threaded studs into tapped lugs on back of plaque. Set in predrilled holes filled with quick-setting cement.
b. Face Mounting: Mount plaques using exposed fasteners with rosettes attached through face of plaque into wall surface.
6. Photoluminescent Marking and Signs
a. Approved stair markings shall be provided for all enclosed stairways in buildings three or more stories above grade or three or more levels below grade and in any exit pathways leading from the stairways with the exception of ground floor lobbies leading to the exterior of the building in the following manner:
b. Horizontal Leading Edge of each stair step shall be marked by Option 1 or Option 2.

1) Option 1: A minimum one inch and a maximum of two inches (25 mm) shaped contrasting marker of photoluminescent material on both side edges of the step. These markers shall be placed a minimum of 0inch to a maximum of 1/2inch (13 mm) from the leading edge of the step parallel to the nose of the step or landing.
2) Option 2: A minimum one inch and a maximum of two inches (25mm) "zig-zag" pattern contrasting marker of photoluminescent material on both sides of the step. This shall be a continuous pattern along the walls of the stair step. (See Option 1 & 2 attachments)

c. Stair Landings shall also be marked with a contrasting photoluminescent pathway marker located around the perimeter wall and across the face or floor in front of non-exit doors, on or within four inches (102 mm) of the floor. The dimensions, distances and locations shall be consistent and uniform throughout the same exit. Any spaces intervening between portions of the stairwell shall be marked as directed by the Owner. (See attachments)

d. Photoluminescent Directional Signs shall be placed in the following locations:
1) Stairwell or exit: directional arrow visible upon opening the door into the stairwell or exit indicating the direction of travel.
2) Transfer levels: A directional arrow on the wall. Exception: Markings shall be as directed by the Owner if walls are not available.
3) Wherever egress direction is not clear, (turns along horizontal extensions; at transitions from vertical to horizontal direction; at "T" intersections; etc.) a directional arrow or outlined path (or both as determined by the Owner) shall be installed.

e. Door frames (top and sides) of all stair entry, intermediate and final exit doors of the enclosed stairway shall be marked with a solid and continuous contrasting one inch minimum and a two inch maximum (25 mm) stripe of photoluminescent material.

f. An approved photoluminescent "exit" sign shall be mounted on all stair entry, intermediate and final exit doors or adjacent to the door (on the latch side) within 18 inch (455 mm) of the floor. The sign shall state "EXIT", "FINAL EXIT", "EXIT THROUGH LOBBY", or "EXIT TO STREET". These signs shall be required to be UL 924 listed if they are to be viewed at a distance of 50 feet or more.

g. Handrails shall be marked with a minimum one inch and a maximum of two inches (25 mm) solid and continuous stripe of photoluminescent material either on the handrail or on the wall adjacent to handrail.

h. Obstacles at or below six feet six inches (1981 mm) in height and projecting more than four inches (102 mm) into the egress path shall be outlined with markings no less than one inch (25 mm) in width and not more than a two inches maximum comprised of a pattern of alternating equal bands of photoluminescent material and black, with the alternating bands no more than two inches in width and angled at 45 degrees. Examples of such obstacles include standpipes, hose cabinets, wall projections, and restricted height areas.

i. Exit pathways shall be marked with a minimum one inch and a maximum of two inches (25 mm) solid and continuous stripe of photoluminescent pathway marking material on or within four inches of the floor along each side of the pathway. Pathways more than 50 feet in length shall have directional arrows along the wall at intervals not exceeding 50 feet.

j. Minimum Lighting Requirements:
1) All installed photoluminescent materials shall be exposed to a minimum of two foot candles of fluorescent light illumination at all times while the building is occupied or if incandescent lighting is used, the photoluminescent material chosen must be capable of meeting the minimum brightness rating required by this standard with the lighting provided.
2) Motion sensor activated lighting is prohibited in the stairwells addressed by this standard.
3) Timers on stairwell lighting, if used, shall be set to turn on the lights not less than one hour before the building is occupied each day.

k. Maintenance Requirements:
1) Owners shall maintain the required photoluminescent signs and markings in good repair. Every 12 months owners shall perform a visual inspection of the signs and

markings with the normal lighting turned on. Signs and/or markings that are missing, damaged, loose or that show signs of wear shall be noted and properly repaired or replaced.

B. Cleaning And Protection
   1. After installation, clean soiled sign surfaces according to manufacturer's written instructions. Protect signs from damage until acceptance by the Owner.

END OF SECTION 01 58 13 00

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Task	Specification	Specification Description
01 58 13 00	01 22 16 00	No Specification Required
01 66 19 00	01 22 16 00	No Specification Required
01 71 13 00	01 22 16 00	No Specification Required

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SECTION 01 71 23 16 - 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 31 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 01 71 23 16

Task	Specification	Specification Description
01 74 16 00	01 22 16 00	No Specification Required

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SECTION 01 74 19 00 - 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.
Note: All salvageable materials remain the property of the Owner and shall be turned over as directed when specified in the Job Order.
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 Final 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. 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.
5. 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.
6. 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.
7. Qualification Data: For Waste Management Coordinator and refrigerant recovery technician.
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.

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. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
c. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
d. 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: Not permitted.
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 31 Section "Earth Moving" 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 31 Section "Earth Moving" 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 31 Section "Earth Moving" 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 32 Section "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 32 Section "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 32 Section "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 32 Section "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 01 74 19 00

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Task	Specification	Specification Description
01 74 19 00	01 22 16 00	No Specification Required

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SECTION 01 95 06 00 - 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. "Nailing Schedule," and Tables in Section 2304 of the ICC's International Building Code.
   d. Table 2306.1, "Fastening Schedule," in SBCCI's Standard Building Code.
   e. 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.
   f. 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 01 95 06 00

SECTION 01 95 06 00a - 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 Final 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 Final Completion.
   b. Warranty Period for Siding and Trim (Excluding Finish): 25 years from date of Final 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 Final 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 x 10^{-5} inches/inch x deg F (8.1 x 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 01 95 06 00a

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SECTION 01 95 06 00b - 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 Final 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** IBC Standard 703, **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 01 95 06 00b

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SECTION 01 95 06 00c - 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 Glazing".
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 01 95 06 00c

SECTION 01 95 06 00d - CASEWORK

PART 1 - GENERAL

1.01 SUMMARY:

A. Related Section:

1. Documents affecting Work of this Section include, but are not necessarily limited to the GENERAL CONDITIONS, and Sections in DIVISION 1 of these Specifications.

B. Section includes:

1. Special fabricated casework units.

2. Countertops.

3. Cabinet hardware.

C. Work Includes:

1. Furnish and install new kitchen and bathroom cabinetry with hinges and pulls.

2. Provide and install new plastic laminate countertops and backsplashes in itchens and bathrooms.

1.02 REFERENCES:

A. Builders Hardware Manufacturing Association.

1. BHMA A156.9 – Cabinet Hardware.

B. Woodwork Institute of California (W.I.C.).

1. WIC – Manual of Millwork, Latest Edition.

C. National Electrical Manufacturers Association.

1. NEMA LD3 – High Pressure Decorative Laminates.

D. U.S. Department of Commerce – Product Standard.

1. PS 1 – Construction and Industrial Plywood.

2. PS 20 – American Softwood Lumber Standard.

3. PS 51 – American Hardwood and Decorative Plywood Standard.

4. PS 58 – American Basic Hardwood.

E. National Conference of Building Officials.

1. UBC – Chapter 16 Structural Forces.

F. American National Standards Institute.

1. ANSI A135.4 – Hardboard.

2. ANSI A208.1 – Wood Particle Board.

G. South Coast Air Quality Management District.

1. SCAQMD – Rule 1113.

H. American Society for Testing and Materials.

1. ASTM D1037 – Evaluating the Properties of Wood-Base Fiber and Particle Panel Materials.

1.03 SUBMITTALS:

A. Submit under provisions of Section 01300 and WIC Technical Bulletin 434.

B. Show Drawings: Indicate materials, component profiles and elevations, assembly methods, joint details, fastening methods, accessory listings, hardware location, and schedule of finishes based on contractor's field verified measurements.

1. Indicate grounds, backing, blocking and other items required for casework installation.

2. The first page of the Shop Drawings shall bear the WIC Certified Compliance Label. Shop Drawings not complying with this requirement will be returned without approval. Costs of WIC approval(s) to be paid by Contractor.

3. A statement shall appear prominently on the Shop Drawings certifying that all casework construction complies to the structural requirements of UBC Table 16-0 for the required horizontal force factor for anchorage of non- structural components.

C. Submit three samples of each species of finish wood and specified countertop material for approval by the Owner prior to installation.

D. Submit three samples of drawer pulls, hinges and cabinet locks and latches illustrating hardware finish for approval by the Owner prior to installation.

1.04 QUALITY ASSURANCE:

A. Perform work in accordance with WIC Custom Grade.

B. Cabinets and countertops shall be manufactured in accordance with Section 14 and Section 16 of WIC for Type II Style A Frameless Construction or to higher standards as specified herein.

C. If the manufacturer is not a WIC Licensee, the Contractor shall furnish a Certificate of Reinspection by the WIC indicating that the work meets the requirements of the WIC grade specified.

D. If the manufacturer is a WIC licensee, each unit of work shall bear the WIC Certified Compliance grade stamp indicating the grade specified.

E. WIC Certified Compliance Certificates shall indicate that the products furnished fully meet the requirements for the grade specified.

F. One copy of the referenced “WIC Manual of Millwork” shall be made available for reference at the job site throughout the installation period.

G. Inspections by authorized WIC inspectors shall be made in accordance with the following schedule:

1. Site inspection immediately following completed installation of all casework components.

2. Additional site inspections may be required at the option of the Owner and at no cost or time to the Contract when certified WIC inspection reports indicate unsatisfactory conformance with WIC standards of quality and specified requirements.

1.05 QUALIFICATIONS:

A. Manufacturer and Installer: Company specializing in manufacturing the products specified in this section with minimum five years experience.

B. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

1.06 MOCKUP:

A. Provide complete mock-up units for each type of apartment unit including kitchen and bathroom cabinetry with specified countertop, hardware, plumbing fixtures and all associated work for approval by the Owner prior to installation.

B. Units will be examined to ascertain quality and conformity to WIC Quality level standards and specification requirements.

D. Approved mock-up units may remain and be installed as part of the Work.

1.07 DELIVERY, HANDLING

A. Deliver, store and handle casework products under the provisions STORAGE ANDof WIC Manual Section 1.

B. Provide additional protection as needed to assure that the work of this Section remains undamaged during fabrication, installation, and the time between completion of installation and actual acceptance of the total Work.

C. Protect units from moisture damage prior to installation.

D. Use all means necessary to protect delivered units from possible damage from other trades, before, during, and after installation.

E. All casework units delivered to the job-site shall be properly identified as to the location in the structure.

F. In the event of damage to the work of this Section, immediately make all necessary repairs and replacement.

1.08 FIELD AND JOB SITE CONDITIONS:

A. Verify that field measurements and conditions are as indicated on MEASUREMENTS Shop Drawings.

B. Report discrepancies to Owner.

1.09 COORDINATION:

A. Coordinate the work with plumbing and electrical rough-in.

B. Coordinate rough-in for items installed through or in millwork and trim. Locate rough-ins for proper alignment with edges, faces and reveals.

1.10 ENVIRONMENTAL

A. Condition interior casework and trim products to building REQUIREMENTS: environment. Maintain temperature and humidity at complete WorK and accordance with requirements for storage.

B. Do not install casework and trim until required temperature and relative humidity conditions have been stabilized and will be maintained in installation areas.

PART 2 - PRODUCTS

2.01 WOOD

A. Softwood Lumber: PS 20; graded in accordance with WIC MATERIALS: Custom Grade.

1. Moisture content shall be a minimum of 6 percent and shall not exceed 12 percent up to 2 inch nominal thickness and shall not exceed 19 percent for pieces thicker than 2 inches up to 4 inch nominal thickness.

2. Provide solid stock lumber at all locations except where other material is specified or is called for on the Drawings.

B. Hardwood Lumber: PS 58; graded in accordance with WIC Custom Grade.

1. Moisture content shall be a minimum of 6 percent and shall not exceed 12 percent up to 2 inch nominal thickness and shall not exceed 19 percent for members thicker than 2 inches up to 4 inch nominal thickness.

2. Provide solid stock capable of receiving transparent finish, with grain and uniform color matching the adjacent work.

2.02 SHEET MATERIALS:

A. Face Material of Softwood Plywood: PS 1; graded in accordance with WIC Custom Grade, Grade A for opaque and transparent finish, core materials as specified herein.

B. Face Material of Hardwood Plywood: PS 51; graded in accordance with WIC Custom Grade, Grade B for opaque finish, Grade AA for transparent finish, core materials as specified herein, type of glue recommended for application, face veneer and types of veneer cuts as selected by Owner.

C. Core, one of the following:

1. Veneer Core: Constructed of an odd number of plies, with inner plies in pairs, except innermost ply. Grain of each ply shall be at right angles to the grain of the adjacent ply.

2.03 LAMINATE MATERIALS:

A. Plastic Laminate: NEMA LD3; decorative high pressure laminate, general purpose type. Comply with Section 16 of WIC, color, (BATHROOM AND pattern, gloss and surface texture to be selected by Owner.

KITCHEN Minimum required thicknesses:

1. Countertops: 0.050 inch

2. Vertical post forming: 0.030 inch

3. Horizontal surfaces other than countertops: 0.040 inch

4. Self-edge bands: 0.028 inch

5. Cabinet liners: 0.020 inch

6. Backing sheets: 0.020 inch

B. Laminate Backing Sheet: NEMA LD-3; backing grade, undecorated plastic laminate, for backing at countertops and other concealed locations.

C. Acceptable manufacturers: Formica, Wilsonart, and Nevamar. .

2.04 ACCESSORIES:

A. Adhesive: Urea-formaldehyde resin, cold setting, or phenol type with catalytic agent set under a pressure of not less than 30 lbs psi.

1. Adhesives shall comply with SCAQMD Rule 1113.

2. Alternate glues must be approved by the WIC standards.

3. No contact cement is allowed.

B. Anchors: Select materials, type, and size and finish required by each substrate for secure anchorage. Provide non-ferrous metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance.

1. Anchors:Select material, type, and size and finish required by each substrate for secure anchorage. Provide non-ferrous metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance.

C. Fasteners: Size and type to suit application. Material, color and finish shall be same as metal to which applied, except use only stainless steel at aluminum materials and use cadmium plated at interior pre-painted steel products.

D. Bolts, Nuts, Washers, Lags, Pins, and Screws: Of size and type to suit application; white metal finish in all locations.

E. Nails: Select material, type, size and finish required for each use.

F. Concealed Joint Fasteners: Threaded steel.

2.05 HARDWARE:

A. Hardware: BHMA A156.9. Comply with Supplement No. 1 to Section 14 and 15, WIC. Any hardware listed therein may be installed, except where these standards are exceeded as described below:

B. Hinges:

1. On doors between 40 inches and 60 inches in height, provide three hinges. On doors 60 inches and taller, provide 4 hinges.

a. Blum min 110 degree opening concealed, self closing B95m365.

b. Blum Compact 33 face frame hinge 110 degree opening B33.360 with 133.2 wrap around plate.

c. Door and drawer pulls:

1. Stanley #4484 Aluminum.

D. Drawer guides, full extension:

1. Typical Drawers, 100 lb capacity rated:

a. KV#1429.

b. Blum B430E.

E. Adjustable shelf standards:

1. AM #231.100.068 and #207.100.068.

2. Grant #120 aluminum.

3. KDV #255, zinc/steel or aluminum.

4. KDV #255, zinc/steel or aluminum.

The above listed hardware is available from Louis and Company — Brea, California. Telephone # (714) 529-1771.

Note: Contractor will be responsible for coordinating correct model numbers with existing conditions on partial work. If the described

hardware listed above does not meet the job conditions notify Owner before proceeding.

2.06 HARDWARE FINISH

A. All concealed hardware: Polished or satin chrome or stainless steel.

2.07 FABRICATION — WOOD CASEWORK

A. Casework Components:

1. Construction: Custom grade, style A, frameless, construction Type II, in accordance with WIC Section 14 .

a. Upper wall cabinet depth: 13 inches (inside clearance min 11~"), typically excluding door and drawer front thicknesses. Height: 30 inches (typical). Match existing configurations .

b. Base cabinet height: Including countertop 36 inches (34"max. for handicap), typically. Depth: 24 inches, including door and drawer front thicknesses. Match existing configurations.

c. Countertop overhang: Provide 3/4 inch overhang on sides and front.

d. Shelves: Unless otherwise indicated, wall and base cabinets shall have two adjustable shelves.

e. Toe-kicks: Separate base unit for casework, 4 inches high by 3 inches deep at front and 4 inches high by 3/4 inch deep at exposed ends.

f. The amount of face frame that is exposed will be a consistent dimension, both horizontally and vertically.

2. Use solid stock for frames, jambs, heads, stops, mounting strips and edges.

a. Provide minimum two mounting strips, 1/2 inch by 21/2 inch by 21/2 inches, at top and bottom of each case. Provide intermediate mounting strip at middle of casework 60 inches high or higher.

3. Use plywood core material for body construction of cabinets where members are more than 11 inches wide.

B. Backs: 1/4 inch thick hardboard, dadoed into top rail, sides and bottom of cabinet.

1. Accurately fit and align the separate parts.

2. Provide ample screw, glue-and-bolt blocks, draw-bolts, tongues, grooves, splines, dowels, tenons, mortises, and other means of fastening to render the work substantial, rigid, and permanently secured in the proper position.

3. Provide sufficient additional material to permit scribing to walls, floors, and related work.

4. Provide adequate allowance for shrinkage occurring after installation.

C. Drawers: % inch thick maple plywood, seven ply plywood Grade B with banding on all 4 edges, 1/2 inch thick sides, backs and sub- fronts, and 1/4 inch thick bottoms.

1. Provide slip dovetail construction, well glued, or other joinery type of lock joint consistent with specified grade of casework.

2. Provide full extension slides at all drawers.

D. Doors: % inch thick maple plywood, with all four edges edge- banded. Face pattern shall be continuous with drawer fronts and trim.

1. Provide rubber stops at ends and backs of doors.

2. Fit and adjust as necessary to achieve smooth and noiseless operation.

3. The reveal dimension will be consistent across the cabinet elevation. The doors and drawer faces shall align.

E. When necessary to cut and fit on site, provide materials with ample allowance for cutting.

1. Assemble with bolted and screwed connections, securing to structural backings with cinch anchors, expansion screws, or toggle bolts.

2. Mortise-and-tenon all rails and stiles, neatly miter and member throughout, make butt joints flush and smooth, and make up permanent joints with water resistant glue.

3. Assemble fixtures without exposed face nails or face screws.

F. Provide cutouts for plumbing fixtures, inserts, appliances, outlet boxes, fixtures and fittings. Verify locations of cutouts from on-site dimensions. Prime paint contact surfaces of cut edges.

G. Rout, drill, and otherwise prepare the surfaces as needed, and firmly install all finish hardware and accessories in accordance with the approved design and the manufacturers' recommendations.

H. Adjustable Shelves: Plywood or solid stock, support shelves on vertical metal shelf standards, recessed-mounted on sides of cabinet, spaced not more than 2 inches from front and back, provided with shelf clips which lock into standards with thumb- press.

1. Provide adjustable shelves supported by metal shelf rests inserted into vertical rows of cleanly-bored holes in cabinet sides, not exceeding 2 inches oc. Locate rows between 1 1/2 and 2 inches from front and back faces of cabinet body. Row size, spacing and location shall be identical throughout all casework units.

I. Closures: Minimum 1 inch and maximum 2 inches wide, scribed to wall. Close all gaps at face, bottom and top of cabinets. Provide closure at all cabinet sides abutting walls, to ensure clearance for door to swing open fully.

J. Finishes: (Refer to WIC Section 5, for both shop and field applied millwork finishes).

1. Before finishing, all exposed portions of millwork shall have handling marks or effects of exposure to moisture removed with a thorough, final sanding over all surfaces to exposed portions, using at least 150 grit or fine sandpaper, and shall be cleaned before applying finish. Finishes shall be applied in factory or shop for all new casework.

2. Exposed portions of new and existing plywood cabinets, including inside faces of all doors, door edges and exposed edges shall receive 3 coats of clear lacquer semigloss finish.

3. Interior and exterior of all cases, drawers, shelves and doors to be provided with 3 coats of lacquer.

4. Provide samples to Owner for approval prior to finishing.

2.08 FABRICATION — COUNTERTOPS:

A. Provide WIC Custom Grade at all locations.

B. Provide plastic laminite over medium density fiberboard core (MDF), 3/4 inch thick at all countertops.

C. Locate counter butt joints minimum 24 inches from sink cut-outs.

D. Countertops shall extend 3/a inch beyond faces of doors and drawer fronts along the front face of base cabinets and 3/a inch beyond the exposed ends of base cabinets, where not abutting walls.

E. Unless indicated otherwise on the Drawings, back and side splashes shall be 4 inches high.

F. Provide support from below countertop, either by base cabinets or corbels spaced so that unsupported length does not exceed 36 inches.

G. Countertop Edges:

1. Front Edge, Countertops: No-drip bullnose.

2. Backsplash, Countertops: Integral coved, postformed.

3. Backsplash, Top Edge: 1/2” radius.

4. Sidesplash, Top Edge: 1/2” radius.

I. Finish edges and ends adjacent to ranges.

3.01 EXAMINATION:

A. Verify adequacy of backing and support framing.

3.02 INSTALLATION:

A. Set and secure casework in place; rigid, plumb, and level. Secure casework to walls or floors or both. Install toe kick bases first and level before setting casework bodies. Secure to floor structure with appropriate angles and anchors, concealed.

B. Use fixture attachments in concealed locations for wall mounted components.

C. All joint fasteners to align and secure adjoining cabinet units and counter tops. Use threaded steel fasteners where possible.

D. Carefully scribe casework abutting other components, with maximum gaps of 1/16 inch. Do not use additional overlay trim for this purpose.

E. Attach plastic laminate-covered countertops with concealed screws or other approved mechanical fasteners. Do not use adhesive. Finish cut-edges at sink cut-outs with one coat of oil- based wood primer.

F. Countersink anchorage devices at any exposed locations. In locations here plastic laminate is not applied, conceal anchorage devices with solid wood plugs of species to match surrounding wood. Finish flush with surrounding surfaces.

3.03 ADJUSTING:

A. Countersink anchorage devices at any exposed locations. In locations here plastic laminate is not applied, conceal anchorage devices with solid wood plugs of species to match surrounding wood. Finish flush with surrounding surfaces.

B. Adjust doors, drawers, hardware, fixtures and other moving or operating parts to function smoothly and correctly, without binding or squeaking.

3.04 CLEANING:

A. Perform cleaning operations under provisions of Section 01710.

B. Visually inspect each installed casework unit and countertop and thoroughly clean all surfaces using the cleaning material recommended by the manufacturer of the finish being cleaned and carefully adjust all operating components for optimum operation after the cleaning operation.

C. Remove all rubbish, debris, tools and equipment and leave the immediate work areas and casework units and countertops in a clean and acceptable.

3.05 FIELD INSPECTIONS:

A. Contractor shall schedule and request field inspection of completed installation, as required herein, by WIC, and in accordance with WIC Reinspection Service Program.

B. All fees, if any, for WIC field inspection shall be included in the work of this Section.

END OF SECTION 01 95 06 00d

Task	Specification	Specification Description
01 95 06 00	01 22 16 00	No Specification Required
01 95 07 00	07 62 00 00	Sheet Metal Flashing And Trim
01 95 08 00	01 22 16 00	No Specification Required
01 95 09 00	01 22 16 00	No Specification Required
01 95 09 00	09 91 23 00	Interior Painting
01 95 22 00	01 22 16 00	No Specification Required
01 95 22 00	01 95 06 00c	Interior Architectural Woodwork

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SECTION 01 95 23 00 - PACKAGED TERMINAL AIR CONDITIONERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for packaged terminal air conditioners. 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 packaged terminal air conditioners and their accessories and controls, in the following configurations:
   a. Through-the-wall and freestanding air conditioners.
   b. Cooling-only units.
   c. Heat-pump units.
   d. Cooling units with electric heat.
   e. Cooling units with hydronic heat.
   f. Cooling units with indirect-fired gas heat.

C. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
   a. Product Data for Credit EA 4: Documentation required by Credit EA 4 indicating that equipment and refrigerants comply.
   b. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
3. Shop Drawings: For packaged terminal air conditioners. Include plans, elevations, sections, details for wall penetrations, seismic bracing, **as directed**, 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.
4. Color Samples: For unit cabinet, discharge grille, and exterior louver, and for each color and texture specified.
5. Field quality-control reports.
6. Operation and maintenance data.
7. Warranty: Sample of special warranty.

D. Quality Assurance
1. 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.
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."
3. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

E. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged terminal air conditioners that fail in materials or workmanship within specified warranty period.
   a. Warranty Period for Sealed Refrigeration System: Manufacturer's standard, but not less than five years from date of Final Completion, including components and labor.
   b. Warranty Period for Nonsealed System Parts: Manufacturer's standard, but not less than five years from date of Final Completion, including only components and excluding labor.

c. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than five years from date of Final Completion.

1.2 PRODUCTS

A. Manufactured Units
1. Description: Factory-assembled and -tested, self-contained, packaged terminal air conditioner with room cabinet, electric refrigeration system, heating, **as directed**, and temperature controls; fully charged with refrigerant and filled with oil; with cord-connected **OR** hardwired, **as directed**, chassis.

B. Chassis
1. Cabinet: 0.052-inch- (1.32-mm-) thick steel with removable front panel with concealed latches.
   a. Mounting: Wall with wall sleeve **OR** Floor with subbase, **as directed**.
   b. Discharge Grille: Punched-louver discharge grille allowing four-way discharge-air pattern **OR** Extruded-aluminum discharge grille **OR** Reversible polycarbonate discharge grille allowing upward and horizontal airflow, **as directed**.
   c. Louvers: Extruded aluminum with enamel finish **OR** Stamped aluminum with clear-anodized finish **OR** Stamped steel with enamel finish, **as directed**; white **OR** bronze **OR** brown **OR** beige, **as directed**, color.
   d. Finish: Epoxy coating **OR** Baked enamel, **as directed**.
   e. Access Door: Hinged door in top of cabinet for access to controls.
   f. Cabinet Extension: Matching cabinet in construction and finish, allowing diversion of airflow to adjoining room; with grille.
   g. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
   h. Subbase: Enameled steel with adjustable leveling feet and adjustable end plates, with factory-installed and -wired, fused disconnect switch and receptacle sized for unit, **as directed**.
   i. Wall Sleeves: Galvanized steel with polyester finish **OR** Molded polymer **OR** Molded fiberglass-reinforced polyester, **as directed**.
2. Refrigeration System: Direct-expansion indoor coil with capillary restrictor; and hermetically sealed scroll compressor with vibration isolation and overload protection.
   a. Indoor and Outdoor Coils: Seamless copper tubes mechanically expanded into aluminum fins with capillary tube distributor on indoor coil, **as directed**.
   b. Accumulator.
   c. Constant-pressure expansion valve.
   d. Reversing valve.
   e. Charge: R-407C **OR** R-410A, **as directed**.
3. Indoor Fan: Forward curved, centrifugal; with motor and positive-pressure ventilation damper with concealed manual **OR** electric, **as directed**, operator.
4. Filters: Washable polyurethane in molded plastic frame.
5. Condensate Drain: Drain pan to direct condensate to outdoor coil for re-evaporation **OR** and piping to direct condensate to building waste and vent piping, **as directed**.
   a. Comply with ASHRAE 62.1 for drain pan construction and connections.
6. Outdoor Fan: Forward curved, centrifugal **OR** Propeller, **as directed**, type with separate **OR** driven by indoor fan, **as directed**, motor.
   a. Indoor and Outdoor Fan Motors: Two speed; comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
      1) Fan Motors: Permanently lubricated split capacitor.
      2) 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.

3) Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 22.

C. Heating

1. Electric-Resistance Heating Coil: Nickel-chromium-wire, electric-resistance heating elements with contactor and high-temperature-limit switch.

OR

Hot-Water Heating Coil: Seamless copper tubes mechanically expanded into aluminum fins with two-way modulating control valve and air vent.

OR

Gas Heat:

a. General Requirements for Gas-Fired, Noncondensing Furnaces: Factory assembled, piped, wired, and tested; complying with ANSI Z21.86/CSA 2.32, "Vented Gas-Fired Space Heating Appliances," and with NFPA 54.
b. Type of Gas: Natural **OR** Propane, **as directed**.
c. Heat Exchanger: Aluminized-steel **OR** Stainless steel, **as directed**.
d. Burner:
   1) Gas Valve: 100 percent safety two-stage **OR** modulating, **as directed**, main gas valve, main shutoff valve, pressure regulator, safety pilot with electronic flame sensor, limit control, transformer, and combination ignition/fan timer control board.
   2) Ignition: Electric pilot ignition with hot-surface igniter or electric spark ignition.
e. Gas-Burner Safety Controls:
   1) Electronic Flame Sensor: Prevents gas valve from opening until pilot flame is proven; stops gas flow on ignition failure.
   2) Flame Rollout Switch: Installed on burner box; prevents burner operation.
   3) Limit Control: Fixed stop at maximum permissible setting; de-energizes burner on excessive bonnet temperature; automatic reset.
f. Combustion-Air Inducer: Centrifugal fan prepurges heat exchanger and vents combustion products; thermally protected motor with sleeve bearings; pressure switch prevents operation if combustion-air inlet or flue outlet is blocked.
g. Furnace Controls: Solid-state board integrates ignition, heat, cooling, and fan speeds; adjustable fan-on and fan-off timing; and terminals for connection to accessories.

D. Controls

1. Control Module: Unit-mounted digital panel with touchpad temperature control and with touchpad for heating, cooling, and fan operation. Include the following features:
   a. Low Ambient Lockout Control: Prevents cooling-cycle operation below 40 deg F (5 deg C) outdoor air temperature.
   b. Heat-Pump Ambient Control: Field-adjustable switch changes to heat-pump heating operation above 40 deg F (5 deg C) and to supplemental heating below plus 25 deg F (minus 4 deg C).
   c. Temperature-Limit Control: Prevents occupant from exceeding preset setback **OR** setup, **as directed**, temperature.
   d. Building Automation System Interface: Allows remote on-off control with setback temperature control.
   e. Reverse-Cycle Defrost: Solid-state sensor monitors frost buildup on indoor **OR** outdoor, **as directed**, coil and reverses unit to melt frost.
2. Remote Control: Standard unit-mounted controls with remote-mounted, low-voltage adjustable thermostat with heat anticipator, heat-off-cool-auto **OR** heat-off-cool, **as directed**, switch, and on-auto, **as directed**, fan switch.
3. Outdoor Air: Manual **OR** Motorized, **as directed**, intake damper. Open intake when unit indoor air fan runs, **as directed**.

E. Source Quality Control

1. Sound-Power Level Ratings: Factory test to comply with ARI 300, "Sound Rating and Sound Transmission Loss of Packaged Terminal Equipment."

2. Unit Performance Ratings: Factory test to comply with ARI 310/380/CSA C744, "Packaged Terminal Air-Conditioners and Heat Pumps."

1.3 EXECUTION

A. Installation
1. Install units level and plumb, maintaining manufacturer's recommended clearances and tolerances.
2. Install wall sleeves in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Division 07 Section "Joint Sealants".
3. Install and anchor wall sleeves to withstand, without damage to equipment and structure, seismic forces required by building code.

B. Connections
1. Comply with requirements for piping specified in Division 23 Section "Hydronic Piping". Drawings indicate general arrangement of piping, fittings, and specialties.
2. Comply with requirements for piping specified in Division 23 Section "Facility Natural-gas Piping". Drawings indicate general arrangement of piping, fittings, and specialties.
3. Install piping adjacent to machine to allow service and maintenance.

C. Field Quality Control
1. Perform tests and inspections.
2. Tests and Inspections:
   a. Inspect for and remove shipping bolts, blocks, and tie-down straps.
   b. After installing packaged terminal air conditioners and after electrical circuitry has been energized, test for compliance with requirements.
   c. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Packaged terminal air conditioners will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.

D. Startup Service
1. Perform startup service.
2. After installation, verify the following:
   a. Unit is level on base and is flashed in exterior wall.
   b. Unit casing has no visible damage.
   c. Compressor, air-cooled condenser coil, and fans have no visible damage.
   d. Labels are clearly visible.
   e. Controls are connected and operable.
   f. Shipping bolts, blocks, and tie-down straps are removed.
   g. Filters are installed and clean.
   h. Drain pan and drain line are installed correctly.
   i. Electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 22.
   j. Installation. Perform startup checks according to manufacturer's written instructions, including the following:
      1) Lubricate bearings on fan.
      2) Check fan-wheel rotation for correct direction without vibration and binding.
3. After startup service and performance test, change filters.

E. Adjusting

1. Adjust initial temperature set points.
2. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

F. Demonstration
1. Train Owner's maintenance personnel to adjust, operate, and maintain packaged terminal air conditioners.

END OF SECTION 01 95 23 00

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Task	Specification	Specification Description
01 95 23 00	01 22 16 00	No Specification Required

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SECTION 01 95 26 00 - POWER VENTILATORS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for power ventilators. 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. Utility set fans.
b. Centrifugal roof ventilators.
c. Axial roof ventilators.
d. Upblast propeller roof exhaust fans.
e. Centrifugal wall ventilators.
f. Ceiling-mounting ventilators.
g. In-line centrifugal fans.
h. Propeller fans.

C. Performance Requirements
1. Project Altitude: Base fan-performance ratings on actual Project site elevations **OR** sea level, **as directed**.
2. Operating Limits: Classify according to AMCA 99.

D. Submittals
1. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
a. Certified fan performance curves with system operating conditions indicated.
b. Certified fan sound-power ratings.
c. Motor ratings and electrical characteristics, plus motor and electrical accessories.
d. Material thickness and finishes, including color charts.
e. Dampers, including housings, linkages, and operators.
f. Roof curbs.
g. Fan speed controllers.
2. Shop Drawings: 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. Delegated-Design Submittal: For unit hangars and supports 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. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
b. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
4. Field quality-control reports.
a. Operation and Maintenance Data: For power ventilators 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, by a testing agency, and marked for intended use.
2. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.
3. UL Standard: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.2 PRODUCTS

A. Utility Set Fans
1. Description: Direct **OR** Belt, **as directed,**-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories.
2. Housing: Fabricated of galvanized, **as directed**, steel with side sheets fastened with a deep lock seam or welded to scroll sheets.
   a. Housing Discharge Arrangement: Adjustable to eight standard positions.
3. Fan Wheels: Single-width, single inlet; welded to cast-iron or cast-steel hub and spun-steel inlet cone, with hub keyed to shaft.
   a. Blade Materials: Steel **OR** Aluminum, **as directed**.
   b. Blade Type: Backward inclined **OR** Forward curved **OR** Airfoil, **as directed**.
   c. Spark-Resistant Construction: AMCA 99, Type A **OR** B **OR** C, **as directed**.
4. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
5. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings with ABMA 9, L_{50} of 200,000 hours **OR** L_{10} of 80,000 hours, **as directed**.
6. Belt Drives:
   a. Factory mounted, with final alignment and belt adjustment made after installation.
   b. Service Factor Based on Fan Motor Size: 1.5 **OR** 1.4 **OR** 1.3 **OR** 1.2, **as directed**.
   c. Motor Pulleys: Adjustable pitch for use with motors through 5, **as directed**, hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
   d. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
   e. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.
7. Accessories:
   a. Inlet and Outlet: Flanged.
   b. Companion Flanges: Rolled flanges for duct connections of same material as housing.
   c. Backdraft Dampers: Gravity actuated with counterweight and interlocking aluminum blades with felt edges in steel frame installed on fan discharge.
   d. Access Door: Gasketed door in scroll with latch-type handles.
   e. Scroll Dampers: Single-blade damper installed at fan scroll top with adjustable linkage.
   f. Inlet Screens: Removable wire mesh.
   g. Drain Connections: NPS 3/4 (DN 20) threaded coupling drain connection installed at lowest point of housing.
   h. Weather Hoods: Weather resistant with stamped vents over motor and drive compartment.
   i. Discharge Dampers: Assembly with parallel **OR** opposed, **as directed,** blades constructed of two plates formed around and to shaft, channel frame, sealed ball bearings, with blades linked outside of airstream to single control lever of same material as housing.
   j. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
   k. Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

B. Centrifugal Roof Ventilators
1. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

2. Housing: Removable, spun-aluminum, dome top and outlet baffle **OR** extruded-aluminum, rectangular top **OR** galvanized steel, mushroom-domed top, **as directed**; square, one-piece, aluminum base with venturi inlet cone.
   a. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains and grease collector, **as directed**.
   b. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
3. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
4. Belt-Driven Drive:
   a. Resiliently mounted to housing.
   b. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
   c. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
   d. Pulleys: Cast-iron, adjustable-pitch motor pulley.
   e. Fan and motor isolated from exhaust airstream.
5. Accessories:
   a. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
   b. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside **OR** outside, **as directed,** fan housing, factory wired through an internal aluminum conduit.
   c. Bird Screens: Removable, 1/2-inch (13-mm) mesh, aluminum or brass wire.
   d. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
   e. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
6. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- (40-mm-) thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch (40-mm) wood nailer. Size as required to suit roof opening and fan base.
   a. Configuration: Self-flashing without a cant strip, with mounting flange **OR** Built-in cant and mounting flange **OR** Built-in raised cant and mounting flange, **as directed**.
   b. Overall Height: 8 inches (200 mm) **OR** 9-1/2 inches (240 mm) **OR** 12 inches (300 mm) **OR** 16 inches (400 mm) **OR** 18 inches (450 mm), **as directed**.
   c. Sound Curb: Curb with sound-absorbing insulation matrix.
   d. Pitch Mounting: Manufacture curb for roof slope.
   e. Metal Liner: Galvanized steel.
   f. Burglar Bars: 1/2-inch- (13-mm-) **OR** 5/8-inch- (16-mm-) **OR** 3/4-inch- (19-mm-), **as directed,** thick steel bars welded in place to form 6-inch (150-mm) squares.
   g. Mounting Pedestal: Galvanized steel with removable access panel.
   h. Vented Curb: Unlined with louvered vents in vertical sides.

C. Axial Roof Ventilators
1. Description: Direct- or belt-driven axial fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.
2. Housing: Heavy-gage, removable, spun-aluminum, dome top and outlet baffle; square, one-piece, hinged, aluminum base.
   a. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
3. Fan Wheel: Aluminum **OR** Steel, **as directed,** hub and blades.
4. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
   a. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
   b. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
   c. Pulleys: Cast-iron, adjustable-pitch motor pulley.
5. Accessories:
   a. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside **OR** outside, **as directed,** fan housing, factory wired through an internal aluminum conduit.
   b. Bird Screens: Removable, 1/2-inch (13-mm) mesh, aluminum or brass wire.

c. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
d. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

6. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- (40-mm-) thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch (40-mm) wood nailer. Size as required to suit roof opening and fan base.
   a. Configuration: Self-flashing without a cant strip, with mounting flange **OR** Built-in cant and mounting flange **OR** Built-in raised cant and mounting flange, **as directed**.
   b. Overall Height: 8 inches (200 mm) **OR** 9-1/2 inches (240 mm) **OR** 12 inches (300 mm) **OR** 16 inches (400 mm) **OR** 18 inches (450 mm), **as directed**.
   c. Sound Curb: Curb with sound-absorbing insulation matrix.
   d. Pitch Mounting: Manufacture curb for roof slope.
   e. Metal Liner: Galvanized steel.
   f. Burglar Bars: 1/2-inch- (13-mm-) **OR** 5/8-inch- (16-mm-) **OR** 3/4-inch- (19-mm-), **as directed,** thick steel bars welded in place to form 6-inch (150-mm) squares.
   g. Mounting Pedestal: Galvanized steel with removable access panel.

D. Upblast Propeller Roof Exhaust Fans
1. Description: Direct- or belt-driven propeller fans consisting of housing, wheel, butterfly-type discharge damper, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.
2. Wind Band, Fan Housing, and Base: Reinforced and braced galvanized steel **OR** aluminum, **as directed**, containing galvanized-steel **OR** aluminum, **as directed,** butterfly dampers and rain trough, motor and drive assembly, and fan wheel.
   a. Damper Rods: Steel with bronze **OR** nylon, **as directed,** bearings.
   b. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
3. Fan Wheel: Replaceable, cast **OR** extruded, **as directed,**-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.
4. Belt-Driven Drive Assembly: Resiliently mounted to housing; weatherproof housing of same material as fan housing with the following features:
   a. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
   b. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings.
   c. Pulleys: Cast-iron, adjustable-pitch motor pulley.
   d. Motor Mount: On outside of fan cabinet, adjustable base for belt tensioning.
5. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- (40-mm-) thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch (40-mm) wood nailer. Size as required to suit roof opening and fan base.
   a. Configuration: Self-flashing without a cant strip, with mounting flange **OR** Built-in cant and mounting flange **OR** Built-in raised cant and mounting flange, **as directed**.
   b. Overall Height: 8 inches (200 mm) **OR** 9-1/2 inches (240 mm) **OR** 12 inches (300 mm) **OR** 16 inches (400 mm) **OR** 18 inches (450 mm), **as directed**.
   c. Sound Curb: Curb with sound-absorbing insulation matrix.
   d. Pitch Mounting: Manufacture curb for roof slope.
   e. Metal Liner: Galvanized steel.
   f. Burglar Bars: 1/2-inch- (13-mm-) **OR** 5/8-inch- (16-mm-) **OR** 3/4-inch- (19-mm-), **as directed,** thick steel bars welded in place to form 6-inch (150-mm) squares.
   g. Mounting Pedestal: Galvanized steel with removable access panel.

E. Centrifugal Wall Ventilators
1. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories.
2. Housing: Heavy-gage, removable, spun-aluminum, dome top and outlet baffle; venturi inlet cone.
3. Fan Wheel: Aluminum hub and wheel with backward-inclined blades.

4. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
   a. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
   b. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
   c. Pulleys: Cast-iron, adjustable-pitch motor pulley.
   d. Fan and motor isolated from exhaust airstream.
5. Accessories:
   a. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
   b. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through internal aluminum conduit.
   c. Bird Screens: Removable, 1/2-inch (13-mm) mesh, aluminum or brass wire.
   d. Wall Grille: Ring type for flush mounting.
   e. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in wall sleeve; factory set to close when fan stops.
   f. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

F. Ceiling-Mounting Ventilators
1. Description: Centrifugal fans designed for installing in ceiling or wall or for concealed in-line applications.
2. Housing: Steel, lined with acoustical insulation.
3. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.
4. Grille: Plastic **OR** Stainless steel **OR** Aluminum **OR** Painted aluminum, **as directed**, louvered grille with flange on intake and thumbscrew attachment to fan housing.
5. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
6. Accessories:
   a. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
   b. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
   c. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
   d. Motion Sensor: Motion detector with adjustable shutoff timer.
   e. Ceiling Radiation Damper: Fire-rated assembly with ceramic blanket, stainless-steel springs, and fusible link.
   f. Filter: Washable aluminum to fit between fan and grille.
   g. Isolation: Rubber-in-shear vibration isolators.
   h. Manufacturer's standard roof jack or wall cap, and transition fittings.

G. In-Line Centrifugal Fans
1. Description: In-line, direct **OR** belt, **as directed,**-driven centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.
2. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
3. Direct-Driven Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing; with wheel, inlet cone, and motor on swing-out service door, **as directed**.
4. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.
5. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.
6. Accessories:
   a. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
   b. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
   c. Companion Flanges: For inlet and outlet duct connections.

d. Fan Guards: 1/2- by 1-inch (13- by 25-mm) mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
e. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

H. Propeller Fans
1. Description: Direct- or belt-driven propeller fans consisting of fan blades, hub, housing, orifice ring, motor, drive assembly, and accessories.
2. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.
3. Steel Fan Wheels: Formed-steel blades riveted to heavy-gage steel spider bolted to cast-iron hub.
4. Fan Wheel: Replaceable, cast **OR** extruded, **as directed,**-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.
5. Belt-Driven Drive Assembly: Resiliently mounted to housing, statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
a. Service Factor Based on Fan Motor Size: 1.4.
b. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
c. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
1) Ball-Bearing Rating Life: ABMA 9, L_{10} of 100,000 hours.
d. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
e. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
f. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
g. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.
6. Accessories:
a. Gravity Shutters: Aluminum blades in aluminum frame; interlocked blades with nylon bearings.
b. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
c. Wall Sleeve: Galvanized steel to match fan and accessory size.
d. Weathershield Hood: Galvanized steel to match fan and accessory size.
e. Weathershield Front Guard: Galvanized steel with expanded metal screen.
f. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
g. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

I. Motors
1. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
2. Enclosure Type: Open dripproof **OR** Totally enclosed, fan cooled, **as directed**.

J. Source Quality Control
1. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
2. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

1.3 EXECUTION

A. Installation
1. Install power ventilators level and plumb.
2. Support units using elastomeric mounts **OR** restrained elastomeric mounts **OR** spring isolators **OR** restrained spring isolators, **as directed,** having a static deflection of 1 inch (25 mm). Vibration- and seismic-control devices are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
   a. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.
3. For projects not in seismic areas, install floor-mounting units on concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-place Concrete".
4. For projects in seismic areas, install floor-mounting units on concrete bases designed to withstand, without damage to equipment, the seismic force required by code. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-place Concrete".
5. Secure roof-mounting fans to roof curbs with cadmium-plated hardware. Refer to Division 07 Section "Roof Accessories" for installation of roof curbs.
6. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
7. Support suspended units from structure using threaded steel rods and elastomeric hangers **OR** spring hangers **OR** spring hangers with vertical-limit stops, **as directed,** having a static deflection of 1 inch (25 mm). Vibration-control devices are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
8. Install units with clearances for service and maintenance.
9. Label units according to requirements specified in Division 23 Section "Identification For Hvac Piping And Equipment".
10. Duct installation and connection requirements are specified in other Division 21. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories".
11. Install ducts adjacent to power ventilators to allow service and maintenance.
12. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
13. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

B. Field Quality Control
1. Perform the following field tests and inspections and prepare test reports:
   a. Verify that shipping, blocking, and bracing are removed.
   b. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   c. Verify that cleaning and adjusting are complete.
   d. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
   e. Adjust belt tension.
   f. Adjust damper linkages for proper damper operation.
   g. Verify lubrication for bearings and other moving parts.
   h. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
   i. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
   j. Shut unit down and reconnect automatic temperature-control operators.
   k. Remove and replace malfunctioning units and retest as specified above.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 01 95 26 00

SECTION 01 95 26 00a - INTERIOR LIGHTING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for interior lighting. 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 lighting fixtures, lamps, and ballasts.
b. Emergency lighting units.
c. Exit signs.
d. Lighting fixture supports.
e. Retrofit kits for fluorescent lighting fixtures.

C. Definitions
1. BF: Ballast factor.
2. CCT: Correlated color temperature.
3. CRI: Color-rendering index.
4. HID: High-intensity discharge.
5. LER: Luminaire efficacy rating.
6. Lumen: Measured output of lamp and luminaire, or both.
7. Luminaire: Complete lighting fixture, including ballast housing if provided.

D. Submittals
1. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
a. Physical description of lighting fixture including dimensions.
b. Emergency lighting units including battery and charger.
c. Ballast, including BF.
d. Energy-efficiency data.
e. Air and Thermal Performance Data: For air-handling lighting fixtures. Furnish data required in "Submittals" Article in Division 23 Section "Diffusers, Registers, And Grilles".
f. Sound Performance Data: For air-handling lighting fixtures. Indicate sound power level and sound transmission class in test reports certified according to standards specified in Division 23 Section "Diffusers, Registers, And Grilles".
g. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
h. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
1) Testing Agency Certified Data: For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by manufacturer.
OR
Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
2. Shop Drawings: For nonstandard or custom lighting fixtures. 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. Samples: For each lighting fixture indicated in the Interior Lighting Fixture Schedule. Each Sample shall include the following:
   a. Lamps and ballasts, installed.
   b. Cords and plugs.
   c. Pendant support system.
4. Installation instructions.
5. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   a. Lighting fixtures.
   b. Suspended ceiling components.
   c. Partitions and millwork that penetrate the ceiling or extends to within 12 inches (305 mm) of the plane of the luminaires.
   d. Ceiling-mounted projectors.
   e. Structural members to which suspension systems for lighting fixtures will be attached.
   f. Other items in finished ceiling including the following:
      1) Air outlets and inlets.
      2) Speakers.
      3) Sprinklers.
      4) Smoke and fire detectors.
      5) Occupancy sensors.
      6) Access panels.
   g. Perimeter moldings.
6. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.
7. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.
8. Field quality-control reports.
9. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
   a. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.
10. Warranty: Sample of special warranty.

E. Quality Assurance
1. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
   OR
   Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910, complying with the IESNA Lighting Measurements Testing & Calculation Guides.
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. Comply with NFPA 70.
4. FM Global Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

F. Coordination
1. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

G. Warranty
1. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
a. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Final Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
b. Warranty Period for Emergency Fluorescent Ballast and Self-Powered Exit Sign Batteries: Seven years from date of Final Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

1.2 PRODUCTS

A. General Requirements For Lighting Fixtures And Components
1. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
2. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.
3. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
4. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.
5. Metal Parts: Free of burrs and sharp corners and edges.
6. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
7. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
8. Diffusers and Globes:
a. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
1) Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.
2) UV stabilized.
b. Glass: Annealed crystal glass unless otherwise indicated.
9. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
a. Label shall include the following lamp and ballast characteristics:
1) "USE ONLY" and include specific lamp type.
2) Lamp diameter code (T-4, T-5, T-8, T-12, etc.), tube configuration (twin, quad, triple, etc.), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
3) Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
4) Start type (preheat, rapid start, instant start, etc.) for fluorescent and compact fluorescent luminaires.
5) ANSI ballast type (M98, M57, etc.) for HID luminaires.
6) CCT and CRI for all luminaires.
10. Electromagnetic-Interference Filters: Factory installed to suppress conducted electromagnetic interference as required by MIL-STD-461E. Fabricate lighting fixtures with one filter on each ballast indicated to require a filter.
11. Air-Handling Fluorescent Fixtures: For use with plenum ceiling for air return and heat extraction and for attaching an air-diffuser-boot assembly specified in Division 15 Section "Diffusers, Registers, and Grilles."
a. Air-Supply Units: Slots in one or both side trims join with air-diffuser-boot assemblies.

b. Heat-Removal Units: Air path leads through lamp cavity.
c. Combination Heat-Removal and Air-Supply Unit: Heat is removed through lamp cavity at both ends of the fixture door with air supply same as for air-supply units.
d. Dampers: Operable from outside fixture for control of return-air volume.
e. Static Fixture: Air-supply slots are blanked off, and fixture appearance matches active units.

B. Ballasts For Linear Fluorescent Lamps
1. General Requirements for Electronic Ballasts:
a. Comply with UL 935 and with ANSI C82.11.
b. Designed for type and quantity of lamps served.
c. Ballasts shall be designed for full light output unless another BF, dimmer, or bi-level control is indicated.
d. Sound Rating: Class A **OR** Class A except Class B for T8/HO and T12/Slimline lamp ballasts, **as directed**.
e. Total Harmonic Distortion Rating: Less than 10 **OR** 20, **as directed**, percent.
f. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
g. Operating Frequency: 42 kHz or higher.
h. Lamp Current Crest Factor: 1.7 or less.
i. BF: 0.88 or higher.
j. Power Factor: 0.95 **OR** 0.98, **as directed**, or higher.
k. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.
2. Luminaires controlled by occupancy sensors shall have programmed-start ballasts.
3. Electronic Programmed-Start Ballasts for T5 **OR** T8 **OR** T5HO **OR** T5 and T5HO, **as directed**, Lamps: Comply with ANSI C82.11 and the following:
a. Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
b. Automatic lamp starting after lamp replacement.
4. Electromagnetic Ballasts: Comply with ANSI C82.1; energy saving, high-power factor, Class P, and having automatic-reset thermal protection.
a. Ballast Manufacturer Certification: Indicated by label.
5. Single Ballasts for Multiple Lighting Fixtures: Factory wired with ballast arrangements and bundled extension wiring to suit final installation conditions without modification or rewiring in the field.
6. Ballasts for Low-Temperature Environments:
a. Temperatures 0 Deg F (Minus 17 Deg C) and Higher: Electronic or electromagnetic type rated for 0 deg F (minus 17 deg C) starting and operating temperature with indicated lamp types.
b. Temperatures Minus 20 Deg F (Minus 29 Deg C) and Higher: Electromagnetic type designed for use with indicated lamp types.
7. Ballasts for Residential Applications: Fixtures designated as "Residential" may use low-power-factor electronic ballasts having a Class B sound rating and total harmonic distortion of approximately 30 percent.
8. Ballasts for Low Electromagnetic-Interference Environments: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for consumer equipment.
9. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.
a. Dimming Range: 100 to 5 percent of rated lamp lumens.
b. Ballast Input Watts: Can be reduced to 20 percent of normal.
c. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.
d. Control: Coordinate wiring from ballast to control device to ensure that the ballast, controller, and connecting wiring are compatible.
10. Ballasts for Bi-Level Controlled Lighting Fixtures: Electronic type.

a. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.
   1) High-Level Operation: 100 percent of rated lamp lumens.
   2) Low-Level Operation: 30 percent of rated lamp lumens.
b. Ballast shall provide equal current to each lamp in each operating mode.
c. Compatibility: Certified by manufacturer for use with specific bi-level control system and lamp type indicated.

11. Ballasts for Tri-Level Controlled Lighting Fixtures: Electronic type.
   a. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.
      1) High-Level Operation: 100 percent of rated lamp lumens.
      2) Low-Level Operation: 30 and 50 **OR** 30 and 60, **as directed**, percent of rated lamp lumens.
   b. Ballast shall provide equal current to each lamp in each operating mode.
   c. Compatibility: Certified by manufacturer for use with specific tri-level control system and lamp type indicated.

C. Ballasts For Compact Fluorescent Lamps
1. Description: Electronic-programmed rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:
   a. Lamp end-of-life detection and shutdown circuit.
   b. Automatic lamp starting after lamp replacement.
   c. Sound Rating: Class A.
   d. Total Harmonic Distortion Rating: Less than 20 percent.
   e. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
   f. Operating Frequency: 20 kHz or higher.
   g. Lamp Current Crest Factor: 1.7 or less.
   h. BF: 0.95 or higher unless otherwise indicated.
   i. Power Factor: 0.95 **OR** 0.98, **as directed**, except fixtures designated as "Residential" may use low-power-factor electronic ballasts, **as directed**, or higher.
   j. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.

D. Emergency Fluorescent Power Unit
1. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.
   a. Emergency Connection: Operate one fluorescent lamp(s) continuously at an output of 1100 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
   b. Nightlight Connection: Operate one fluorescent lamp continuously.
   c. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
      1) Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
      2) Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
   d. Battery: Sealed, maintenance-free, nickel-cadmium type.
   e. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
   f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more fluorescent lamps, remote mounted from lighting fixture. Comply with UL 924.
   a. Emergency Connection: Operate one fluorescent lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
   b. Nightlight Connection: Operate one fluorescent lamp in a remote fixture continuously.
   c. Battery: Sealed, maintenance-free, nickel-cadmium type.
   d. Charger: Fully automatic, solid-state, constant-current type.
   e. Housing: NEMA 250, Type 1 enclosure.
   f. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
   g. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
   h. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
   i. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

E. Ballasts For HID Lamps
   1. Electromagnetic Ballast for Metal-Halide Lamps: Comply with ANSI C82.4 and UL 1029. Include the following features unless otherwise indicated:
      a. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
      b. Minimum Starting Temperature: Minus 22 deg F (Minus 30 deg C) for single-lamp ballasts.
      c. Rated Ambient Operating Temperature: 104 deg F (40 deg C).
      d. Open-circuit operation that will not reduce average life.
      e. Low-Noise Ballasts: Manufacturers' standard epoxy-encapsulated models designed to minimize audible fixture noise.
   2. Electronic Ballast for Metal-Halide Lamps: Include the following features unless otherwise indicated:
      a. Minimum Starting Temperature: Minus 20 deg F (Minus 29 deg C) for single-lamp ballasts.
      b. Rated Ambient Operating Temperature: 130 deg F (54 deg C).
      c. Lamp end-of-life detection and shutdown circuit.
      d. Sound Rating: Class A.
      e. Total Harmonic Distortion Rating: Less than 20 percent.
      f. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
      g. Lamp Current Crest Factor: 1.5 or less.
      h. Power Factor: 0.90 or higher.
      i. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
      j. Protection: Class P thermal cutout.
      k. Bi-Level Dimming Ballast: Ballast circuit and leads provide for remote control of the light output of the associated fixture between high- and low-level and off.
         1) High-Level Operation: 100 percent of rated lamp lumens.
         2) Low-Level Operation: 35 **OR** 50, **as directed**, percent of rated lamp lumens.
         3) Compatibility: Certified by ballast manufacturer for use with specific bi-level control system and lamp type indicated. Certified by lamp manufacturer that ballast operating modes are free from negative effect on lamp life and color-rendering capability.
      l. Continuous Dimming Ballast: Dimming range shall be from 100 to 35 percent of rated lamp lumens without flicker.

1) Ballast Input Watts: Reduced to a maximum of 50 percent of normal at lowest dimming setting.

3. High-Pressure Sodium Ballasts: Electromagnetic type, with solid-state igniter/starter. Igniter/starter shall have an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg C.
   a. Instant-Restrike Device: Integral with ballast, or solid-state potted module, factory installed within fixture and compatible with lamps, ballasts, and mogul sockets up to 150 W.
   b. Minimum Starting Temperature: Minus 40 deg F (Minus 40 deg C).

F. Quartz Lamp Lighting Controller
1. General Requirements for Controllers: Factory installed by lighting fixture manufacturer. Comply with UL 1598.
2. Standby (Quartz Restrike): Automatically switches quartz lamp on when a HID lamp in the fixture is initially energized and during the HID lamp restrike period after brief power outages.
3. Connections: Designed for a single branch -circuit connection.
4. Switching Off: Automatically switches quartz lamp off when HID lamp strikes.
   OR
   Switching Off: Automatically switches quartz lamp off when HID lamp reaches approximately 60 percent light output.

G. Exit Signs
1. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
2. Internally Lighted Signs:
   a. Lamps for AC Operation: Fluorescent, two for each fixture, 20,000 hours of rated lamp life.
      OR
      Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
   b. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
      1) Battery: Sealed, maintenance-free, nickel-cadmium type.
      2) Charger: Fully automatic, solid-state type with sealed transfer relay.
      3) Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
      4) Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
      5) LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
      6) Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
      7) Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.
   c. Master/Remote Sign Configurations:
      1) Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply **OR** ballast **OR** battery, **as directed**, for power connection to remote unit.
      2) Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery, and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

3. Self-Luminous Signs: Powered by tritium gas, with universal bracket for flush-ceiling, wall, or end mounting. Signs shall be guaranteed by manufacturer to maintain the minimum brightness requirements in UL 924 for 10 **OR** 15 **OR** 20, **as directed**, years.
   OR
   Self-Luminous Signs: Using strontium oxide aluminate compound to store ambient light and release the stored energy when the light is removed. Provide with universal bracket for flush-ceiling, wall, or end mounting.

H. Emergency Lighting Units
   1. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.
      a. Battery: Sealed, maintenance-free, lead-acid type.
      b. Charger: Fully automatic, solid-state type with sealed transfer relay.
      c. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
      d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
      e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
      f. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
      g. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
      h. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
      i. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

I. Fluorescent Lamps
   1. T8 rapid-start lamps, rated 32 W maximum, nominal length of 48 inches (1220 mm), 2800 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life 20,000 hours unless otherwise indicated.
   2. T8 rapid-start lamps, rated 17 W maximum, nominal length of 24 inches (610 mm), 1300 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life of 20,000 hours unless otherwise indicated.
   3. T5 rapid-start lamps, rated 28 W maximum, nominal length of 45.2 inches (1150 mm), 2900 initial lumens (minimum), CRI 85 (minimum), color temperature 3000 K, and average rated life of 20,000 hours unless otherwise indicated.
   4. T5HO rapid-start, high-output lamps, rated 54 W maximum, nominal length of 45.2 inches (1150 mm), 5000 initial lumens (minimum), CRI 85 (minimum), color temperature 4100 K, and average rated life of 20,000 hours unless otherwise indicated.
   5. Compact Fluorescent Lamps: 4-Pin, CRI 80 (minimum), color temperature 3500 K, average rated life of 10,000 hours at three hours operation per start, and suitable for use with dimming ballasts, **as directed**.

J. HID Lamps
   1. High-Pressure Sodium Lamps: ANSI C78.42, CRI 21 (minimum), color temperature 1900 K, and average rated life of 24,000 hours, minimum.

a. Dual-Arc Tube Lamps: Arranged so only one of two arc tubes is lighted at one time and, when power is restored after an outage, the cooler arc tube, with lower internal pressure, lights instantly, providing an immediate 8 to 15 percent of normal light output.

2. Metal-Halide Lamps: ANSI C78.43, with minimum CRI 65, and color temperature 4000 K.
3. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and color temperature 4000 K.
4. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and color temperature 4000 K.
5. Low-Pressure Sodium Lamps: ANSI 78.41, CRI 0, and color temperature 1800 K.

K. Lighting Fixture Support Components
1. Comply with Division 26 Section "Hangers And Supports For Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
2. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
3. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
4. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).
5. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage (2.68 mm).
6. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
7. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

L. Retrofit Kits For Fluorescent Lighting Fixtures
1. Reflector Kit: UL 1598, Type I. Suitable for two- to four-lamp, surface-mounted or recessed lighting fixtures by improving reflectivity of fixture surfaces.
2. Ballast and Lamp Change Kit: UL 1598, Type II. Suitable for changing existing ballast, lamps, and sockets.

1.3 EXECUTION

A. Installation
1. Lighting fixtures:
a. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
b. Install lamps in each luminaire.
2. Temporary Lighting: If it is necessary, and approved by the Owner, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.
3. Remote Mounting of Ballasts: Distance between the ballast and fixture shall not exceed that recommended by ballast manufacturer. Verify, with ballast manufacturers, maximum distance between ballast and luminaire.
4. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.
a. Install ceiling support system rods or wires, independent of the ceiling suspension devices, **as directed**, for each fixture. Locate not more than 6 inches (150 mm) from lighting fixture corners.
b. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
c. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.
d. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
5. Suspended Lighting Fixture Support:
a. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.

b. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
c. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
d. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

6. Air-Handling Lighting Fixtures: Install with dampers closed and ready for adjustment.
7. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

B. Identification
1. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Division 26 Section "Identification For Electrical Systems".

C. Field Quality Control
1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
2. Verify that self-luminous exit signs are installed according to their listing and the requirements in NFPA 101.
3. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

D. Startup Service
1. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by the Owner. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage.

E. Adjusting
1. Occupancy Adjustments: When requested within 12 months of date of Final Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.
a. Adjust aimable luminaires in the presence of the Owner.

END OF SECTION 01 95 26 00a

Task	Specification	Specification Description
01 95 26 00	01 22 16 00	No Specification Required

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SECTION 01 95 99 99 - 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 Rough 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 Rough 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 31 Section "Earth Moving".
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 31 Section "Earth Moving".
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 32 Section "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 01 95 99 99

SECTION 01 95 99 99a - RELIEF WELLS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for relief 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. Submittals
1. Shop Drawings: Submit shop drawings.
2. Statements
a. Before installation, all well screen shall be approved.
b. The filter pack material and its gradation shall be approved before it is placed.
c. Submit the cement grout mixture proportion to be used in plugging abandoned wells.
3. Reports: Submit sampling and testing reports for each relief well, logs of the borings, well screen and riser pipe, backfill material, and pump tests. Register each well with the state as required by the state in which the well is installed.

C. Regulatory Requirements: The state statutory and regulatory requirements form a part of this specification.

1.2 PRODUCTS

A. Well Screen: The Contractor may, at its option, furnish and install well screen of any of the alternate types specified. The clear inside diameter of the screen shall be as directed by the Owner. Screen openings shall be uniform in size and pattern, and shall be spaced approximately equally around the circumference of the pipe.
1. PVC Pipe Screen: Pipe, fittings, and screen shall be of the size and types specified. Pipe, fittings, and screen shall conform to ASTM D 1784, ASTM D 1785, ASTM D 2466, or ASTM D 2467. All joints in the PVC pipe shall include couplings and shall be glued with a solvent cement conforming to ASTM D 2564. The PVC pipe strength properties shall be equivalent to PVC 1120 Schedule 40 **OR** 80, **as directed**, unthreaded plastic pipe.
a. Couplings: Couplings shall be bonded socket **OR** threaded, **OR** certilock, **as directed**, type. Fittings shall be produced of the same material and equal quality as specified for plastic pipe screen. Socket type fitting connections of pipe sections shall be bonded with solvent cement. The determination of the proportions and preparation of adhesives, the method of application, and the procedure used for making and curing the connections shall be the responsibility of the Contractor. The system for making joints at the relief well site shall provide a curing period adequate to develop the ultimate strength of the solvent cement. Self-tapping screws or other devices for holding pipe in the couplings during the setting period may be utilized as long as the screws do not penetrate the inside of the pipe. In no case shall a newly-made joint in the casing be stressed, lowered into the relief well, or be submerged in water prior to complete curing of the solvent cement adhesive.
b. Perforations: The PVC well screen shall be mill slot **OR** continuous wire wrapped rod base **OR** continuous wire wrapped rod base on perforated pipe **OR** continuous wire wrapped on perforated pipe screen **OR** similar to that manufactured by Johnson Well Equipment, Inc., Pensacola, FL, telephone (904) 453-3131, **as directed**. All well screen shall have smooth, sharp-edged openings free of burns, chipped edges, or broken areas on the interior and exterior surfaces of the pipe. The slots or groups of slots shall be distributed in a uniform pattern around the periphery of the pipe and shall be oriented with the length of the slot parallel to, normal to, or diagonal with the axis of the pipe.

2. Fiberglass Pipe Screen: Fiberglass pipe screen and fittings shall be manufactured from thermosetting epoxy resins and glass fiber by either a centrifugal casting process or by a filament winding process. Glass fiber used shall be continuous filament, electrical glass with a finish compatible with epoxy resins. Each glass fiber or filament shall be thoroughly impregnated with epoxy resin. Fiberglass pipe wall thickness, strength and durability requirements shall be equivalent to the Fiberglass/Epoxy pipe produced by Fiberglass Resources Corporation of Farmingdale, New York or Burgess Well Company, Inc., Minden, Nebraska, telephone (308) 832-1642. All fiberglass pipe and fittings shall be round and straight, of uniform quality and workmanship, and free from all defects including indentation, delamination, bends, cracks, blisters, porosity, dry spots, resin segregation and resin-starved areas. The inside of the pipe and fittings shall be smooth and uniform. The impregnation of the glass fiber with resin shall be such that when the pipe is cut or slotted, no fraying or looseness of glass fiber occurs.
   a. Couplings: Couplings for fiberglass pipe sections shall be socket threaded or mechanical key-type couplings. The couplings shall be manufactured of the same materials used for the fiberglass pipe specified herein and may be either cast integrally with the pipe sections or as separate components for attachment to the pipe in the manufacturers plant. Key-type couplings shall consist of male and female halves designed for joining and locking together by means of a key strip inserted in grooves in the coupling halves. The minimum wall thickness remaining at any grooved section shall not be less than the minimum thickness specified for pipe. Key strips and locking strips shall be of fiberglass, plastic or other non-corrosive material capable of withstanding shearing and bearing stresses equivalent to the design load for the coupling. Socket type fitting connections of the pipe sections shall be bonded with epoxy adhesive. The epoxy materials and bonding agents shall be as recommended by the pipe manufacturer. Self-tapping screws or other devices for holding adhesive-joined pipe in the couplings during the curing period may be utilized. In no case shall a newly-made joint in the casing pipe be lowered into the relief well, or be submerged in water prior to complete curing of the adhesive.
   b. Perforations: All fiberglass well screen shall be mill slot **OR** continuous wire wrapped rod base, **as directed**. All relief well screen shall have smooth, sharp-edged openings free of burrs, chipped edges, or broken areas on the interior and exterior surfaces of the pipe. The slots or groups of slots shall be distributed in a uniform pattern around the periphery of the pipe and shall be oriented with the length of the slot parallel to, normal to, or diagonal with the axis of the pipe.
3. Steel Pipe Screen: Steel well screen shall consist of perforated or slotted sections of steel pipe conforming to the requirements of ASTM A 53.
   a. Couplings: Couplings for steel pipe screen shall be welded joints or threaded couplings. Welding shall be performed in accordance with requirements in ASME B31.9. Couplings shall meet the material requirements specified for steel pipe screen, except perforations shall be omitted. All threaded pipe and fittings shall be threaded in accordance with ASME B1.20.1. All threaded pipe sections may be field connected. Couplings shall be given the same protection against corrosion as specified for the well screen pipe. Protective coatings damaged while making couplings shall have the areas recoated.
   b. Perforations: All steel pipe to be used as relief well screen shall be provided with perforations which shall consist of either machine-cut slots; drilled or punched openings. The slots or groups of slots shall be distributed in a uniform pattern around the periphery of the pipe and shall be oriented with the length of the slot parallel to, normal to, or diagonal with the axis of the pipe. The pattern of the openings shall be uniformly spaced around the periphery of the pipe.
4. Stainless Steel Well Screen: The perforated well screen and fittings shall be fabricated entirely from stainless steel conforming to ASTM A 312/A 312M, Type 304, 304-L, 316 or 316-L. The well screen shall be of stainless steel with a keystone wire-wrapped continuous slot strainer equivalent to that manufactured by Howard Smith Screen Company, Houston, TX, telephone (713) 869-5771 or Johnson Screens, St. Paul, MN 55164, telephone (612) 636-3900.
   a. Couplings: Couplings for the stainless steel well screen shall consist of the same material as the well screen and shall be threaded, flanged, and/or fitted with a welding ring. The

couplings shall conform in design to the couplings recommended by the manufacturer of the well screen.

b. Tailpipe for Well Screen: The tailpipe for each well screen shall be made of the same material and at least the same minimum thickness as the riser pipe and shall include a bottom plug.

B. Riser Pipe: The relief well riser pipe material and method of manufacture shall conform to the requirements specified in paragraph WELL SCREEN, except that the screen perforations or opening shall be omitted. The relief well riser pipe diameter and discharge details shall be as directed. Couplings to the well screen and between riser pipe sections shall be as specified in paragraph COUPLING.

C. Filter Pack: Material for the filter pack around the riser pipes and screens shall be a washed grave, **OR** washed sand **OR** dry processed sand, **as directed**, composed of hard, tough, and durable particles free from adherent coating. The filter pack shall not be crushed stone. The filter pack material shall contain no detrimental quantities of organic matter nor soft, friable, thin, or elongated particles in accordance with the quality requirements in ASTM C 33, Table 1 and Table 3, Class 5S, and in ASTM E 11, Table 1.

D. Outlet For Relief Well: Check Valve.

1. The check valve shall be a one piece reinforced all rubber (neoprene) check valve with an integral elastomer flange similar and equal to the Red Valve Series 35, manufactured by Red Valve Company, Inc., 700 North Bell Ave., Pittsburgh, PA 15106, telephone (412) 279-0044. The backup ring for the check valve shall be stainless steel. Stainless steel bolts, washers, and nuts shall be used to fasten the valves onto the flanged end of the pipes. The check valve shall be installed with the flared end duck bill in a vertical position.
   OR
   Fabricate check valves of brass **OR** stainless steel **OR** aluminum, **as directed**, plate, threaded fasteners and rods. Fabricate sealing disc of silicone sponge rubber free of porous areas, foreign materials, and visible defects.
2. Workmanship and metalwork fabrication of check valves shall be as directed. Install check valves accurately vertically and adjust to the required elevation.

E. Concrete: Concrete shall conform to the requirements specified in Division 03 Section "Cast-in-place Concrete".

1.3 EXECUTION

A. Drilling: Wells may be drilled by the reverse rotary circulation method or other method approved, which will ensure proper placement of the well screen, riser pipe, and filter pack. Methods which involve radical displacement of the formation, or which may reduce the yield of the well, will not be permitted. Excavated material shall be disposed of as directed.

1. Reverse Circulation Method: If the reverse circulation method is used for drilling wells, all of the drilling fluid shall be removed from the filter pack and the natural pervious formation. If in the opinion of the Owner the walls of the hole above the top of the filter pack require support during development operations, a temporary casing similar to that specified in paragraph TEMPORARY CASING shall be placed so as to extend from the ground surface to at least 3 ft (1 m) below the top of the filter pack. The diameter of the hole shall be such as will permit the placement of the minimum thickness of filter pack as specified in paragraph FILTER PACK PLACEMENT. The drilling fluid shall be a suspension of fine grained soil or shall be a commercial product of a recognized manufacturer, shall be approved by the Owner, and shall have the characteristic of being readily removable from the filter pack and the walls of the formation by development as specified in paragraph DEVELOPMENT. The use of bentonite will not be permitted.
2. Temporary Casing: Temporary well casing of either iron or steel of sufficient length to case to the bottom of all borings shall be available at the construction site. the Owner will direct the use of a temporary casing to the bottom of the boring during drilling and placement of screen, riser, and

filter pack when it believes it is necessary to provide adequate support to the sides of the hole. When the walls of the boring will require support only during development operations a temporary casing will be required to extend only to a depth 3 ft (3 m) below the top of the filter pack. The temporary casing, shall have sufficient thickness to retain its shape and maintain a true section throughout its depth, and may be in sections of any convenient length. The temporary casing shall be such as to permit its removal without disturbing the filter pack, riser, or well screen. The setting of temporary casing shall be such that no cavity will be created outside of it at any point along its length. In the event the temporary casing should become unduly distorted or bent it shall be discarded and a new casing shall be used during installation of any additional relief wells.

B. Installation Of Riser Pipe And Screen

1. Assembly: All riser pipe and screen shall be in good condition before installation and all couplings and other accessory parts shall be securely fastened in place. The successive lengths of pipe shall be arranged to provide accurate placement of the screen sections in the bore hole. The riser-pipe shall be provided with an approved cap and a flanged top section, the top of which shall be set at the elevation directed. Centralizers shall be attached to the assembled riser pipe and screen in such numbers and of a type that they will satisfactorily center the riser pipe and screen in the well and will hold it securely in position while the filter pack material is being placed.
2. Joints: Sections of relief well pipe shall be joined together as specified in paragraph COUPLINGS. Joints shall be designed and constructed to have the strength of the pipe and where possible a strength capable to support the weight of the relief well stem as it is lowered into the hole. When not practicable to construct joints that will support the weight of the relief well stem, the stem shall be supported at the lower end by any approved means that will assure that the joints do not open while being lowered into place in the well.
3. Installation: The assembled riser pipe and screen shall be placed in the bore hole in such manner as to avoid jarring impacts and to ensure that the assembly is centered and not damaged or disconnected. The screen shall be suspended in the hole and not resting on the bottom of the hole. After the screen and riser pipe have been placed, a filter pack shall be constructed around the screen section as specified in paragraph FILTER PACK PLACEMENT and the well developed as specified in paragraph DEVELOPMENT. The top of the riser pipe shall be held at the designated elevation during placement of the filter pack.
4. Check for Plumbness and Alignment: The well shall be constructed and all casing set round, plumb, and true. The Contractor shall perform the following tests after the installation of the well but prior to backfilling, and before its acceptance. Additional tests may be made during the performance of the work at the option of the Contractor. Should the Contractor fail to correct, at no additional cost to the Owner, any faulty alignment or plumbness disclosed as a result of these tests, the Owner may refuse to accept the well. the Owner may waive the requirements for plumbness if in its judgement the Contractor has exercised all possible care in constructing the well and the defect is due to circumstances beyond its control or if the utility of the completed well is not materially affected or if the cost of necessary remedial measures will be excessive. In no event will the provisions with respect to alignment be waived.
    a. Plumbness: Plumbness shall be tested by use of a plumb line. The plummet shall be suspended from a small diameter wire rope and its point of suspension shall be in the exact center of the plummet. The plummet shall be sufficiently heavy to stretch the wire rope taut. The wire rope shall pass over a guide sheave which shall be positioned above the top of the well and adjusted horizontally so that the plummet hangs in the center of the well. Displacement of the wire rope during the plumbness check shall be measured by means of a transparent plastic sheet on which a number of concentric circles shall be scribed or drawn, and which is centered on the top of the well. The exact center of these circles shall be marked, and then a slot, slightly larger than the plumb line and extending from this center to the edge, shall be cut in the plastic sheet. As the plummet is lowered, any out-of-plumb condition of the well will be indicated by the wire rope tending to drift away from the center, and the plastic sheet shall be rotated until the slot is oriented in the direction of this drift, while at all times maintaining the center of the concentric circles coincident with the center of the well. Measurement of the amount of drift shall be made

along the edge of the slot for each increment by which the plummet is lowered into the well. Drift at any depth shall be determined by multiplying the measured plumb line displacement by the total length of the plumb line and dividing the result by the fixed distance between the guide sheave and the top of the well. If desired, alignment may be calculated from the plumbness data in lieu of the alignment check described in paragraph ALIGNMENT. Should the well vary from the vertical in excess of allowable, the plumbness of the well shall be corrected by the Contractor at no additional cost to the Owner.

b. Alignment: Alignment shall be tested by lowering into the well a section of cylinder or a dummy of the same length. The outside diameter of cylinder shall be smaller than the inside diameter of the well. Should the cylinder fail to move freely throughout the length of the well, the alignment of the well shall be corrected by the Contractor at no additional expense to the Owner.

C. Filter Pack Placement: After the well screen and riser pipe have been installed, the filter pack material shall be placed by tremie, when using a well graded material, in an approved manner such that segregation will not occur. When using a uniform graded filter material, the material may be poured around the well screen at a rate that will prevent bridging of the material. The material shall be placed around all sides of the screen to assure that the screen is not pushed against the side of the bore hole causing the screen to come in contact with foundation material or prevent the proper thickness of filter from being placed uniformly around the screen. The filter pack shall be placed at a constant rate from the start of placement until it has reached the elevation directed. If a tremie is required, a double string of tremie pipe shall be used. The pipes shall be placed on opposite sides of the screen and/or casing, that is, 180 degrees apart, and shall be guided in such a manner that they will remain in this position throughout the placing process. The tremie pipes shall be set in place, filled completely with filter pack prior to being lifted off the bottom of the hole. The filter pack in the tremie pipe shall be kept above the water surface in the well throughout the placing process. In no case shall the gradation of the filter pack fall outside of the range specified in paragraph FILTER PACK.

D. Development

1. General: Following placement of filter pack materials, the Contractor shall develop the relief well by jetting, surging, intermittent pumping, or other approved methods as may be necessary to give the maximum yield of water. At the time of development of any relief well, the well shall be free of drawdown or surcharge effects due to pump testing, developing or drilling at another location. The Contractor shall be responsible for maintaining at the relief well the needed access and work area and clearance in the relief well necessary to accomplish development. The Contractor shall furnish, install, or construct the necessary discharge line and troughs to conduct and dispose of the discharge a sufficient distance from the work areas to prevent damage. Development shall be conducted to achieve a stable well of maximum efficiency and shall be continued until a satisfactory sand test, as specified in paragraph SAND TEST, is obtained. As development proceeds, filter pack material shall be added to the annular space around the screen to maintain the top elevation of the filter pack to the specified elevation. The Contractor shall provide an open tube or other approved means for accurately determining the water level in the well under all conditions. If at any time during the development process it becomes apparent in the opinion of the Owner that the well may be damaged, development operations shall be immediately terminated. the Owner may require a change in method if the method selected does not accomplish the desired results. the Owner may order that wells which continue to produce excessive amounts of fines after development for 6 hours be abandoned, plugged, and backfilled, and may require the Contractor to construct new wells nearby. All materials pulled into the well by the development process shall be removed prior to performing the pumping test.

a. Jetting: Jetting should be performed using either a single or double ring jet. The jetting tool shall be constructed of high-strength material and conservatively designed and proportioned so that it will withstand high pressures. The jetting tool shall have two hydraulically balanced nozzles spaced 180 degrees **OR** four diameter holes spaced 90 degrees, **as directed**, apart and which shall exert the jetting force horizontally through the screen slots. The rings shall be constructed such that the tips of the jets shall be within 1/2 in. (13 mm) from the inner surface of the well screen. The pump used in conjunction with

the jetting tool shall be capable of providing a minimum jetting fluid exit velocity of 150 feet per second (45 meters per second). Prior to commencing jetting, and following each jetting cycle, all sand and/or other materials shall be removed from inside the screen. All wells shall be pumped during the jetting cycle to remove incoming sand and other material. Such pumping shall be at a rate not less than 115 percent of the rate at which fluid is introduced through the jetting tool. This will allow a flow of material into the well as it is being developed. Water used for development shall be free of sand. the Owner may require other means of developing the well such as intermittent pumping method, variation of the intermittent pumping method, or surge block if it appears that the development of the well is not producing the desired results.

b. Intermittent Pumping: Intermittent pumping shall be performed by pumping the well at a capacity sufficient to produce a rapid drawdown, stopping the pump (backflow through pump will not be permitted) to permit the water surface to rise to its former elevation, and repeating this procedure. Cycle time for this procedure will vary as directed but will not be more than 3 cycles per minute. A deep well turbine pump, or electric submersible pump with check valve, shall be used with any attachment necessary to accomplish rapid starting and stopping for intermittent pumping. The intake shall be set below the maximum expected drawdown in the well. Prior to commencing intermittent pumping, and periodically during development by this method, all sand and/or other materials shall be removed from inside the screen. The amount of drawdown may be decreased if, in the opinion of the Owner, the efficiency of the well might otherwise be impaired.

c. Surging: Surging of the well shall require use of a circular block which is smaller in diameter than the inside diameter of the relief well and is constructed of a material which will not damage the screen if the block comes in contact with the screen, and a bailer or pump to remove materials drawn into the well. The surging shall be continued for a period of approximately one hour or until little or no additional material from the foundation or filter pack can be pulled through the screen. The surge block shall be moved by a steady motion up and down the full length of the well screen. Prior to commencing surging, and periodically during development by this method, all sand and/or other materials shall be removed from inside the screen. All materials pulled into the well by the surging process shall be removed by the Contractor.

E. Backfilling: After the well has been developed, additional filter pack shall be added if necessary to meet the requirements of paragraph FILTER PACK PLACEMENT. Then the annular space above the filter pack, shall be backfilled by first placing a layer of concrete sand on the filter pack and then filling the remainder of the space up to the finished ground surface **OR** well pit, **as directed**, with grout or concrete. The concrete backfill shall be placed to a depth at least equal to the existing impervious blanket. For PVC riser pipe, after the well has been developed, additional filter pack shall be added if necessary for it to meet the requirements of paragraph FILTER PACK PLACEMENT. Then the remaining annular space above the filter pack shall be backfilled by first placing a layer of concrete sand on the filter pack and then filling the remainder of the space up to the finished ground surface **OR** well pit, **as directed**, with bentonite. The temporary casing, if used, shall be withdrawn in increments as the backfill is placed. The Contractor shall fill with impervious material to original grade all pits such as those incidental to the reverse rotary circulation method of drilling.

F. Plugging Of Abandoned Wells: The Contractor has the option of attempting to remove the well screen. If the well screen can be removed, the Contractor will grout the bore hole starting from the bottom of the hole. The grouting shall start at the elevation of the bottom of the tailpipe of the well. If the well screen can not be removed or breaks off during the removal attempt, the Contractor shall still be responsible for grouting the well from the bottom of the tailpipe to within 3 ft (1 m) of ground surface. Either of the above abandonment procedures may require the Contractor to redrill the hole so that the bore hole can be grouted. The well shall be grouted from the bottom of the tailpipe. After the grout has setup the riser pipe shall be cutoff. Then the hole shall be backfilled. The cement grout mixture proportion to be used shall be submitted for approval.

G. Tests

1. Pump Test: Upon completion but before acceptance, each well shall be subjected to a pump test of which a sand test will form a part. The Contractor shall provide a deep well turbine pump, capable of producing the specified drawdowns over periods of time sufficient to satisfactorily perform the pump test specified herein. The intake shall be set below the maximum expected drawdown in the well. The amount of sand shall be measured after each test. The pump shall be complete with either gasoline, diesel, or electric motor of adequate size. In case an electric motor is used, the Contractor shall provide, without additional cost to the Owner, the electric power and the necessary wiring. The Contractor shall provide an open tube or other approved means for accurately determining the water level in the well. The Contractor shall furnish and install an orifice meter of approved design or other approved equipment for the purpose of measuring the discharge from the well during the pumping test. The Contractor shall furnish, install, or construct the necessary pipe discharge line, troughs, or ditches necessary to dispose of the pumping test discharge a sufficient distance from the work area to prevent damage. The tests will be conducted under the direction of the Owner and may be made as soon as each well is completed. Test data will be recorded by the Owner. The Contractor shall test each well by pumping continuously for a minimum of 6 hours. Prior to starting the pump test all material shall be removed from the bottom of the well. If the test is interrupted, other than by order of the Owner, prior to the completion of the specified period of continuous operation, the test shall be re-run. In addition to the required pumping test, the Owner may direct the Contractor to perform additional pump tests. Such additional testing shall conform in general to the requirements specified herein except that the duration of the tests and the approximate draw-down will be determined by the Owner. In the event that sand or other material collects in the well as a result of the pump test, accurate measurements shall be taken as to the quantity of material in the well and all such material shall be removed by the Contractor. Upon completion of the pump test, the Contractor shall remove all equipment, discharge lines, electrical lines, lumber, and debris, and shall backfill any excavated areas with impervious material.
2. Sand Test: As part of each Pump Test or at the end of each intermittent pumping a determination of the amount of sand (filter pack and/or foundation material) a well is producing shall be performed. Prior to starting the sand test all material shall be removed from the bottom of the tailpipe. After the pump is at the desired pumping rate the flow from the discharge shall be diverted into a container that will collect all the sand being carried by the water **OR** through a Rossum Sand Tester, **as directed**. Upon completion of the test the amount of sand in the tailpipe shall be determined to verify that no material is being deposited in the bottom of the well.
3. Filter Pack Sampling and Testing: The Contractor shall verify that all materials conform to the specifications before delivery to the project. The particle size distribution of the filter pack shall be sampled and tested by the Contractor in accordance with ASTM C 136 and ASTM D 75. Within 48 hours before being placed in the relief well to be back-filled, the filter pack shall be sampled from the material stockpiled at the project site. There shall be at least one particle size distribution test on the filter pack for each well. A pump test shall be performed in accordance with technical provisions herein specified.
4. Reports: Reports shall include, for each relief well, logs of the boring, elevations of the well screen, top of riser pipe, bottom of the tailpipe, filter pack gradation, quantity of filter pack added during development, pump test, sand test, and report of backfilling. The log of backfill material shall include the filter pack particle size distribution test data, and notes concerning installation and development of the relief well. The pump test log shall include the duration of the test and the draw-down response data with time in the pumped well, in adjacent wells, and in nearby piezometers. The relief well log and the pump test log shall be submitted to the Owner. The Contractor shall also submit a report of the well installation to the appropriate public agency and in the form required by state statutory and/or regulatory requirements specified in paragraph REGULATORY REQUIREMENTS.

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SECTION 01 95 99 99b - 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 the 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 the Owner no fewer than two days in advance of proposed interruption of service.
b. Do not proceed with interruption of water-distribution service without the 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 33 Section "Common Work Results For Utilities" 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 31 Section "Earth Moving" 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 22 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 22 Section "Common Work Results For Plumbing".
14. Mechanical sleeve seals are specified in Division 22 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 21 Section "Common Work Results For Fire Suppression" for fire-suppression-water piping inside the building.
17. See Division 22 Section "Common Work Results For Plumbing" for potable-water piping inside the building.

F. Joint Construction
1. See Division 22 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 22 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 28.

U. Connections
1. Piping installation requirements are specified in other Division 22. Drawings indicate general arrangement of piping, fittings, and specialties.
2. See Division 22 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 22 for connection to sanitary-sewer **OR** storm-drainage system. See Division 23 for connection to storm-sewer, **as directed**, piping.
6. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
7. Connect wiring according to Division 26 Section "Low-voltage Electrical Power 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 31 Section "Earth Moving".
2. Permanently attach equipment nameplate or marker indicating plastic water-service piping, on main electrical meter panel. See Division 22 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 01 95 99 99b

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SECTION 01 95 99 99c - 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 the 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 the Owner no fewer than seven days in advance of proposed interruption of water service.
b. Do not proceed with interruption of water service without the 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 22 Section "Facility Indoor 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 22 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 22.

1.3 EXECUTION

A. Preparation
1. Pilot-Hole Data: Review pilot-hole test analysis furnished by the 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 22 Section "Facility Water Distribution Piping". 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 26 Section "Grounding And Bonding For Electrical Systems".
3. Connect wiring according to Division 26 Section "Low-voltage Electrical Power 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 01 95 99 99c

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SECTION 01 95 99 99d - 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 1064/A 1064M, 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 1064/A 1064M, 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 31 Section "Earth Moving".

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 22 Section "Sanitary Waste And Vent Piping".
2. Connect force-main piping to building's sanitary force mains specified in Division 22 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 22 Section "Sanitary Waste 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 31 Section "Earth Moving".

J. Identification

1. Materials and their installation are specified in Division 31 Section "Earth Moving". 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 01 95 99 99d

SECTION 01 95 99 99e - CHAIN-LINK FENCES AND GATES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for 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. Chain-link fences.
b. Gates: Manually and Motor operated, horizontal slide and swing.

C. Performance Requirements
1. Delegated Design: Design chain-link fences and gates, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Structural Performance: Chain-link fence 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 and Maximum Spacing: Determine according to CLFMI WLG 2445, based on mesh size and pattern specified and on the following:
1) Wind Loads: <**Insert loads required for Project location**>.
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**.
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.
a. Fence and gate posts, rails, and fittings.
b. Chain-link fabric, reinforcements, and attachments.
c. Accessories: Privacy slats **OR** Barbed wire **OR** Barbed tape, **as directed**.
d. Gates and hardware.
e. Gate operators, including operating instructions.
f. Motors: Show nameplate data, ratings, characteristics, and mounting arrangements.
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, and gate, from manufacturer.
7. Product Test Reports: For framing strength according to ASTM F 1043.
8. Field quality-control reports.
9. Operation and Maintenance Data: For the following to include in emergency, operation, and maintenance manuals:
   a. Polymer finishes.
   b. Gate hardware.
   c. Gate operator.
10. 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 gates with 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 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) Faulty operation of gate operators and controls.
      2) Deterioration of metals, metal finishes, and other materials beyond normal weathering.
   b. Warranty Period: Five **OR** 15, **as directed**, years from date of Final Completion.

1.2 PRODUCTS

A. Chain-Link Fence Fabric
1. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist. Comply with CLFMI Product Manual and with requirements indicated below:
   a. Fabric Height: As indicated on Drawings **OR** As directed.
   b. 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**.
      1) Mesh Size: 2-1/8 inches (54 mm) **OR** 2 inches (50 mm) **OR** 1-3/4 inches (44 mm) **OR** 1 inch (25 mm), **as directed**.
      2) 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**.
      3) 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.

4) Zn-5-Al-MM Aluminum-Mischmetal-Coated Fabric: ASTM F 1345, Type III, Class 1, 0.60 oz./sq. ft. (183 g/sq. m) **OR** Class 2, 1.0 oz./sq. ft. (305 g/sq. m), **as directed**.
5) Polymer-Coated Fabric: ASTM F 668, 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: Dark green **OR** Olive green **OR** Brown **OR** Black **OR** As selected from manufacturer's full range, **as directed**, complying with ASTM F 934.
6) Coat selvage ends of fabric that is metallic coated before the weaving process with manufacturer's standard clear protective coating.

c. Aluminum Wire Fabric: ASTM F 1183, with mill **OR** caustic-cleaned or etched, **as directed**, finish, and wire diameter of 0.148 inch (3.76 mm) **OR** 0.192 inch (4.88 mm), **as directed**.
1) Mesh Size: 2 inches (50 mm) **OR** 1 inch (25 mm), **as directed**.

d. Selvage: Knuckled at both selvages **OR** Twisted top and knuckled bottom, **as directed**.

B. Fence Framing

1. Posts and Rails: Comply with ASTM F 1043 for framing, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 or ASTM F 1083, **as directed**, based on the following:
a. Fence Height: 72 inches (1830 mm) **OR** 96 inches (2440 mm) **OR** As indicated on Drawings, **as directed**.
b. Light Industrial Strength: Material Group IC-L, round steel pipe, electric-resistance-welded pipe **OR** Group II-L, roll-formed steel C-section shapes **OR** Group III-L, hot-rolled H-beam shapes **OR** Group IV, Alternative Design, **as directed**.
1) Line Post: 1.9 inches (48 mm) in diameter **OR** 2.375 inches (60 mm) in diameter **OR** 2.875 inches (73 mm) in diameter **OR** 2.25 by 1.7 inches (57 by 43 mm), **as directed**.
2) End, Corner and Pull Post: 2.375 inches (60 mm) **OR** 2.875 inches (73 mm) **OR** 4.0 inches (102 mm) **OR** 2.25 by 1.7 inches (57 by 43 mm), **as directed**.
c. Heavy Industrial Strength: Material Group IA, round steel pipe, Schedule 40 **OR** Group IC, round steel pipe, electric-resistance-welded pipe **OR** Group II, roll-formed steel C-section shapes **OR** Group III, hot-rolled H-beam shapes **OR** Group IV, Alternative Design, **as directed**.
1) Line Post: 1.9 inches (48 mm) in diameter **OR** 2.375 inches (60 mm) in diameter **OR** 2.875 inches (73 mm) in diameter **OR** 4.0 inches (102 mm) in diameter **OR** 6.625 inches (168 mm) in diameter **OR** 1.875 by 1.63 inches (48 by 41 mm) **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: 2.375 inches (60 mm) in diameter **OR** 2.875 inches (73 mm) in diameter **OR** 4.0 inches (102 mm) in diameter **OR** 6.625 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) **OR** 3.5 by 1.5 inches (89 by 38 mm), **as directed**.
d. Horizontal Framework Members: Intermediate, top and bottom rails, **as directed**, complying with ASTM F 1043.
1) Top Rail: 1.66 inches (42 mm) in diameter **OR** 1.25 by 1.63 inches (32 by 41 mm), **as directed**.
e. Brace Rails: Comply with ASTM F 1043.
f. 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.
g. 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 the following minimum coating weight:
1) Class 3: Not less than 0.8 oz./sq. ft. (244 g/sq. m) of uncoated wire surface.
2) Class 4: Not less than 1.2 oz./sq. ft. (366 g/sq. m) of uncoated wire surface.
3) Class 5: Not less than 2 oz./sq. ft. (610 g/sq. m) of uncoated wire surface.
4) Matching chain-link fabric coating weight.
c. Type III, Zn-5-Al-MM alloy with the following minimum coating weight:
1) Class 60: Not less than 0.6 oz./sq. ft. (183 g/sq. m) of uncoated wire surface.
2) Class 100: Not less than 1 oz./sq. ft. (305 g/sq. m) of uncoated wire surface.
3) Matching chain-link fabric coating weight.
2. Polymer-Coated Steel Wire: 0.177-inch- (4.5-mm-) **OR** 0.148-inch- (3.8-mm-), **as directed**, 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.
3. Aluminum Wire: 0.192-inch- (4.88-mm-) diameter tension wire, mill finished, complying with ASTM B 211 (ASTM B211M), Alloy 6061-T94 with 50,000-psi (344-MPa) minimum tensile strength.

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 Posts: Round tubular steel **OR** Rectangular tubular steel **OR** Round tubular aluminum **OR** Rectangular tubular aluminum, **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**.
4. Extended Gate Posts and Frame Members: Extend gate posts and frame end members above top of chain-link fabric at both ends of gate frame 12 inches (300 mm) **OR** as indicated, **as directed**, to attach barbed wire **OR** tape, **as directed**, assemblies.
5. Hardware:

a. Hinges: 180-degree inward **OR** 180-degree outward **OR** 360-degree inward and outward, **as directed**, swing.
b. Latches permitting operation from both sides 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 internal device furnished in lieu of gate latch, **as directed**.
e. Closer: Manufacturer's standard, **as directed**.

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 (opening widths to 40 feet (12.2 m) with an overhead clearance of up to 22 feet (6.7 m)).
1) Gate Leaf Width: As indicated **OR** As directed.
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 (opening widths to 30 feet (9.1 m) and heights to 8 feet (2.44 m))
1) Class 1 with external **OR** Class 2 with internal, **as directed**, roller assemblies.
2) 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 Posts: Comply with ASTM F 1184. Provide round tubular steel **OR** rectangular tubular steel **OR** round tubular aluminum **OR** rectangular tubular aluminum, **as directed**, posts.
d. Gate Frames and Bracing: Round tubular steel **OR** Rectangular tubular steel **OR** Round tubular aluminum **OR** Rectangular tubular aluminum, **a directed**.
3. Frame Corner Construction: Welded **OR** Assembled with corner fittings, **as directed**.
4. Extended Gate Posts and Frame Members: Extend gate posts and frame end members 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 both sides 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 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 **OR** Aluminum Alloy 6063, **as directed**, 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: Pressed steel **OR** Aluminum Alloy 6063, **as directed**.
6. Tension Bars: Steel **OR** Aluminum **OR** Fiberglass, **as directed**, length not less than 2 inches (50 mm) shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.
7. Truss Rod Assemblies: Steel, hot-dip galvanized after threading **OR** Mill-finished aluminum, **as directed**, rod and turnbuckle or other means of adjustment.
8. 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.
9. Tie Wires, Clips, and Fasteners: According to ASTM F 626.
   a. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, complying with the following:
      1) Hot-Dip Galvanized Steel: 0.106-inch- (2.69-mm-) **OR** 0.148-inch- (3.76-mm-), **as directed**, diameter wire; galvanized coating thickness matching coating thickness of chain-link fence fabric, **as directed**.
      2) Aluminum: ASTM B 211 (ASTM B 211M); Alloy 1350-H19; 0.148-inch- (3.76-mm-) **OR** 0.192-inch- (4.88-mm-), **as directed**, diameter, mill-finished wire.
10. Finish:
    a. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz. /sq. ft. (366 g /sq. m) zinc.
       1) Polymer coating over metallic coating.
    b. Aluminum: Mill finish.

G. Privacy Slats

1. Material: PVC, UV-light stabilized, flame resistant, four ply, **as directed**, not less than 0.006 inch (0.15 mm) **OR** 0.023 inch (0.58 mm), **as directed**, thick; attached to not less than 0.0475-inch- (1.21-mm-) diameter, twisted galvanized wire; hedge-type lattice, **as directed**; sized to fit mesh specified for direction indicated.

   OR

   Material: Polyethylene tubular slats, not less than 0.023 inch (0.58 mm) thick, manufactured for chain-link fences from virgin polyethylene containing UV inhibitor, sized to fit mesh specified for direction indicated; with vandal-resistant fasteners and lock strips **OR** fins for increased privacy factor, **as directed**.

   OR

   Material: Fiber-glass-reinforced plastic, UV-light stabilized, not less than 0.06 inch (1.5 mm) thick, sized to fit mesh specified for direction indicated; with vandal-resistant fasteners and lock strips, **as directed**.

   OR

   Material: Aluminum, not less than 0.01 inch (0.25 mm) thick, sized to fit mesh specified for direction indicated.

   OR

   Material: Redwood, 5/16 inch (7.9 mm) thick, sized to fit mesh specified for direction indicated.
2. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range **OR** As indicated on Drawings, **as directed**.

H. Barbed Wire

1. Steel Barbed Wire: Comply with ASTM A 121, 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 5 inches (127 mm) o.c.
   a. Aluminum Coating: Type A.
   b. Zinc Coating: Type Z, Class 3.
2. Polymer-Coated, Galvanized-Steel Barbed Wire: Comply with ASTM F 1665 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 5 inches (127 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.

I. 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, **as directed**.
2. Clips: Stainless steel, 0.065 inch (1.7 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 (1.7 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 (300 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**.

J. 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** -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: Fabricate 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: Light **OR** Medium **OR** Heavy, **as directed**, duty, residential **OR** commercial/industrial, **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: 300 lb (137 kg).
      4) Frequency of Use: 10 cycles per hour **OR** 25 cycles per hour **OR** Continuous duty, **as directed**.
      5) Locking: Hydraulic in both directions.
      6) Heater: Manufacturer's standard track and roller heater with thermostatic control.
      7) Operating Type: Crank arm **OR** Wheel and rail drive **OR** Roller chain, **as directed**, with manual release, **as directed**.
   b. Mechanical Swing **OR** Slide, **as directed**, Gate Operators:
      1) Duty: Light **OR** Medium **OR** Heavy, **as directed**, duty, residential **OR** commercial/industrial, **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: 600 lb (272 kg) **OR** 800 lb (363 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** Wheel and rail drive **OR** Roller chain, **as directed**, with manual release, **as directed**.
      6) Drive Type: Enclosed worm gear **OR** 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) Residential 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 the presence or transit of a vehicle in gate pathway when 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.
   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**.
9. Operating Features:
   a. Digital Microprocessor Control: Electronic programmable means for setting, changing, and adjusting control features with capability for 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.
10. 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**, alarm.
    f. Intercom System: <**Insert 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: Cast-in-place or precast concrete, depth not less than 12 inches (300 mm), dimensioned and reinforced according to gate-operator component manufacturer's written instructions and as indicated on Drawings.

K. 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.

L. 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 mm) wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.
2. Connectors and Grounding Rods: Comply with 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).

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 (152.5 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 and more stringent requirements indicated.
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 (50 mm) above grade; shape and smooth to shed water.
2) Concealed Concrete: Top 2 inches (50 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 (125 mm) deep and 3/4 inch (20 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.

c. Mechanically Driven Posts: Drive into soil to depth of 30 inches (762 mm) **OR** 36 inches (914 mm), **as directed**. Protect post top to prevent distortion.

3. Terminal Posts: Locate 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 **OR** 30 degrees or more **OR** as indicated on Drawings, **as directed**.
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. Tension Wire: Install according to ASTM F 567, 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 **OR** bottom **OR** 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.
7. 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 in writing by fencing manufacturer.
8. Intermediate and Bottom Rails: Install and secure to posts with fittings.
9. Chain-Link Fabric: Apply fabric to outside **OR** inside, **as directed**, of enclosing framework. Leave 1 inch (25.4 mm) **OR** 2 inches (50 mm), **as directed**, between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.
10. 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 (380 mm) o.c.
11. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric per ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.
    a. Maximum Spacing: Tie fabric to line posts at 12 inches (300 mm) o.c. and to braces at 24 inches (610 mm) o.c.
12. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts, **as directed**.
13. Privacy Slats: Install slats in direction indicated, securely locked in place.
    a. Vertically **OR** Horizontally, **as directed**, for privacy factor of 70 to 75.

       OR

       Diagonally, for privacy factor of 80 to 85.

       OR

       Direction and privacy factor, **as directed**, as indicated.

14. Barbed Wire: Install barbed wire uniformly spaced, angled toward security side of fence **OR** as indicated on Drawings, **as directed**. Pull wire taut, install securely to extension arms, and secure to end post or terminal arms.
15. Barbed Tape: Comply with ASTM F 1911. Install barbed tape uniformly in configurations indicated and fasten securely to prevent movement or displacement.

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 1500 feet (450 m), **as directed**, except as follows:
    a. Fences within 100 Feet (30 m) of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet (225 m), **as directed**.
        1) Gates and Other Fence Openings: Ground fence on each side of opening.
            a) Bond metal gates to gate posts.
            b) 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 (460 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 (150 mm) below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at the 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. Field Quality Control
1. 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 a testing agency of grounding resistance at each test location. Include observations of weather and other phenomena that may affect test results.

I. 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.

J. Demonstration
1. Train the Owner's personnel to adjust, operate, and maintain chain-link fences and gates.

END OF SECTION 01 95 99 99e

SECTION 01 95 99 99f - 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 Final Completion.
      2) Glazing: Five **OR** 10, **as directed**, years from date of Final Completion.
      3) Vinyl Finish: Five years from date of Final 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 01 95 99 99f

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SECTION 01 95 99 99g - 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 "Thermal Insulation".
7. Vapor Retarder: As specified in Division 07 Section "Thermal 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 01 95 99 99g

SECTION 01 95 99 99h - 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 Final 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 Final Completion.

END OF SECTION 01 95 99 99h

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SECTION 01 95 99 99i - COMMON WORK RESULTS FOR FIRE SUPPRESSION

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for common work results for fire suppression. 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 materials and installation instructions common to most piping systems.
b. Mechanical sleeve seals.
c. Sleeves.
d. Escutcheons.
e. Grout.
f. Fire-suppression equipment and piping demolition.
g. Equipment installation requirements common to equipment sections.
h. Painting and finishing.
i. Concrete bases.
j. Supports and anchorages.

C. Definitions
1. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, 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. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
5. Concealed, Exterior 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.
6. The following are industry abbreviations for plastic materials:
a. CPVC: Chlorinated polyvinyl chloride plastic.
7. The following are industry abbreviations for rubber materials:
a. EPDM: Ethylene-propylene-diene terpolymer rubber.
b. NBR: Acrylonitrile-butadiene rubber.

D. Submittals
1. Welding certificates.

E. Quality Assurance
1. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
2. Steel Pipe 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. Electrical Characteristics for Fire-Suppression Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

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. Pipe, Tube, And Fittings
1. Refer to individual Division 28 for pipe, tube, and fitting materials and joining methods.
2. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

B. Joining Materials
1. Refer to individual Division 28 for special joining materials not listed below.
2. 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 thickness or specific material is 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.
3. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
4. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
5. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
6. 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.
7. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
8. Solvent Cements for Joining CPVC Plastic Piping: ASTM F 493.

C. 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.
   b. Pressure Plates: Plastic **OR** Carbon steel **OR** Stainless steel, **as directed**. Include two for each sealing element.
   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 for each sealing element.

D. Sleeves
1. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
2. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

3. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
4. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   a. Underdeck Clamp: Clamping ring with set screws.
5. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
6. PVC Pipe: ASTM D 1785, Schedule 40.
7. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

E. Escutcheons
1. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
2. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
3. One-Piece, Cast-Brass Type: With set screw.
   a. Finish: Polished chrome-plated **OR** Rough brass **OR** Polished chrome-plated and rough brass, **as directed**.
4. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   a. Finish: Polished chrome-plated **OR** Rough brass **OR** Polished chrome-plated and rough brass, **as directed**.
5. One-Piece, Stamped-Steel Type: With set screw **OR** spring clips, **as directed**, and chrome-plated finish.
6. Split-Plate, Stamped-Steel Type: With concealed **OR** exposed-rivet, **as directed**, hinge, set screw **OR** spring clips, **as directed**, and chrome-plated finish.
7. One-Piece, Floor-Plate Type: Cast-iron floor plate.
8. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

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.

1.3 EXECUTION

A. Fire-Suppression Demolition
1. Refer to Division 01 Section(s) "Cutting And Patching" AND Division 02 Section(s) "Selective Structure Demolition" for general demolition requirements and procedures.
2. Disconnect, demolish, and remove fire-suppression 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 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 equipment operational.
   e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to the 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. Piping Systems - Common Requirements
1. Install piping according to the following requirements and Division 28 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 Coordination Drawings.
3. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
4. 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.
5. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
6. Install piping to permit valve servicing.
7. Install piping at indicated slopes.
8. Install piping free of sags and bends.
9. Install fittings for changes in direction and branch connections.
10. Install piping to allow application of insulation.
11. Select system components with pressure rating equal to or greater than system operating pressure.
12. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
    a. New Piping:
        1) Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
        2) Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
        3) Insulated Piping: One-piece, stamped-steel type with spring clips.
        4) Bare Piping at Wall and Floor Penetrations in Finished Spaces:
            a) One-piece, cast-brass type with polished chrome-plated finish.
            OR
            One-piece, stamped-steel type.
        5) Bare Piping at Ceiling Penetrations in Finished Spaces:
            a) One-piece **OR** Split-casting, **as directed**, cast-brass type with polished chrome-plated finish.
            OR
            One-piece, stamped-steel type **OR** Split-plate, stamped-steel type with concealed hinge, **as directed**, and set screw.
        6) Bare Piping in Unfinished Service Spaces:
            a) One-piece, cast-brass type with polished chrome-plated **OR** rough-brass, **as directed**, finish.
            OR
            One-piece, stamped-steel type with concealed **OR** exposed-rivet, **as directed**, hinge and set screw **OR** spring clips, **as directed**.
        7) Bare Piping in Equipment Rooms:
            a) One-piece, cast-brass type.

            One-piece, stamped-steel type with set screw **OR** spring clips, **as directed**.
        8) Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
    b. Existing Piping: Use the following:

    c. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
    d. Insulated Piping: Split-plate, stamped-steel type with concealed **OR** exposed-rivet, **as directed**, hinge and spring clips.
    e. Bare Piping at Wall and Floor Penetrations in Finished Spaces:
        1) Split-casting, cast-brass type with chrome-plated finish.
        OR
        Split-plate, stamped-steel type with concealed hinge and spring clips.

f. Bare Piping at Ceiling Penetrations in Finished Spaces:
   1) Split-casting, cast-brass type with chrome-plated finish.
      OR
      Split-plate, stamped-steel type with concealed hinge and set screw.
g. Bare Piping in Unfinished Service Spaces:
   1) Split-casting, cast-brass type with polished chrome-plated **OR** rough-brass, **as directed**, finish.
      OR
      Split-plate, stamped-steel type with concealed **OR** exposed-rivet, **as directed**, hinge and set screw or spring clips.
h. Bare Piping in Equipment Rooms:
   1) Split-casting, cast-brass type.
      OR
      Split-plate, stamped-steel type with set screw or spring clips.
i. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

13. Sleeves are not required for core-drilled holes.
14. Permanent sleeves are not required for holes formed by removable PE sleeves.
15. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
16. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, 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 mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
    b. Install sleeves in new walls and slabs as new walls and slabs are constructed.
    c. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
       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.
       3) Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing And Trim" for flashing.
          a) Seal space outside of sleeve fittings with grout.
    d. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
17. 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.
    c. 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.
18. 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.
    a. 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.

19. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
20. Verify final equipment locations for roughing-in.
21. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

C. Piping Joint Construction
1. Join pipe and fittings according to the following requirements and Division 28 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. 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 complying with ASTM B 32.
5. 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.
6. 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.
7. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Para. 1.1 "Quality Assurance" Article.
8. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
9. Plastic Piping Solvent-Cement 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. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
10. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

D. Painting
1. Painting of fire-suppression systems, equipment, and components is specified in Division 09 Section(s) "Exterior Painting" AND "Interior Painting".
2. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

E. 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 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. 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".

F. 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 fire-suppression materials and equipment.
3. Field Welding: Comply with AWS D1.1.

G. Erection Of Wood Supports And Anchorages
1. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor fire-suppression materials and equipment.
2. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
3. Attach to substrates as required to support applied loads.

H. Grouting
1. Mix and install grout for fire-suppression 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 01 95 99 99i

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SECTION 01 95 99 99j - COMMON WORK RESULTS FOR PLUMBING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for common work results for plumbing. 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 materials and installation instructions common to most piping systems.
b. Transition fittings.
c. Dielectric fittings.
d. Mechanical sleeve seals.
e. Sleeves.
f. Escutcheons.
g. Grout.
h. Plumbing demolition.
i. Equipment installation requirements common to equipment sections.
j. Painting and finishing.
k. Concrete bases.
l. Supports and anchorages.

C. Definitions
1. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, 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. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
5. Concealed, Exterior 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.
6. The following are industry abbreviations for plastic materials:
a. ABS: Acrylonitrile-butadiene-styrene plastic.
b. CPVC: Chlorinated polyvinyl chloride plastic.
c. PE: Polyethylene plastic.
d. PVC: Polyvinyl chloride plastic.
7. The following are industry abbreviations for rubber materials:
a. EPDM: Ethylene-propylene-diene terpolymer rubber.
b. NBR: Acrylonitrile-butadiene rubber.

D. Submittals
1. Welding certificates.

E. Quality Assurance
1. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

2. Steel Pipe 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. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

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. Pipe, Tube, And Fittings
1. Refer to individual Division 14 for pipe, tube, and fitting materials and joining methods.
2. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

B. Joining Materials
1. Refer to individual Division 14 for special joining materials not listed below.
2. 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 thickness or specific material is 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.
3. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
4. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
5. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
6. 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.
7. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
8. 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.
9. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

C. Transition Fittings
1. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
   a. Underground Piping NPS 1-1/2 (DN 40) and Smaller: Manufactured fitting or coupling.

b. Underground Piping NPS 2 (DN 50) and Larger: AWWA C219, metal sleeve-type coupling.
c. Aboveground Pressure Piping: Pipe fitting.

2. Plastic-to-Metal Transition Fittings: CPVC **OR** PVC, **as directed**, one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
3. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
4. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC **OR** PVC, **as directed**, four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
5. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

D. Dielectric Fittings
1. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
2. Insulating Material: Suitable for system fluid, pressure, and temperature.
3. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
4. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
5. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   a. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure where required to suit system pressures.
6. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
7. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

E. 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.
   b. Pressure Plates: Plastic **OR** Carbon steel **OR** Stainless steel, **as directed**. Include two for each sealing element.
   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 for each sealing element.

F. Sleeves
1. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
2. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
3. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
4. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   a. Underdeck Clamp: Clamping ring with set screws.
5. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
6. PVC Pipe: ASTM D 1785, Schedule 40.

7. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

G. Escutcheons
1. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
2. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
3. One-Piece, Cast-Brass Type: With set screw.
   a. Finish: Polished chrome-plated **OR** Rough brass **OR** Polished chrome-plated and rough brass, **as directed**.
4. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   a. Finish: Polished chrome-plated **OR** Rough brass **OR** Polished chrome-plated and rough brass, **as directed**.
5. One-Piece, Stamped-Steel Type: With set screw **OR** spring clips, **as directed**, and chrome-plated finish.
6. Split-Plate, Stamped-Steel Type: With concealed **OR** exposed-rivet, **as directed**, hinge, set screw **OR** spring clips, **as directed**, and chrome-plated finish.
7. One-Piece, Floor-Plate Type: Cast-iron floor plate.
8. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

H. 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.

1.3 EXECUTION

A. Plumbing Demolition
1. Refer to Division 01 Section(s) "Cutting And Patching" AND Division 02 Section(s) "Selective Structure Demolition" for general demolition requirements and procedures.
2. Disconnect, demolish, and remove plumbing 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 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 equipment operational.
   e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to the 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. Piping Systems - Common Requirements
1. Install piping according to the following requirements and Division 14 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 Coordination Drawings.

3. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
4. 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.
5. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
6. Install piping to permit valve servicing.
7. Install piping at indicated slopes.
8. Install piping free of sags and bends.
9. Install fittings for changes in direction and branch connections.
10. Install piping to allow application of insulation.
11. Select system components with pressure rating equal to or greater than system operating pressure.
12. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
    a. New Piping:
        1) Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
        2) Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
        3) Insulated Piping: One-piece, stamped-steel type with spring clips.
        4) Bare Piping at Wall and Floor Penetrations in Finished Spaces:
            a) One-piece, cast-brass type with polished chrome-plated finish.
            OR
            One-piece, stamped-steel type.
        5) Bare Piping at Ceiling Penetrations in Finished Spaces:
            a) One-piece **OR** Split-casting, **as directed**, cast-brass type with polished chrome-plated finish.
            OR
            One-piece, stamped-steel type **OR** Split-plate, stamped-steel type with concealed hinge, **as directed**, and set screw.
        6) Bare Piping in Unfinished Service Spaces:
            a) One-piece, cast-brass type with polished chrome-plated **OR** rough-brass, **as directed**, finish.
            OR
            One-piece, stamped-steel type with concealed **OR** exposed-rivet, **as directed**, hinge and set screw **OR** spring clips, **as directed**.
        7) Bare Piping in Equipment Rooms:
            a) One-piece, cast-brass type.
            OR
            One-piece, stamped-steel type with set screw **OR** spring clips, **as directed**.
        8) Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
    b. Existing Piping: Use the following:
        1) Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
        2) Insulated Piping: Split-plate, stamped-steel type with concealed **OR** exposed-rivet, **as directed**, hinge and spring clips.
        3) Bare Piping at Wall and Floor Penetrations in Finished Spaces:
            a) Split-casting, cast-brass type with chrome-plated finish.
            OR
            Split-plate, stamped-steel type with concealed hinge and spring clips.
        4) Bare Piping at Ceiling Penetrations in Finished Spaces:
            a) Split-casting, cast-brass type with chrome-plated finish.
            OR
            Split-plate, stamped-steel type with concealed hinge and set screw.
        5) Bare Piping in Unfinished Service Spaces:
            a) Split-casting, cast-brass type with polished chrome-plated **OR** rough-brass, **as directed**, finish.
            OR

Split-plate, stamped-steel type with concealed **OR** exposed-rivet, **as directed**, hinge and set screw or spring clips.

6) Bare Piping in Equipment Rooms:
   a) Split-casting, cast-brass type.
      OR
      Split-plate, stamped-steel type with set screw or spring clips.
7) Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

13. Sleeves are not required for core-drilled holes.
14. Permanent sleeves are not required for holes formed by removable PE sleeves.
15. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
16. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, 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 mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
    b. Install sleeves in new walls and slabs as new walls and slabs are constructed.
    c. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
       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.
       3) Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing And Trim" for flashing.
          a) Seal space outside of sleeve fittings with grout.
    d. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
17. 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.
    c. 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.
18. 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.
    a. 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.
19. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
20. Verify final equipment locations for roughing-in.
21. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

C. Piping Joint Construction
1. Join pipe and fittings according to the following requirements and Division 14 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. 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 complying with ASTM B 32.
5. 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.
6. 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.
7. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Para. 1.1 "Quality Assurance" Article.
8. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
9. Plastic Piping Solvent-Cement 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.
10. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
11. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
12. 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.
13. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

D. 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. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
   d. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

E. Equipment Installation - Common Requirements
1. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

2. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
3. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
4. Install equipment to allow right of way for piping installed at required slope.

F. Painting
1. Painting of plumbing systems, equipment, and components is specified in Division 09 Section(s) "Exterior Painting" AND "Interior Painting".
2. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

G. 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 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. 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".

H. 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 plumbing materials and equipment.
3. Field Welding: Comply with AWS D1.1.

I. Erection Of Wood Supports And Anchorages
1. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.
2. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
3. Attach to substrates as required to support applied loads.

J. Grouting
1. Mix and install grout for plumbing 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.

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SECTION 01 95 99 99k - COMMON WORK RESULTS FOR HVAC

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for common work results for HVAC. 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 materials and installation instructions common to most piping systems.
b. Transition fittings.
c. Dielectric fittings.
d. Mechanical sleeve seals.
e. Sleeves.
f. Escutcheons.
g. Grout.
h. HVAC demolition.
i. Equipment installation requirements common to equipment sections.
j. Painting and finishing.
k. Concrete bases.
l. Supports and anchorages.

C. Definitions
1. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, 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. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
5. Concealed, Exterior 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.
6. The following are industry abbreviations for plastic materials:
a. CPVC: Chlorinated polyvinyl chloride plastic.
b. PE: Polyethylene plastic.
c. PVC: Polyvinyl chloride plastic.
7. The following are industry abbreviations for rubber materials:
a. EPDM: Ethylene-propylene-diene terpolymer rubber.
b. NBR: Acrylonitrile-butadiene rubber.

D. Submittals
1. Welding certificates.

E. Quality Assurance
1. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
2. Steel Pipe 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. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

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. Pipe, Tube, And Fittings
1. Refer to individual Division 21 for pipe, tube, and fitting materials and joining methods.
2. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

B. Joining Materials
1. Refer to individual Division 21 for special joining materials not listed below.
2. 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 thickness or specific material is 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.
3. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
4. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
5. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
6. 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.
7. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
8. Solvent Cements for Joining Plastic Piping:
a. CPVC Piping: ASTM F 493.
b. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
9. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

C. Transition Fittings
1. Plastic-to-Metal Transition Fittings: CPVC **OR** PVC, **as directed**, one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
2. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
3. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC **OR** PVC, **as directed**, four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

D. Dielectric Fittings
   1. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
   2. Insulating Material: Suitable for system fluid, pressure, and temperature.
   3. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
   4. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
   5. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
      a. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure where required to suit system pressures.
   6. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
   7. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

E. 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.
      b. Pressure Plates: Plastic **OR** Carbon steel **OR** Stainless steel, **as directed**. Include two for each sealing element.
      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 for each sealing element.

F. Sleeves
   1. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
   2. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
   3. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
   4. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
      a. Underdeck Clamp: Clamping ring with set screws.
   5. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
   6. PVC Pipe: ASTM D 1785, Schedule 40.
   7. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

G. Escutcheons
   1. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
   2. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
   3. One-Piece, Cast-Brass Type: With set screw.
      a. Finish: Polished chrome-plated **OR** Rough brass **OR** Polished chrome-plated and rough brass, **as directed**.
   4. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
      a. Finish: Polished chrome-plated **OR** Rough brass **OR** Polished chrome-plated and rough brass, **as directed**.

5. One-Piece, Stamped-Steel Type: With set screw **OR** spring clips, **as directed**, and chrome-plated finish.
6. Split-Plate, Stamped-Steel Type: With concealed **OR** exposed-rivet, **as directed**, hinge, set screw **OR** spring clips, **as directed**, and chrome-plated finish.
7. One-Piece, Floor-Plate Type: Cast-iron floor plate.
8. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

H. 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.

1.3 EXECUTION

A. HVAC Demolition
1. Refer to Division 01 Section(s) "Cutting And Patching" AND Division 02 Section(s) "Selective Structure Demolition" for general demolition requirements and procedures.
2. Disconnect, demolish, and remove HVAC 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 and cap or plug piping with same or compatible piping material.
   c. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
   d. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
   e. Equipment to Be Removed: Disconnect and cap services and remove equipment.
   f. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
   g. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to the 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. Piping Systems - Common Requirements
1. Install piping according to the following requirements and Division 21 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 Coordination Drawings.
3. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
4. 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.
5. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
6. Install piping to permit valve servicing.
7. Install piping at indicated slopes.
8. Install piping free of sags and bends.
9. Install fittings for changes in direction and branch connections.

10. Install piping to allow application of insulation.
11. Select system components with pressure rating equal to or greater than system operating pressure.
12. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
    a. New Piping:
        1) Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
        2) Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
        3) Insulated Piping: One-piece, stamped-steel type with spring clips.
        4) Bare Piping at Wall and Floor Penetrations in Finished Spaces:
            a) One-piece, cast-brass type with polished chrome-plated finish.
            OR
            One-piece, stamped-steel type.
        5) Bare Piping at Ceiling Penetrations in Finished Spaces:
            a) One-piece **OR** Split-casting, **as directed**, cast-brass type with polished chrome-plated finish.
            OR
            One-piece, stamped-steel type **OR** Split-plate, stamped-steel type with concealed hinge, **as directed**, and set screw.
        6) Bare Piping in Unfinished Service Spaces:
            a) One-piece, cast-brass type with polished chrome-plated **OR** rough-brass, **as directed**, finish.
            OR
            One-piece, stamped-steel type with concealed **OR** exposed-rivet, **as directed**, hinge and set screw **OR** spring clips, **as directed**.
        7) Bare Piping in Equipment Rooms:
            a) One-piece, cast-brass type.
            OR
            One-piece, stamped-steel type with set screw **OR** spring clips, **as directed**.
        8) Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
    b. Existing Piping: Use the following:
        1) Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
        2) Insulated Piping: Split-plate, stamped-steel type with concealed **OR** exposed-rivet, **as directed**, hinge and spring clips.
        3) Bare Piping at Wall and Floor Penetrations in Finished Spaces:
            a) Split-casting, cast-brass type with chrome-plated finish.
            OR
            Split-plate, stamped-steel type with concealed hinge and spring clips.
        4) Bare Piping at Ceiling Penetrations in Finished Spaces:
            a) Split-casting, cast-brass type with chrome-plated finish.
            OR
            Split-plate, stamped-steel type with concealed hinge and set screw.
        5) Bare Piping in Unfinished Service Spaces:
            a) Split-casting, cast-brass type with polished chrome-plated **OR** rough-brass, **as directed**, finish.
            OR
            Split-plate, stamped-steel type with concealed **OR** exposed-rivet, **as directed**, hinge and set screw or spring clips.
        6) Bare Piping in Equipment Rooms:
            a) Split-casting, cast-brass type.
            OR
            Split-plate, stamped-steel type with set screw or spring clips.
        7) Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.
13. Sleeves are not required for core-drilled holes.
14. Permanent sleeves are not required for holes formed by removable PE sleeves.

15. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
16. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, 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 mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
    b. Install sleeves in new walls and slabs as new walls and slabs are constructed.
    c. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
        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.
        3) Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing And Trim" for flashing.
            a) Seal space outside of sleeve fittings with grout.
    d. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
17. 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.
    c. 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.
18. 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.
    a. 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.
19. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
20. Verify final equipment locations for roughing-in.
21. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

C. Piping Joint Construction
    1. Join pipe and fittings according to the following requirements and Division 21 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. 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 complying with ASTM B 32.
    5. 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.

6. 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.
7. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Para. 1.1 "Quality Assurance" Article.
8. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
9. Plastic Piping Solvent-Cement 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. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
   c. 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.
   d. PVC Nonpressure Piping: Join according to ASTM D 2855.
10. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
11. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
12. 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.
13. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

D. 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. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
      d. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

E. Equipment Installation - Common Requirements
   1. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
   2. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
   3. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
   4. Install equipment to allow right of way for piping installed at required slope.

F. Painting
   1. Painting of HVAC systems, equipment, and components is specified in Division 09 Section(s) "Exterior Painting" AND "Interior Painting".
   2. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

G. 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 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. 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".

H. 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 HVAC materials and equipment.
   3. Field Welding: Comply with AWS D1.1.

I. Erection Of Wood Supports And Anchorages
   1. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor HVAC materials and equipment.
   2. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
   3. Attach to substrates as required to support applied loads.

J. Grouting
   1. Mix and install grout for HVAC 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 01 95 99 99k

SECTION 01 95 99 99I - DOMESTIC WATER PIPING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for domestic water piping. 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. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
b. Encasement for piping.
c. Specialty valves.
d. Flexible connectors.
e. Water meters furnished by utility company for installation by Contractor.
OR
Water meters.
f. Escutcheons.
g. Sleeves and sleeve seals.
h. Wall penetration systems.

C. Performance Requirements
1. Seismic Performance: Domestic water piping and support and installation shall withstand effects of earthquake motions determined according to ASCE/SEI 7.

D. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:
a. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.
3. Field quality-control reports.

E. Quality Assurance
1. Piping materials shall bear label, stamp, or other markings of specified testing agency.
2. Comply with NSF 14 for plastic, potable domestic water piping and components. Include marking "NSF-pw" on piping, **as directed**.
3. Comply with NSF 61 for potable domestic water piping and components.

F. Project Conditions
1. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by the 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 the Owner no fewer than two days in advance of proposed interruption of water service.
b. Do not proceed with interruption of water service without the Owner's written permission.

1.2 PRODUCTS

A. Piping Materials

1. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Copper Tube And Fittings
   1. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) water tube, drawn temper.
      a. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
      b. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
      c. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
      d. 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.
      e. Copper Pressure-Seal-Joint Fittings:
         1) NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
         2) NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.
      f. Copper Push-on-Joint Fittings:
         1) Description: Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B 16.22; with stainless-steel teeth and EPDM-rubber O-ring seal in each end instead of solder-joint ends.
      g. Copper-Tube Extruded-Tee Connections:
         1) Description: Tee formed in copper tube according to ASTM F 2014.
      h. Grooved-Joint Copper-Tube Appurtenances:
         1) Copper Grooved-End Fittings: ASTM B 75 (ASTM B 75M) copper tube or ASTM B 584 bronze castings.
         2) Grooved-End-Tube Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.
   2. Soft Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) and ASTM B 88, Type L (ASTM B 88M, Type B) water tube, annealed temper.
      a. Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
      b. Copper Pressure-Seal-Joint Fittings:
         1) NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
         2) NPS 3 and NPS 4 (DN 80 and DN 100): Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.

C. 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. Standard-Pattern, Mechanical-Joint Fittings: AWWA C110, ductile or gray iron.
      b. Compact-Pattern, Mechanical-Joint Fittings: AWWA C153, ductile iron.
         1) 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. Standard-Pattern, Push-on-Joint Fittings: AWWA C110, ductile or gray iron.
         1) Gaskets: AWWA C111, rubber.
      b. Compact-Pattern, Push-on-Joint Fittings: AWWA C153, ductile iron.
         1) Gaskets: AWWA C111, rubber.
   3. Plain-End, Ductile-Iron Pipe: AWWA C151.
      a. Grooved-Joint, 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-Pipe Couplings: AWWA C606 for ductile-iron-pipe dimensions. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.

D. Galvanized-Steel Pipe And Fittings
1. Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B, Standard Weight. Include ends matching joining method.
a. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Standard Weight, seamless steel pipe with threaded ends.
b. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
c. Malleable-Iron Unions: ASME B16.39, Class 150, hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface, and female threaded ends.
d. Flanges: ASME B16.1, Class 125, cast iron.
e. Grooved-Joint, Galvanized-Steel-Pipe Appurtenances:
1) Galvanized, Grooved-End Fittings for Galvanized-Steel Piping: ASTM A 47/A 47M, malleable-iron casting; ASTM A 106/A 106M, steel pipe; or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
2) Grooved-End-Pipe Couplings for Galvanized-Steel Piping: AWWA C606 for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.

E. CPVC Piping
1. CPVC Pipe: ASTM F 441/F 441M, Schedule 40 and Schedule 80.
a. CPVC Socket Fittings: ASTM F 438 for Schedule 40 and ASTM F 439 for Schedule 80.
b. CPVC Threaded Fittings: ASTM F 437, Schedule 80.
2. CPVC Piping System: ASTM D 2846/D 2846M, SDR 11, pipe and socket fittings.
3. CPVC Tubing System: ASTM D 2846/D 2846M, SDR 11, tube and socket fittings.

F. PEX Tube And Fittings
1. PEX Distribution System: ASTM F 877, SDR 9 tubing.
a. Fittings for PEX Tube: ASTM F 1807, metal-insert type with copper or stainless-steel crimp rings and matching PEX tube dimensions.
b. Manifold: Multiple-outlet, plastic or corrosion-resistant-metal assembly complying with ASTM F 877; with plastic or corrosion-resistant-metal valve for each outlet.

G. PVC Pipe And Fittings
1. PVC Pipe: ASTM D 1785, Schedule 40 and Schedule 80.
a. PVC Socket Fittings: ASTM D 2466 for Schedule 40 and ASTM D 2467 for Schedule 80.
b. PVC Schedule 80 Threaded Fittings: ASTM D 2464.

H. Piping Joining Materials
1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.
2. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
3. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
4. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
5. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.
a. Use CPVC solvent cement that has a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
b. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

a. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
b. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

7. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

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

J. Specialty Valves
1. Comply with requirements in Division 22 Section "General-duty Valves For Plumbing Piping" for general-duty metal valves.
2. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.
3. CPVC Union Ball Valves:
   a. Description:
      1) Standard: MSS SP-122.
      2) Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, at 73 deg F (23 deg C).
      3) Body Material: CPVC.
      4) Body Design: Union type.
      5) End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket **OR** threaded, **as directed**.
      6) End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable, socket **OR** threaded **OR** flanged, **as directed**.
      7) Ball: CPVC; full port.
      8) Seals: PTFE or EPDM-rubber O-rings.
      9) Handle: Tee shaped.
4. PVC Union Ball Valves:
   a. Description:
      1) Standard: MSS SP-122.
      2) Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, at 73 deg F (23 deg C).
      3) Body Material: PVC.
      4) Body Design: Union type.
      5) End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket **OR** threaded, **as directed**.
      6) End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable, socket **OR** threaded **OR** flanged, **as directed**.
      7) Ball: PVC; full port.
      8) Seals: PTFE or EPDM-rubber O-rings.
      9) Handle: Tee shaped.
5. CPVC Non-Union Ball Valves:
   a. Description:
      1) Standard: MSS SP-122.
      2) Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, at 73 deg F (23 deg C).
      3) Body Material: CPVC.
      4) Body Design: Non-union type.

5) End Connections: Socket or threaded.
6) Ball: CPVC; full or reduced port.
7) Seals: PTFE or EPDM-rubber O-rings.
8) Handle: Tee shaped.

6. PVC Non-Union Ball Valves:
   a. Description:
      1) Standard: MSS SP-122.
      2) Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, at 73 deg F (23 deg C).
      3) Body Material: PVC.
      4) Body Design: Non-union type.
      5) End Connections: Socket or threaded.
      6) Ball: PVC; full or reduced port.
      7) Seals: PTFE or EPDM-rubber O-rings.
      8) Handle: Tee shaped.
7. CPVC Butterfly Valves:
   a. Description:
      1) Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, at 73 deg F (23 deg C).
      2) Body Material: CPVC.
      3) Body Design: Lug or wafer type.
      4) Seat: EPDM rubber.
      5) Seals: PTFE or EPDM-rubber O-rings.
      6) Disc: CPVC.
      7) Stem: Stainless steel.
      8) Handle: Lever.
8. PVC Butterfly Valves:
   a. Description:
      1) Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, at 73 deg F (23 deg C).
      2) Body Material: PVC.
      3) Body Design: Lug or wafer type.
      4) Seat: EPDM rubber.
      5) Seals: PTFE or EPDM-rubber O-rings.
      6) Disc: PVC.
      7) Stem: Stainless steel.
      8) Handle: Lever.
9. CPVC Ball Check Valves:
   a. Description:
      1) Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, at 73 deg F (23 deg C).
      2) Body Material: CPVC.
      3) Body Design: Union-type ball check.
      4) End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket **OR** threaded, **as directed**.
      5) End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable, socket **OR** threaded **OR** flanged, **as directed**.
      6) Ball: CPVC.
      7) Seals: EPDM- or FKM-rubber O-rings.
10. PVC Ball Check Valves:
    a. Description:
       1) Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, at 73 deg F (23 deg C).
       2) Body Material: PVC.
       3) Body Design: Union-type ball check.

4) End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket **OR** threaded, **as directed**.
5) End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable, socket **OR** threaded **OR** flanged, **as directed**.
6) Ball: PVC.
7) Seals: EPDM- or FKM-rubber O-rings.

11. CPVC Gate Valves:
    a. Description:
        1) Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, at 73 deg F (23 deg C).
        2) Body Material: CPVC.
        3) Body Design: Nonrising stem.
        4) End Connections for Valves NPS 2 (DN 50) and Smaller: Socket **OR** Threaded, **as directed**.
        5) End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Socket **OR** Threaded **OR** Flanged, **as directed**.
        6) Gate and Stem: Plastic.
        7) Seals: EPDM rubber.
        8) Handle: Wheel.
12. PVC Gate Valves:
    a. Description:
        1) Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, at 73 deg F (23 deg C).
        2) Body Material: PVC.
        3) Body Design: Nonrising stem.
        4) End Connections for Valves NPS 2 (DN 50) and Smaller: Socket **OR** Threaded, **as directed**.
        5) End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Socket **OR** Threaded **OR** Flanged, **as directed**.
        6) Gate and Stem: Plastic.
        7) Seals: EPDM rubber.
        8) Handle: Wheel.

K. Transition Fittings
1. General Requirements:
    a. Same size as pipes to be joined.
    b. Pressure rating at least equal to pipes to be joined.
    c. End connections compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Sleeve-Type Transition Coupling: AWWA C219.
4. Plastic-to-Metal Transition Fittings:
    a. Description: CPVC **OR** PVC, **as directed**, one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert and one solvent-cement-socket threaded, **as directed**, end.
5. Plastic-to-Metal Transition Unions:
    a. Description: CPVC **OR** PVC, **as directed**, four-part union. Include brass or stainless-steel, **as directed**, threaded end, solvent-cement-joint or threaded, **as directed**, plastic end, rubber O-ring, and union nut.

L. Dielectric Fittings
1. General Requirements: 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:
1) Pressure Rating: 150 psig (1035 kPa) **OR** 250 psig (1725 kPa), **as directed**, at 180 deg F (82 deg C).
2) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:
a. Description:
1) Factory-fabricated, bolted, companion-flange assembly.
2) Pressure Rating: 150 psig (1035 kPa) **OR** 175 psig (1200 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
3) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Kits:
a. Description:
1) Nonconducting materials for field assembly of companion flanges.
2) Pressure Rating: 150 psig (1035 kPa).
3) Gasket: Neoprene or phenolic.
4) Bolt Sleeves: Phenolic or polyethylene.
5) Washers: Phenolic with steel backing washers.

5. Dielectric Couplings:
a. Description:
1) Galvanized-steel coupling.
2) Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
3) End Connections: Female threaded.
4) Lining: Inert and noncorrosive, thermoplastic.

6. Dielectric Nipples:
a. Description:
1) Electroplated steel nipple complying with ASTM F 1545.
2) Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
3) End Connections: Male threaded or grooved.
4) Lining: Inert and noncorrosive, propylene.

M. Flexible Connectors
1. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
a. Working-Pressure Rating: Minimum 200 psig (1380 kPa) **OR** 250 psig (1725 kPa), **as directed**.
b. End Connections NPS 2 (DN 50) and Smaller: Threaded copper pipe or plain-end copper tube.
c. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged copper alloy.
2. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
a. Working-Pressure Rating: Minimum 200 psig (1380 kPa) **OR** 250 psig (1725 kPa), **as directed**.
b. End Connections NPS 2 (DN 50) and Smaller: Threaded steel-pipe nipple.
c. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged steel nipple.

N. Water Meters
1. Displacement-Type Water Meters:
a. Description:
1) Standard: AWWA C700.
2) Pressure Rating: 150-psig (1035-kPa) working pressure.
3) Body Design: Nutating disc; totalization meter.
4) Registration: In gallons (liters) or cubic feet (cubic meters) as required by utility.
5) Case: Bronze.
6) End Connections: Threaded.
2. Turbine-Type Water Meters:

a. Description:
1) Standard: AWWA C701.
2) Pressure Rating: 150-psig (1035-kPa) working pressure.
3) Body Design: Turbine; totalization meter.
4) Registration: In gallons (liters) or cubic feet (cubic meters) as required by utility company.
5) Case: Bronze.
6) End Connections for Meters NPS 2 (DN 50) and Smaller: Threaded.
7) End Connections for Meters NPS 2-1/2 (DN 65) and Larger: Flanged.

3. Compound-Type Water Meters:
a. Description:
1) Standard: AWWA C702.
2) Pressure Rating: 150-psig (1035-kPa) working pressure.
3) Body Design: With integral mainline and bypass meters; totalization meter.
4) Registration: In gallons (liters) or cubic feet (cubic meters) as required by utility company.
5) Case: Bronze.
6) Pipe Connections: Flanged.

4. Fire-Service-Type Water Meters:
a. Description:
1) Standard: AWWA C703 and UL listing.
2) Pressure Rating: 175-psig (1200-kPa) working pressure.
3) Body Design:
a) Proportional, Detector-Type Water Meters: With meter on bypass.
i. Bypass Meter: AWWA C701, turbine **OR** AWWA C702, compound, **as directed**, type with bronze case; size not less than one-half nominal size of main-line meter.
b) Turbine-Type Water Meters: With strainer, and with meter on bypass.
i. Strainer: Full size, matching water meter.
ii. Bypass Meter: AWWA C701, turbine type with bronze case; not less than NPS 2 (DN 50).
4) Registration: In gallons (liters) or cubic feet (cubic meters) as required by utility company.
5) Case: Bronze.
6) Pipe Connections for Meters NPS 2 (DN 50) and Smaller: Threaded.
7) Pipe Connections for Meters NPS 2-1/2 (DN 65) and Larger: Flanged.

5. Remote Registration System: Direct-reading type complying with AWWA C706; modified with signal transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.
OR
Remote Registration System: Encoder type complying with AWWA C707; modified with signal transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

O. Escutcheons
1. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.
2. One Piece, Cast Brass: Polished, chrome-plated **OR** rough-brass, **as directed**, finish with setscrews.
3. One Piece, Deep Pattern: Deep-drawn, box-shaped brass with chrome-plated finish.
4. One Piece, Stamped Steel: Chrome-plated finish with setscrew **OR** spring clips, **as directed**.
5. Split Casting, Cast Brass: Polished, chrome-plated **OR** rough-brass, **as directed**, finish with concealed hinge and setscrew.
6. Split Plate, Stamped Steel: Chrome-plated finish with concealed **OR** exposed-rivet, **as directed**, hinge, setscrew **OR** spring clips, **as directed**.
7. One-Piece Floor Plates: Cast-iron flange with holes for fasteners, **as directed**.

8. Split-Casting Floor Plates: Cast brass with concealed hinge.

P. Sleeves
1. Cast-Iron Wall Pipes: Fabricated of cast iron, and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
2. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
3. Molded-PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
4. Molded-PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.
5. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
6. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc-coated, with plain ends.
7. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   a. Underdeck Clamp: Clamping ring with setscrews.

Q. Sleeve Seals
1. Description: Modular sealing element unit, designed for field assembly, used to fill annular space between pipe and sleeve.
   a. Sealing Elements: EPDM-rubber **OR** NBR, **as directed**, interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   b. Pressure Plates: Carbon steel **OR** Plastic **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.

R. Wall Penetration Systems
1. Description: Wall-sleeve assembly, consisting of housing and gland, gaskets, and pipe sleeve.
   a. Carrier-Pipe Deflection: Up to 5 percent without leakage.
   b. Housing: Ductile-iron casting with hub, waterstop, anchor ring, and locking devices. Include gland, bolts, and nuts.
   c. Housing-to-Sleeve Gasket: EPDM rubber **OR** NBR, **as directed**.
   d. Housing-to-Carrier-Pipe Gasket: AWWA C111, EPDM rubber **OR** NBR, **as directed**.
   e. Pipe Sleeve: AWWA C151, ductile-iron pipe **OR** ASTM A 53/A 53M, Schedule 40, zinc-coated steel pipe, **as directed**.

S. Grout
1. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
2. Characteristics: Nonshrink; recommended for interior and exterior applications.
3. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

1.3 EXECUTION

A. Earthwork
1. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

B. Piping Installation
1. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. 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.
2. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

3. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
4. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105.
5. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 Section "Meters And Gages For Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.
6. Install shutoff valve immediately upstream of each dielectric fitting.
7. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for pressure-reducing valves.
8. Install domestic water piping level with 0.25 percent slope downward toward drain **OR** without pitch, **as directed**, and plumb.
9. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
10. Install seismic restraints on piping. Comply with requirements in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment" for seismic-restraint devices.
11. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
12. 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.
13. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
14. Install piping adjacent to equipment and specialties to allow service and maintenance.
15. Install piping to permit valve servicing.
16. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.
17. Install piping free of sags and bends.
18. Install fittings for changes in direction and branch connections.
19. Install PEX piping with loop at each change of direction of more than 90 degrees.
20. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
21. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump. Comply with requirements in Division 22 Section "Meters And Gages For Plumbing Piping" for pressure gages.
22. Install thermostats in hot-water circulation piping. Comply with requirements in Division 22 Section "Domestic Water Pumps" for thermostats.
23. Install thermometers on inlet **OR** inlet and outlet, **as directed**, piping from each water heater. Comply with requirements in Division 22 Section "Meters And Gages For Plumbing Piping" for thermometers.

C. Joint Construction
1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
3. 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.
   b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
4. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

5. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
6. Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.
7. Copper-Tubing, Push-on Joints: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on-joint fittings by inserting tube to measured depth.
8. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
9. Copper-Tubing Grooved Joints: Roll groove end of tube. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for roll-grooved joints.
10. Ductile-Iron-Piping Grooved Joints: Cut groove end of pipe. Assemble coupling with housing, gasket, lubricant, and bolts. Join ductile-iron pipe and grooved-end fittings according to AWWA C606 for ductile-iron-pipe, cut-grooved joints.
11. Steel-Piping Grooved Joints: Cut **OR** Roll, **as directed**, groove end of pipe. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
12. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
13. Plastic Piping Solvent-Cement 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. Apply primer.
    b. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
    c. PVC Piping: Join according to ASTM D 2855.
14. PEX Piping Joints: Join according to ASTM F 1807.
15. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

D. Valve Installation
1. General-Duty Valves: Comply with requirements in Division 22 Section "General-duty Valves For Plumbing Piping" for valve installations.
2. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2 (DN 50) and smaller. Use butterfly or gate valves for piping NPS 2-1/2 (DN 65) and larger.
3. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties".
    a. Hose-End Drain Valves: At low points in water mains, risers, and branches.
    b. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.
4. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball valves for piping NPS 2 (DN 50) and smaller and butterfly valves for piping NPS 2-1/2 (DN 65) and larger. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves.
5. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for calibrated balancing valves.

E. Transition Fitting Installation
1. Install transition couplings at joints of dissimilar piping.
2. Transition Fittings in Underground Domestic Water Piping:

a. NPS 1-1/2 (DN 40) and Smaller: Fitting-type coupling.
b. NPS 2 (DN 50) and Larger: Sleeve-type coupling.

3. Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) and Smaller: Plastic-to-metal transition fittings **OR** unions, **as directed**.

F. Dielectric Fitting Installation
1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric couplings **OR** nipples **OR** unions, **as directed**.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges **OR** flange kits **OR** nipples, **as directed**.
4. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

G. Flexible Connector Installation
1. Install flexible connectors in suction and discharge piping connections to each domestic water pump and in suction and discharge manifold connections to each domestic water booster pump, **as directed**.
2. Install bronze-hose flexible connectors in copper domestic water tubing.
3. Install stainless-steel-hose flexible connectors in steel domestic water piping.

H. Water Meter Installation
1. Rough-in domestic water piping for water meter installation, and install water meters, **as directed**, according to utility company's requirements.
2. Water meters will be furnished and installed by utility company.
OR
Install water meters according to AWWA M6 and utility company's requirements.
3. Install displacement-type water meters with shutoff valve on water-meter inlet. Install valve on water-meter outlet and valved bypass around meter unless prohibited by authorities having jurisdiction.
OR
Install turbine-type water meters with shutoff valve on water-meter inlet. Install valve on water-meter outlet and valved bypass around meter unless prohibited by authorities having jurisdiction.
OR
Install compound-type water meters with shutoff valves on water-meter inlet and outlet and on valved bypass around meter. Support meters, valves, and piping on brick or concrete piers.
OR
Install fire-service water meters with shutoff valves on water-meter inlet and outlet and on full-size valved bypass around meter. Support meter, valves, and piping on brick or concrete piers.
4. Install remote registration system according to standards of utility company and of authorities having jurisdiction.

I. Hanger And Support Installation
1. Comply with requirements in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment" for seismic-restraint devices.
2. Comply with requirements in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment" for pipe hanger and support products and installation.
a. Vertical Piping: MSS Type 8 or 42, clamps.
b. Individual, Straight, Horizontal Piping Runs:
1) 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
2) Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
3) Longer Than 100 Feet (30 m) If Indicated: MSS Type 49, spring cushion rolls.
c. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
d. Base of Vertical Piping: MSS Type 52, spring hangers.
3. Support vertical piping and tubing at base and at each floor.

4. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch (10 mm).
5. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 3/4 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
   b. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
   c. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
   d. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
   e. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
   f. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
   g. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod.
6. Install supports for vertical copper tubing every 10 feet (3 m).
7. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 1-1/4 (DN 32) and Smaller: 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
   b. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
   c. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
   d. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
   e. NPS 3 and NPS 3-1/2 (DN 80 and DN 90): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
   f. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
   g. NPS 6 (DN 150): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.
   h. NPS 8 to NPS 12 (DN 200 to DN 300): 12 feet (3.7 m) with 7/8-inch (22-mm) rod.
8. Install supports for vertical steel piping every 15 feet (4.5 m).
9. Install vinyl-coated hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 1 (DN 25) and Smaller: 36 inches (900 mm) with 3/8-inch (10-mm) rod.
   b. NPS 1-1/4 to NPS 2 (DN 32 to DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
   c. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
   d. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
   e. NPS 6 (DN 150): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
   f. NPS 8 (DN 200): 48 inches (1200 mm) with 7/8-inch (22-mm) rod.
10. Install supports for vertical CPVC piping every 60 inches (1500 mm) for NPS 1 (DN 25) and smaller, and every 72 inches (1800 mm) for NPS 1-1/4 (DN 32) and larger.
11. Install vinyl-coated hangers for PEX piping with the following maximum horizontal spacing and minimum rod diameters:
    a. NPS 1 (DN 25) and Smaller: 32 inches (815 mm) with 3/8-inch (10-mm) rod.
12. Install hangers for vertical PEX piping every 48 inches (1200 mm).
13. Install vinyl-coated hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
    a. NPS 2 (DN 50) and Smaller: 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
    b. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
    c. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
    d. NPS 6 (DN 150): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
    e. NPS 8 (DN 200): 48 inches (1200 mm) with 7/8-inch (22-mm) rod.
14. Install supports for vertical PVC piping every 48 inches (1200 mm).
15. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

J. Connections
   1. Drawings indicate general arrangement of piping, fittings, and specialties.
   2. Install piping adjacent to equipment and machines to allow service and maintenance.

3. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
4. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
    a. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
    b. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
    c. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 Section(s) "Plumbing Fixtures" OR "Healthcare Plumbing Fixtures" OR "Emergency Plumbing Fixtures" OR "Security Plumbing Fixtures", **as directed**, for connection sizes.
    d. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (DN 65) and larger.

K. Escutcheon Installation
1. Install escutcheons for penetrations of walls, ceilings, and floors.
2. Escutcheons for New Piping:
    a. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
    b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** stamped steel with set screw **OR** stamped steel with set screw or spring clips **OR** stamped steel with spring clips, **as directed**.
    c. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** One piece or split casting, cast brass with polished chrome-plated finish **OR** Split casting, cast brass with polished chrome-plated finish **OR** One piece, stamped steel with set screw **OR** One piece or split plate, stamped steel with set screw **OR** Split plate, stamped steel with set screw, **as directed**.
    d. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish **OR** cast brass with rough-brass finish **OR** stamped steel with set screw **OR** stamped steel with spring clips **OR** stamped steel with set screw or spring clips, **as directed**.
    e. Bare Piping in Equipment Rooms: One piece, cast brass **OR** stamped steel with set screw **OR** stamped steel with spring clips **OR** stamped steel with set screw or spring clips, **as directed**.
    f. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.
3. Escutcheons for Existing Piping:
    a. Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.
    b. Insulated Piping: Split plate, stamped steel with concealed **OR** exposed-rivet, **as directed**, hinge and spring clips.
    c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and spring clips, **as directed**.
    d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and set screw, **as directed**.
    e. Bare Piping in Unfinished Service Spaces: Split casting, cast brass with polished chrome-plated finish **OR** casting, cast brass with rough-brass finish **OR** plate, stamped steel with concealed hinge and set screw or spring clips **OR** plate, stamped steel with concealed or exposed-rivet hinge and set screw or spring clips **OR** plate, stamped steel with exposed-rivet hinge and set screw or spring clips, **as directed**.
    f. Bare Piping in Equipment Rooms: Split casting, cast brass **OR** plate, stamped steel with set screw or spring clips, **as directed**.
    g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.

L. Sleeve Installation

1. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.
2. Sleeves are not required for core-drilled holes.
3. Permanent sleeves are not required for holes formed by removable PE sleeves.
4. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.
5. Install sleeves in new partitions, slabs, and walls as they are built.
6. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants" for joint sealants.
7. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants" for joint sealants.
8. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals **OR** wall penetration systems, **as directed**, specified in this Section.
9. Seal space outside of sleeves in concrete slabs and walls with grout.
10. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.
11. Install sleeve materials according to the following applications:
    a. Sleeves for Piping Passing through Concrete Floor Slabs: Molded PE **OR** Molded PVC **OR** Steel pipe, **as directed**.
    b. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Steel pipe **OR** Stack sleeve fittings, **as directed**.
        1) Extend sleeves 2 inches (50 mm) above finished floor level.
        2) For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim" for flashing.
    c. Sleeves for Piping Passing through Gypsum-Board Partitions:
        1) PVC pipe **OR** Steel pipe, **as directed**, sleeves for pipes smaller than NPS 6 (DN 150).
        2) Galvanized-steel sheet sleeves for pipes NPS 6 (DN 150) and larger.
        3) Exception: Sleeves are not required for water supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.
    d. Sleeves for Piping Passing through Concrete Roof Slabs: Molded PE **OR** Molded PVC **OR** Steel pipe, **as directed**.
    e. Sleeves for Piping Passing through Exterior Concrete Walls:
        1) Steel pipe sleeves for pipes smaller than NPS 6 (DN 150).
        2) Cast-iron wall pipe sleeves for pipes NPS 6 (DN 150) and larger.
        3) Install sleeves that are large enough to provide 1-inch (25-mm) annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.
        4) Do not use sleeves when wall penetration systems are used.
    f. Sleeves for Piping Passing through Interior Concrete Walls:
        1) PVC pipe **OR** Steel pipe, **as directed**, sleeves for pipes smaller than NPS 6 (DN 150).
        2) Galvanized-steel sheet sleeves for pipes NPS 6 (DN 150) and larger.
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 "Penetration Firestopping" for firestop materials and installations.

M. Sleeve Seal Installation
1. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.
2. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe

and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

N. Wall Penetration System Installation
1. Install wall penetration systems in new, exterior concrete walls.
2. Assemble wall penetration system components with sleeve pipe. Install so that end of sleeve pipe and face of housing are flush with wall. Adjust locking devices to secure sleeve pipe in housing.

O. Identification
1. Identify system components. Comply with requirements in Division 22 Section "Identification For Plumbing Piping And Equipment" for identification materials and installation.
2. Label pressure piping with system operating pressure.

P. Field Quality Control
1. Perform tests and inspections.
2. Piping Inspections:
   a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
   b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
      1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
      2) Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
   c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
   d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
3. Piping Tests:
   a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
   b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
   c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   d. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
   e. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
   f. Prepare reports for tests and for corrective action required.
4. Domestic water piping will be considered defective if it does not pass tests and inspections.
5. Prepare test and inspection reports.

Q. Adjusting
1. Perform the following adjustments before operation:
   a. Close drain valves, hydrants, and hose bibbs.
   b. Open shutoff valves to fully open position.
   c. Open throttling valves to proper setting.
   d. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

1) Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
2) Adjust calibrated balancing valves to flows indicated.

e. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
f. Remove and clean strainer screens. Close drain valves and replace drain plugs.
g. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
h. Check plumbing specialties and verify proper settings, adjustments, and operation.

R. Cleaning

1. Clean and disinfect potable and non-potable, **as directed**, domestic water piping as follows:
   a. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   b. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
      1) Flush piping system with clean, potable water until dirty water does not appear at outlets.
      2) Fill and isolate system according to either of the following:
         a) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.
         b) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.
      3) Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
      4) Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
2. Clean non-potable domestic water piping as follows:
   a. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   b. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
      1) Flush piping system with clean, potable water until dirty water does not appear at outlets.
      2) Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
3. Prepare and submit reports of purging and disinfecting activities.
4. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

S. Piping Schedule

1. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
2. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
3. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
4. Under-building-slab, domestic water, building service piping, NPS 3 (DN 80) and smaller, shall be one of the following:
   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. PVC, Schedule 40 pipe; PVC, Schedule 40 **OR** Schedule 80 pipe; PVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.
5. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 (DN 100 to DN 200) and larger, shall be one of the following:

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. Mechanical-joint, ductile-iron pipe; standard-pattern **OR** compact-pattern, **as directed**, mechanical-joint fittings; and mechanical joints.
c. Push-on-joint, ductile-iron pipe; standard-pattern **OR** compact-pattern, **as directed**, push-on-joint fittings; and gasketed joints.
d. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
e. PVC, Schedule 40 pipe; PVC, Schedule 40 **OR** Schedule 80 pipe; PVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.

6. Under-building slab, combined domestic water, building-service, and fire-service-main piping, NPS 6 to NPS 12 (DN 150 to DN 300), shall be one of the following:
   a. Mechanical-joint, ductile-iron pipe; standard-pattern **OR** compact-pattern, **as directed**, mechanical-joint fittings; and mechanical joints.
   b. Push-on-joint, ductile-iron pipe; standard-pattern **OR** compact-pattern, **as directed**, push-on-joint fittings; and gasketed joints.
   c. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
7. Under-building-slab, domestic water piping, NPS 2 (DN 50) and smaller, shall be one of the following:
   a. Hard **OR** Soft, **as directed**, copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); wrought-copper solder-joint fittings; and brazed **OR** copper pressure-seal-joint fittings; and pressure-sealed, **as directed**, joints.
   b. PVC, Schedule 40 pipe; PVC, Schedule 40 **OR** Schedule 80 pipe; PVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.
8. Aboveground domestic water piping, NPS 2 (DN 50) and smaller, shall be one of the following:
   a. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
   b. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; cast-copper **OR** wrought-copper, **as directed**, solder-joint fittings; and brazed **OR** soldered, **as directed**, joints.
   c. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B, **as directed**; copper pressure-seal-joint fittings; and pressure-sealed joints.
   d. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B) **OR**, **as directed**; copper push-on-joint fittings; and push-on joints.
   e. CPVC, Schedule 40 pipe; CPVC, Schedule 40 **OR** Schedule 80 pipe; CPVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.
   f. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
   g. CPVC Tubing System: CPVC tube; CPVC socket fittings; and solvent-cemented joints. NPS 1-1/2 (DN 40) and NPS 2 (DN 50) CPVC pipe with CPVC socket fittings may be used instead of tubing.
   h. PEX Tube, NPS 1 (DN 25) and smaller; fittings for PEX tube; and crimped joints.
   i. PVC, Schedule 40 pipe; PVC, Schedule 40 **OR** Schedule 80 pipe; PVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.
9. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be one of the following:
   a. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; cast-copper **OR** wrought-copper, **as directed**, solder-joint fittings; and brazed **OR** soldered, **as directed**, joints.
   b. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; copper pressure-seal-joint fittings; and pressure-sealed joints.
   c. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B, **as directed**; grooved-joint copper-tube appurtenances; and grooved joints.

d. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
e. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
f. CPVC, Schedule 40 pipe; CPVC, Schedule 40 **OR** Schedule 80 pipe; CPVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.
g. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
h. PVC, Schedule 40 pipe; PVC, Schedule 40 **OR** Schedule 80 pipe; PVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.

10. Aboveground domestic water piping, NPS 5 to NPS 8 (DN 125 to DN 200), shall be one of the following:
    a. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; cast-copper **OR** wrought-copper, **as directed**, solder-joint fittings; and brazed **OR** soldered, **as directed**, joints.
    b. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; grooved-joint copper-tube appurtenances; and grooved joints.
    c. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
    d. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
    e. CPVC, Schedule 40 pipe; CPVC, Schedule 40 **OR** Schedule 80 pipe; CPVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.
    f. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
    g. PVC, Schedule 40 pipe; PVC, Schedule 40 **OR** Schedule 80 pipe; PVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.
11. Aboveground, combined domestic-water-service and fire-service-main piping, NPS 6 to NPS 12 (DN 150 to DN300), shall be one of the following:
    a. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
    b. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
    c. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.

T. Valve Schedule
1. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
    a. Shutoff Duty: Use ball or gate valves for piping NPS 2 (DN 50) and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
    b. Throttling Duty: Use ball or globe valves for piping NPS 2 (DN 50) and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
    c. Hot-Water Circulation Piping, Balancing Duty: Calibrated **OR** Memory-stop, **as directed**, balancing valves.
    d. Drain Duty: Hose-end drain valves.
2. Use check valves to maintain correct direction of domestic water flow to and from equipment.
3. Iron grooved-end valves may be used with grooved-end piping.
4. CPVC and PVC valves matching piping materials may be used.

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SECTION 01 95 99 99m - SANITARY WASTE AND VENT PIPING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for sanitary waste and vent piping. 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:
a. Pipe, tube, and fittings.
b. Special pipe fittings.
c. Encasement for underground metal piping.

C. Performance Requirements
1. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
a. Soil, Waste, and Vent Piping: 10-foot head of water (30 kPa).
b. Sanitary Sewer, Force-Main Piping: 50 psig (345 kPa) **OR** 100 psig (690 kPa) **OR** 150 psig (1035 kPa), **as directed**.
2. Seismic Performance: Soil, waste, and vent piping and support and installation shall be 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 type of product indicated.
2. LEED Submittal:
a. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.
3. Shop Drawings: For solvent Drainage System: Include plans, elevations, sections, and details.
4. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.
a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
b. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.
5. Field quality-control inspection and test reports.

E. Quality Assurance
1. Piping materials shall bear label, stamp, or other markings of specified testing agency.
2. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

F. Project Conditions
1. Interruption of Existing Sanitary Waste 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 sanitary waste service.

b. Do not proceed with interruption of sanitary waste service without the Owner written permission.

1.2 PRODUCTS

A. Piping Materials
1. Comply with requirements in "Piping Applications" Article for applications of pipe, tube, fitting, and joining methods for specific services, service locations, and pipe sizes.

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

C. Hubless, Cast-Iron Soil Pipe And Fittings
1. Pipe and Fittings: ASTM A 888 or CISPI 301.
2. Sovent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.
3. CISPI, Hubless-Piping Couplings:
a. Standards: ASTM C 1277 and CISPI 310
b. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
4. Heavy-Duty, Hubless-Piping Couplings:
a. Standards: ASTM C 1277 and ASTM C 1540.
b. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
5. Cast-Iron, Hubless-Piping Couplings:
a. Standard: ASTM C 1277.
b. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

D. Galvanized-Steel Pipe And Fittings
1. Galvanized Steel Pipe: ASTM A 53/A 53M, Type E, Standard Weight. Include ends matching joining method.
2. Galvanized-Cast-Iron Drainage Fittings: ASME B16.12, galvanized.
3. Steel Pipe Pressure Fittings:
a. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized, seamless steel pipe. Include ends matching joining method.
b. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
c. Galvanized-Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, galvanized, **as directed**, standard pattern.
4. Cast-Iron Flanges: ASME B16.1, Class 125.
a. Flange Gasket Materials: ASME ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
b. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
5. Grooved-Joint Systems:
a. Galvanized, Grooved-End Fittings for Galvanized-Steel Piping: ASTM A 536 ductile-iron castings, ASTM A 47/A 47M malleable-iron castings, ASTM A 234/A 234M forged steel fittings, or ASTM A 106/A 106M steel pipes with dimensions matching ASTM A 53/A 53M steel pipe, and complying with AWWA C606 for grooved ends.
b. Grooved Mechanical Couplings for Galvanized-Steel Piping: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber gasket suitable for hot and cold water; and bolts and nuts.

E. Stainless-Steel Pipe And Fittings
   1. Pipe and Fittings: ASME A112.3.1, drainage pattern with socket and spigot ends.
   2. Internal Sealing Rings: Elastomeric gasket shaped to fit socket groove.
      a. Material: EPDM, unless NBR is indicated.

F. Ductile-Iron Pipe And Fittings
   1. Ductile-Iron, Mechanical-Joint Piping:
      a. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
      b. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
      c. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
   2. Ductile-Iron, Push-on-Joint Piping:
      a. Ductile-Iron Pipe: AWWA C151/A21.51, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
      b. Ductile-Iron Fittings: AWWA C110/A21.10, push-on-joint ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
      c. Gaskets: AWWA C111/A21.11, rubber.
   3. Ductile-Iron, Grooved-Joint Piping:
      a. Ductile-Iron Pipe: AWWA C151/A21.51 with round-cut-grooved ends according to AWWA C606.
      b. Ductile-Iron-Pipe Appurtenances:
         1) Grooved-End, Ductile-Iron Fittings: ASTM A 536 ductile-iron castings with dimensions matching AWWA C110/A 21.10 ductile-iron pipe or AWWA C153/A 21.53 ductile-iron fittings and complying with AWWA C606 for grooved ends.
         2) Grooved Mechanical Couplings for Ductile-Iron Pipe: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber center-leg gasket suitable for hot and cold water; and bolts and nuts.

G. Copper Tube And Fittings
   1. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
   2. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
   3. Hard Copper Tube: ASTM B 88, Types L and M (ASTM B 88M, Types B and C), water tube, drawn temper.
   4. Soft Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B), water tube, annealed temper.
   5. Copper Pressure Fittings:
      a. ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
      b. Copper Unions: MSS SP-123, copper-alley, hexagonal-stock body with ball-and-socket, metal-to metal seating surfaces, and solder-joint or threaded ends
   6. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
      a. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
      b. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
   7. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux

H. ABS Pipe And Fittings
   1. Solid-Wall ABS Pipe: ASTM D 2661, Schedule 40.
   2. Cellular-Core ABS Pipe: ASTM F 628, Schedule 40.
   3. ABS Socket Fittings: ASTM D 2661, made to ASTM D 3311, drain, waste, and vent patterns.
   4. Solvent Cement ASTM D 2235:
      a. Use ABS solvent cement that has a VOC content of 325 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

I. PVC Pipe And Fittings
1. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
2. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.
3. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
4. Adhesive Primer: ASTM F 656.
   a. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
5. Solvent Cement: ASTM D 2564.
   a. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

J. Specialty Pipe Fittings
1. Transition Couplings:
   a. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
   b. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
   c. Unshielded, Nonpressure Transition Couplings:
      1) Standard: ASTM C 1173.
      2) Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
      3) Sleeve Materials:
         a) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
         b) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
         c) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
   d. Shielded Nonpressure Transition Couplings:
      1) ASTM C 1460.
      2) Description: Eelastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
   e. Pressure Transition Pipe Couplings:
      1) AWWA C219.
      2) Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes 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.
2. Dielectric Fittings:
   a. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
   b. Dielectric Unions:
      1) Description:
         a) Standard: ASSE 1079.
         b) Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C) **OR** 150 psig (1035 kPa) **OR** 250 psig (1725 kPa), **as directed**.
         c) End Connections: Solder-joint copper alloy and threaded ferrous.
   c. Dielectric Flanges:
      1) Description:
         a) Standard: ASSE 1079.

b) Factory-fabricated, bolted, companion-flange assembly.
c) Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C) **OR** 150 psig (1035 kPa) **OR** 175 psig (1200 kPa) **OR** 300 psig (2070 kPa), **as directed**.
d) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

d. Dielectric-Flange Insulating Kits:
1) Description:
a) Nonconducting materials for field assembly of companion flanges.
b) Pressure Rating: 150 psig (1035 kPa).
c) Gasket: Neoprene or phenolic.
d) Bolt Sleeves: Phenolic or polyethylene.
e) Washers: Phenolic with steel backing washers.

e. Dieletric Nipples
1) Description:
a) Electroplated steel nipple complying with ASTM F 1545.
b) Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
c) End Connections: Male threaded or grooved.
d) Lining: Inert and noncorrosive, propylene.

K. Encasement For Underground Metal Piping
1. Standard: ASTM A 674 or AWWA C105/A 21.5
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**.

1.3 EXECUTION

A. Earth Moving
1. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

B. Piping Installation
1. 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 coordination drawings.
2. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
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 above accessible ceilings to allow sufficient space for ceiling panel removal.
5. Install piping to permit valve servicing.
6. Install piping at indicated slopes.
7. Install piping free of sags and bends.
8. Install fittings for changes in direction and branch connections.
9. Install piping to allow application of insulation.
10. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment".
11. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with

common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

12. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
13. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:
    a. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; 1 percent **OR** 2 percent, as directed downward in direction of flow for piping NPS 4 (DN 100) and larger.
    b. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
    c. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
14. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
    a. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.
15. Install steel piping according to applicable plumbing code.
16. Install stainless-steel piping according to ASME A112.3.1 and applicable plumbing code.
17. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
18. Install aboveground ABS piping according to ASTM D 2661.
19. Install aboveground PVC piping according to ASTM D 2665.
20. Install underground ABS and PVC piping according to ASTM D 2321.
21. Install engineered soil and waste drainage and vent piping systems as follows:
    a. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
    b. Sovent Drainage System: Comply with ASSE 1043 and sovent fitting manufacturer's written installation instructions.
    c. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
22. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
    a. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.
23. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."
    a. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.
24. Install force mains at elevations indicated.
25. Plumbing Specialties:
    a. Install backwater valves in sanitary waste gravity-flow piping. Comply with requirements for backwater valves specified in Division 22 Section "Sanitary Waste Piping Specialties".
    b. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Division 22 Section "Sanitary Waste Piping Specialties".
    c. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 Section "Sanitary Waste Piping Specialties".
26. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
27. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Common Work Results For Plumbing".
28. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Common Work Results For Plumbing".

29. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Common Work Results For Plumbing".

C. Joint Construction
1. 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.
2. 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.
3. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
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. Join stainless-steel pipe and fittings with gaskets according to ASME A112.3.1.
6. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.
7. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.
8. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.
9. Plastic, Nonpressure-Piping, Solvent-Cement 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. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

D. Specialty Pipe Fitting Installation
1. Transition Couplings:
   a. Install transition couplings at joints of piping with small differences in OD's.
   b. In Drainage Piping: Unshielded **OR** Shielded, **as directed**, nonpressure transition couplings.
   c. In Aboveground Force Main Piping: Fitting-type transition couplings.
   d. In Underground Force Main Piping:
      1) NPS 1-1/2 (DN 40) and Smaller: Fitting-type transition couplings.
      2) NPS 2 (DN 50) and Larger: Pressure transition couplings.
2. Dielectric Fittings:
   a. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
   b. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric nipples **OR** unions, **as directed**.
   c. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100: Use dielectric flanges **OR** flange kits **OR** nipples, **as directed**.
   d. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

E. Valve Installation
1. General valve installation requirements are specified in Division 22 Section "General-duty Valves For Plumbing Piping".
2. Shutoff Valves:
   a. Install shutoff valve on each sewage pump discharge.

b. Install gate or full-port ball valve for piping NPS 2 (DN 50) and smaller.
c. Install gate valve for piping NPS 2-1/2 (DN 65) and larger.

3. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.
4. Backwater Valves: Install backwater valves in piping subject to sewage backflow.
   a. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.
   b. Floor Drains: Drain outlet backwater valves, unless drain has integral backwater valve.
   c. Install backwater valves in accessible locations.
   d. Backwater valve are specified in Division 22 Section "Sanitary Waste Piping Specialties".

F. Hanger And Support Installation
1. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment".
2. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment".
   a. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
   b. Install stainless-steel **OR** fiberglass pipe hangers, **as directed** for horizontal piping in corrosive environments.
   c. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
   d. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
   e. Vertical Piping: MSS Type 8 or Type 42, clamps.
   f. Install individual, straight, horizontal piping runs according to the following:
      1) 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
      2) Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
      3) Longer Than 100 Feet (30 m), if Indicated: MSS Type 49, spring cushion rolls.
   g. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   h. Base of Vertical Piping: MSS Type 52, spring hangers.
3. Support horizontal piping and tubing within 12 inches (300 mm) of each fitting[**, valve,**] and coupling.
4. Support vertical piping and tubing at base and at each floor.
5. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
6. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
   b. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.
   c. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm) with 5/8-inch (16-mm) rod.
   d. NPS 6 (DN 150): 60 inches (1500 mm) with 3/4-inch (19-mm) rod.
   e. NPS 8 to NPS 12 (DN 200 to DN 300): 60 inches (1500 mm) with 7/8-inch (22-mm) rod.
   f. Spacing for 10-foot (3-m) lengths may be increased to 10 feet (3 m). Spacing for fittings is limited to 60 inches (1500 mm).
7. Install supports for vertical cast-iron soil piping every 15 feet (4.5 m).
8. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 1-1/4 (DN 32): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
   b. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
   c. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
   d. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
   e. NPS 3 (DN 80): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
   f. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
   g. NPS 6 and NPS 8 (DN 150 and DN 200): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.
   h. NPS 10 to NPS 12 (DN 250 to DN 300): 12 feet (3.7 m) with 7/8-inch (22-mm) rod.

9. Install supports for vertical steel piping every 15 feet (4.5 m).
10. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:
    a. NPS 2 (DN 50): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
    b. NPS 3 (DN 80): 96 inches (2400 mm) with 1/2-inch (13-mm) rod.
    c. NPS 4 (DN 100): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
    d. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
11. Install supports for vertical stainless-steel piping every 10 feet (3 m).
12. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
    a. NPS 1-1/4 (DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
    b. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
    c. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
    d. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
    e. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
    f. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod.
13. Install supports for vertical copper tubing every 10 feet (3 m).
14. Install hangers for ABS and PVC piping with the following maximum horizontal spacing and minimum rod diameters:
    a. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
    b. NPS 3 (DN 80): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
    c. NPS 4 and 5 (DN 100 and 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
    d. NPS 6 and NPS8 (DN 150 and DN 200): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
    e. NPS 10 to NPS 12 (DN 250 to DN 300): 48 inches (1200 mm) with 7/8-inch (22-mm) rod.
15. Install supports for vertical ABS and PVC piping every 48 inches (1200 mm).
16. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

G. Connections
1. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
3. Connect drainage and vent piping to the following:
    a. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
    b. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
    c. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
    d. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
    e. Install horizontal backwater valves with cleanout cover flush with floor **OR** in pit with pit cover flush with floor**, as directed**.
    f. Comply with requirements for backwater valves, cleanouts and drains specified in Division 22 Section "Facility Storm Drainage Piping".
    g. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 (DN 65) and larger.
4. Connect force-main piping to the following:
    a. Sanitary Sewer: To exterior force main or sanitary manhole.
    b. Sewage Pumps: To sewage pump discharge.
5. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
6. 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.

H. Identification
1. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 22 Section "Identification For Plumbing Piping And Equipment".

I. Field Quality Control
1. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   b. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
2. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
3. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
4. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   a. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   b. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   c. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
   d. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg (250 Pa). Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
   e. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   f. Prepare reports for tests and required corrective action.
5. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   a. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   b. Cap and subject piping to static-water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
   c. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   d. Prepare reports for tests and required corrective action.

J. Cleaning and Protection
   1. Clean interior of piping. Remove dirt and debris as work progresses.
   2. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
   3. Place plugs in ends of uncompleted piping at end of day and when work stops.
   4. Exposed ABS and PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

END OF SECTION 01 95 99 99m

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SECTION 01 95 99 99n - STORM DRAINAGE PIPING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for storm drainage piping. 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. Pipe, tube, and fittings.
b. Special pipe fittings.
c. Encasement for underground metal piping.

C. Performance Requirements
1. Components and installation shall be capable of withstanding the following minimum working-pressure, unless otherwise indicated:
a. Storm Drainage Piping: 10-foot head of water (30 kPa).
b. Storm Drainage, Force-Main Piping: 50 psig (345 kPa) **OR** 100 psig (690 kPa) **OR** 150 psig (1035 kPa), **as directed**.
2. Seismic Performance: Soil, waste, and vent piping and support and installation shall be capable of withstanding the effects of seismic events determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures."

D. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:
a. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.
3. Shop Drawings: For controlled-flow **OR** siphonic roof drainage system, as directed by the Owner. Include calculations, plans, and details. Controlled-Flow Storm Drainage System: Include calculations, plans, and details.
4. Seismic Qualification Certificates: For storm drainage piping, accessories, and components, from manufacturer.
a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
b. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
5. Field quality-control inspection and test reports.

E. Quality Assurance
1. Piping materials shall bear label, stamp, or other markings of specified testing agency.
2. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

F. Project Conditions
1. Interruption of Existing Storm-Drainage Service: Do not interrupt service to facilities occupied by the 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 storm-drainage service.

b. Do not proceed with interruption of storm-drainage service without the Owner's written permission.

1.2 PRODUCTS

A. Piping Materials
1. Refer to Part 1.3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining methods for specific services, service locations, and pipe sizes.

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

C. Hubless Cast-Iron Soil Pipe And Fittings
1. Pipe and Fittings: ASTM A 888 or CISPI 301.
2. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
a. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.
b. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.
c. Heavy-Duty, Shielded, Cast-Iron Couplings: ASTM A 48/A 48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve.
3. Rigid, Unshielded Couplings: 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.

D. Galvanized-Steel Pipe And Fittings
1. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade A or B, Standard Weight or Schedule 40, galvanized. Include ends matching joining method.
2. Drainage Fittings: ASME B16.12, galvanized, **as directed**, threaded, cast-iron drainage pattern.
3. Pressure Fittings:
a. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized, seamless steel pipe. Include ends matching joining method.
b. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
c. Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, galvanized, **as directed**, standard pattern.
d. Cast-Iron Flanges: ASME B16.1, Class 125.
e. Cast-Iron, Flanged Fittings: ASME B16.1, Class 125, galvanized, **as directed**.
4. Grooved-Joint Systems:
a. Grooved-End, Steel-Piping Fittings: ASTM A 47/A 47M, galvanized, **as directed**, malleable-iron casting; ASTM A 106, galvanized-steel pipe; or ASTM A 536, galvanized, **as directed**, ductile-iron casting; with dimensions matching steel pipe.
b. Grooved-End, Steel-Piping Couplings: AWWA C606, for steel-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

E. Ductile-Iron, Pipe and Fittings
1. Ductile-Iron, Mechanical-Joint Piping
a. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot end, unless grooved or flanged ends are indicated.
b. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.

c. Glands, Gaskets, and Bolts: AWWA C111/A121.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2. Ductile-Iron, Push-on-Joint,
   a. Ductile-Iron Pipe: AWWA C151/A21.51, with push-on-joint bell and plain spigot end, unless grooved or flanged ends are indicated.
   b. Ductile-Iron Fittings: AWWA C110/A21.10, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
   c. Gaskets: AWWA C111/A21.11, rubber.
3. Ductile Iron, Grooved-Joint Piping:
   a. Ductile-Iron Pipe: AWWA C151/A21.51 with round-cut-grooved ends according to AWWA C606.
   b. Ductile-Iron-Pipe Appurtenances:
      1) Grooved-End, Ductile-Iron Fittings: ASTM A 536, ductile-iron castings with dimensions matching pipe. AWWA C110/A21.10 ductile-iron pipe or AWWA C153/A21.53 ductile-iron fittings and complying with AWWA C606 for grooved ends.
      2) Grooved Mechanical Couplings for Ductile-Iron Pipe: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys, EPMD-rubber center-leg gasket suitable for hot and cold water, and bolts and nuts.

F. Copper Tube And Fittings
1. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
2. Copper Drainage Fittings: ASME B16.23, cast-copper or ASME B16.29, wrought-copper, solder-joint fittings.
3. Hard Copper Tube: ASTM B 88, Types L and M (ASTM B 88M, Types B and C), water tube, drawn temper.
4. Soft Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B), water tube, annealed temper.
5. Copper Pressure Fittings:
   a. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
   b. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
6. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
   a. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
   b. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
7. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

G. ABS Pipe And Fittings
1. Solid-Wall ABS Pipe: ASTM D 2661, Schedule 40.
2. Cellular-Core ABS Pipe: ASTM F 628, Schedule 40.
3. ABS Socket Fittings: ASTM D 2661, made to ASTM D 3311, drain, waste, and vent patterns.
4. Solvent Cement: ASTM D 2235
   a. Use ABS solvent cement that has a VOC content of 325 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

H. PVC Pipe And Fittings
1. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
2. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.
3. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
4. Adhesive Primer: ASTM F 656.
   a. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
5. Solvent Cement: ASTM D 2564.

a. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

I. Specialty Pipe Fittings
1. Transition Couplings:
a. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
b. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
c. Unshielded, Nonpressure Transition Couplings:
1) Standard: ASTM C 1173.
2) Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
3) Sleeve Materials:
a) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
b) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
c) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
d. Shielded, Nonpressure Transition Couplings:
1) Standard: ASTM C 1460.
2) Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
e. Pressure Transition Couplings:

f. Standard: AWWA C219.
g. Description: Metal, sleeve-type couplings same size as, with pressure rating at least equal to and ends compatible with, pipes to be joined.
h. Center-Sleeve Material: Manufacturer's standard **OR** Carbon steel **OR** Stainless steel **OR** Ductile iron **OR** Malleable iron, **as directed.**
i. Gasket Material: Natural or synthetic rubber.
j. Metal Component Finish: Corrosion-resistant coating or material.
2. Dielectric Fittings:
a. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
b. Dielectric Unions:
1) Description:
a) Standard: ASSE 1079.
b) Pressure Rating: **150 psig (1035 kPa) OR 250 psig (1725 kPa)** at 180 deg F (82 deg C), **as directed.**
c) End Connections: Solder-joint copper alloy and threaded ferrous.
c. Dielectric Flanges:
1) Description:
a) Standard: ASSE 1079.
b) Factory-fabricated, bolted, companion-flange assembly.
c) Pressure Rating: **150 psig (1035 kPa) OR 175 psig (1200 kPa)** minimum **OR 300 psig (2070 kPa), as directed.**
d) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
d. Dielectric-Flange Insulating Kits:
1) Description:
a) Nonconducting materials for field assembly of companion flanges.

b) Pressure Rating: **150 psig (1035 kPa)**
c) Gasket: Neoprene or phenolic.
d) Bolt Sleeves: Phenolic or polyethylene.
e) Washers: Phenolic with steel-backing washers.

e. Dielectric Nipples:
1) Description:
a) Electroplated steel nipple complying with ASTM F 1545.
b) Pressure Rating: **300 psig (2070 kPa)** at **225 deg F (107 deg C)**.
c) End Connections: Male threaded or grooved.
d) Lining: Inert and noncorrosive, propylene.

J. Encasement For Underground Metal Piping
1. Description: ASTM A 674 or AWWA C105
2. Material: High-density, crosslaminated PE film of 0.004-inch (0.10-mm) **OR** LLDPE film of 0.008-inch (0.20-mm), **as directed**, minimum thickness.
3. Form: Sheet **OR** Tube, **as directed**.
4. Color: Black **OR** Natural, **as directed**.

1.3 EXECUTION

A. Earth Moving
1. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

B. Piping Installation
1. 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 from layout are approved on coordination drawings.
2. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
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 above accessible ceilings to allow sufficient space for ceiling panel removal.
5. Install piping to permit valve servicing.
6. Install piping at indicated slopes.
7. Install piping free of sags and bends.
8. Install fittings for changes in direction and branch connections.
9. Install piping to allow application of insulation.
10. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment".
11. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
12. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
13. Install storm drainage piping at the following minimum slopes unless otherwise indicated:
a. Building Storm Drain: 1 percent **OR** 2 percent, **as directed**, downward in direction of flow for piping NPS 3 (DN 80) and smaller; 1 percent **OR** 2 percent**, as directed,** downward in direction of flow for piping NPS 4 (DN 100) and larger.

b. Horizontal Storm-Drainage Piping: **2 percent** downward in direction of flow.

14. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
    a. Install encasement on underground piping according to ASTM A 674 or AWWA C105.
15. Install steel piping according to applicable plumbing code.
16. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
17. Install aboveground ABS piping according to ASTM D 2661.
18. Install aboveground PVC piping according to ASTM D 2665.
19. Install underground ABS and PVC piping according to ASTM D 2321.
20. Install engineered controlled-flow **OR** siphonic**, as directed,** drain specialties and storm drainage piping in locations indicated.
21. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside building between wall and floor penetrations and connection to storm sewer piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
    a. Install encasement on piping according to ASTM A 674 or AWWA C105.
22. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."
    a. Install encasement on piping according to ASTM A 674 or AWWA C105.
23. Install force mains at elevations indicated.
24. Plumbing Specialties:
    a. Install backwater valves in storm drainage gravity-flow piping. Comply with requirements for backwater valves specified in Division 33 Section "Storm Utility Drainage Piping".
    b. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping. Comply with requirements for cleanouts specified in Division 33 Section "Storm Utility Drainage Piping".
    c. Install drains in storm drainage gravity-flow piping. Comply with requirements for drains specified in Division 33 Section "Storm Utility Drainage Piping".
25. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
26. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Common Work Results For Plumbing".
27. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Common Work Results For Plumbing".
28. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Common Work Results For Plumbing".

C. Joint Construction
1. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results For Plumbing".
2. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
3. Hub-and-Spigot, Cast-Iron Soil Piping Calked Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
4. Hubless Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
5. 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.

6. Join copper tube and fittings with soldered joints according to ASTM B 828 procedure. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.
7. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fittings. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.
8. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.
9. Plastic, Nonpressure-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. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

D. Specialty Pipe Fitting Installation
1. Transition Couplings:
    a. Install transition couplings at joints of piping with small differences in OD's.
    b. In Drainage Piping: Unshielded **OR** Shielded, **as directed** nonpressure transition couplings.
    c. In Aboveground Force-Main Piping: Fitting-type transition couplings.
    d. In Underground Force-Main Piping:
        1) NPS 1-1/2 (DN 40) and Smaller: Fitting-type transition couplings.
        2) NPS 2 (DN 50) and Larger: Pressure transition couplings.
2. Dielectric Fittings:
    a. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
    b. Dielectric Fittings for **NPS 2 (DN 50)** and Smaller: Use dielectric nipples **OR** unions, **as directed**.
    c. Dielectric Fittings for **NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**: Use dielectric flanges **OR** flange kits **OR** nipples, **as directed.**
    d. Dielectric Fittings for **NPS 5 (DN 125)** and Larger: Use dielectric flange kits.

E. Valve Installation
1. General valve installation requirements are specified in Division 22 Section "General-duty Valves For Plumbing Piping".
2. Shutoff Valves: Install shutoff valve on each sump pump discharge.
    a. Install gate or full-port ball valve for piping NPS 2 (DN 50) and smaller.
    b. Install gate valve for piping NPS 2-1/2 (DN 65) and larger.
3. Check Valves: Install swing check valve, between pump and shutoff valve, on each sump pump discharge.
4. Backwater Valves: Install backwater valves in piping subject to backflow.
    a. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.
    b. Install backwater valves in accessible locations.
    c. Comply with requirements for backwater valve specified in Division 22 Section "Storm Drainage Piping Specialties".

F. Hanger And Support Installation
1. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment".
2. Comply with requirements for pipe hangers and supports and installation specified in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment".
    a. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
    b. Install stainless-steel **OR** fiberglass pipe hangers, **as directed,** for horizontal piping in corrosive environments.
    c. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.

d. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
e. Vertical Piping: MSS Type 8 or Type 42, clamps.
f. Individual, Straight, Horizontal Piping Runs:
   1) 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
   2) Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
   3) Longer Than 100 Feet (30 m), if Indicated: MSS Type 49, spring cushion rolls.
g. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
h. Base of Vertical Piping: MSS Type 52, spring hangers.

3. Support horizontal piping and tubing within 12 inches (300 mm) of each fitting, valve, and coupling.
4. Support vertical piping and tubing at base and at each floor.
5. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
6. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
   b. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.
   c. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm) with 5/8-inch (16-mm) rod.
   d. NPS 6 (DN 150): 60 inches (1500 mm) with 3/4-inch (19-mm) rod.
   e. NPS 8 to NPS 12 (DN 200 to DN 300): 60 inches (1500 mm) with 7/8-inch (22-mm) rod.
   f. Spacing for 10-foot (3-m) lengths may be increased to 10 feet (3 m). Spacing for fittings is limited to 60 inches (1500 mm).
7. Install supports for vertical cast-iron soil piping every 15 feet (4.5 m).
8. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 1-1/4 (DN 32): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
   b. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
   c. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
   d. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
   e. NPS 3 (DN 80): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
   f. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
   g. NPS 6 (DN 150): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.
   h. NPS 8 to NPS 12 (DN 200 to DN 300): 12 feet (3.7 m) with 7/8-inch (22-mm) rod.
9. Install supports for vertical steel piping every 15 feet (4.5 m).
10. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
    a. NPS 1-1/4 (DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
    b. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
    c. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
    d. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
    e. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
    f. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod.
11. Install supports for vertical copper tubing every 10 feet (3 m).
12. Install hangers for ABS and PVC piping with the following maximum horizontal spacing and minimum rod diameters:
    a. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
    b. NPS 3 (DN 80): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
    c. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
    d. NPS 6 (DN 150): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
    e. NPS 8 to NPS 12 (DN 200 to DN 300): 48 inches (1200 mm) with 7/8-inch (22-mm) rod.
13. Install supports for vertical ABS and PVC piping every 48 inches (1200 mm).

14. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

G. Connections
1. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
3. Connect storm drainage piping to roof drains and storm drainage specialties.
   a. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
   b. Install horizontal backwater valves with cleanout cover flush with floor **OR** in pit with pit cover flush with floor, **as directed.**
   c. Comply with requirements for backwater valves, cleanouts and drains specified in Division 22 Section "Storm Drainage Piping Specialties".
4. Connect force-main piping to the following:
   a. Storm Sewer: To exterior force main or storm manhole.
   b. Sump Pumps: To sump pump discharge.
5. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
6. 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.

H. Identification
1. Identify exposed storm drainage piping. Comply with requirements for identification specified in Division 22 Section "Identification For Plumbing Piping And Equipment".

I. Field Quality Control
1. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
   b. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
2. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
3. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
4. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   a. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   b. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   c. Test Procedure: Test storm drainage piping, except outside leaders, **as directed**, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
   d. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   e. Prepare reports for tests and required corrective action.

5. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   a. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   b. Cap and subject piping to static-water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
   c. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   d. Prepare reports for tests and required corrective action.

J. Cleaning
1. Clean interior of piping. Remove dirt and debris as work progresses.
2. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
3. Place plugs in ends of uncompleted piping at end of day and when work stops.

K. Piping Schedule
1. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
2. Aboveground storm drainage piping NPS 6 (DN 150) and smaller shall be any of the following:
   a. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   b. Hubless, cast-iron soil pipe and fittings; **CISPI, heavy-duty,** hubless-piping couplings; and coupled joints.
   c. Galvanized-steel pipe, drainage fittings, and threaded joints.
   d. Copper tube and fittings in first subparagraph below are only available in NPS 1-1/4 to NPS 8 (DN 32 to DN 200).
   e. Copper DWV tube, copper drainage fittings, and soldered joints.
   f. Solid-wall **OR** Cellular-core ABS pipe, **as directed**, ABS socket fittings, and solvent-cemented joints.
   g. Solid-wall **OR** Cellular-core PVC pipe, **as directed,** PVC socket fittings, and solvent-cemented joints.
   h. Dissimilar Pipe-Material Couplings: Unshielded **OR** Shielded, **as directed,** nonpressure transition couplings.
3. Aboveground, storm drainage piping NPS 8 (DN 200) and larger shall be any of the following:
   a. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   b. Hubless, cast-iron soil pipe and fittings; **CISPI, heavy-duty,** hubless-piping couplings; and coupled joints.
   c. Galvanized-steel pipe, drainage fittings, and threaded joints.
   d. Copper DWV tube, copper drainage fittings, and soldered joints.
   e. Solid-wall **OR** Cellular-core PVC pipe, **as directed**, PVC socket fittings, and solvent-cemented joints.
   f. Dissimilar Pipe-Material Couplings: Unshielded **OR** Shielded, **as directed**, nonpressure transition couplings.
4. Underground storm drainage piping **NPS 6 (DN 150) and smaller** shall be **any of** the following:
   a. Extra Heavy **OR** Service class, **as directed,** cast-iron soil pipe and fittings; gaskets; and gasketed **OR** calking materials; and calked joints, **as directed.**
   b. Hubless, cast-iron soil pipe and fittings; **CISPI, heavy-duty, cast-iron,** hubless-piping couplings; and coupled joints.
   c. Solid-wall **OR** Cellular-core ABS pipe, **as directed**, ABS socket fittings, and solvent-cemented joints.
   d. **Solid-wall OR Cellular-core** PVC pipe, **as directed**, PVC socket fittings, and solvent-cemented joints.

e. Dissimilar Pipe-Material Couplings: Unshielded **OR** Shielded, **as directed**, nonpressure transition couplings.

5. Underground, storm drainage piping **NPS 8 (DN 200) and larger** shall be **any of** the following:
   a. Extra Heavy **OR** Service class, **as directed**, cast-iron soil pipe and fittings; gaskets; and gasketed **OR** calking materials; and calked joints **as directed**,.
   b. Hubless, cast-iron soil pipe and fittings; **CISPI, heavy-duty, cast-iron,** hubless-piping couplings; and coupled joints.
   c. **Solid-wall OR Cellular-core** PVC pipe, **as directed**, PVC socket fittings, and solvent-cemented joints.
   d. Cellular-core, sewer and drain series, PVC pipe; PVC socket fittings; and solvent-cemented joints.
   e. Dissimilar Pipe-Material Couplings: **Unshielded OR Shielded**, **as directed**, nonpressure transition couplings.
6. Aboveground storm drainage force mains **NPS 1-1/2 and NPS 2 (DN 40 and DN 50)** shall be **any of** the following:
   a. Hard copper tube, copper pressure fittings, and soldered joints.
   b. Galvanized-steel pipe, pressure fittings, and threaded joints.
7. Aboveground storm drainage force mains **NPS 2-1/2 to NPS 6 (DN 65 to DN 150)** shall be any of the following:
   a. Hard copper tube, copper pressure fittings, and soldered joints.
   b. Galvanized-steel pipe, pressure fittings, and threaded joints.
   c. Grooved-end, galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
   d. Fitting-type transition couplings if dissimilar pipe materials.
8. Underground storm drainage force mains NPS 4 (DN 100) and smaller shall be any of the following:
   a. Hard **OR** Soft**, as directed** copper tube; **wrought-**copper pressure fittings; and soldered joints.
   b. Ductile-iron, mechanical-joint piping and mechanical joints.
   c. Ductile-iron, push-on-joint piping and push-on joints.
   d. Ductile-iron, grooved-joint piping and grooved joints.
   e. Fitting-type transition coupling for piping smaller than NPS 1-1/2 (DN 40) and pressure transition coupling for NPS 1-1/2 (DN 40) and larger if dissimilar pipe materials.
9. Underground storm drainage force mains NPS 5 (DN 125) and larger shall be any of the following:
   a. Hard copper tube; **wrought-**copper pressure fittings; and soldered joints.
   b. Ductile-iron, mechanical-joint piping and mechanical joints.
   c. Ductile-iron, push-on-joint piping and push-on joints.
   d. Ductile-iron, grooved-joint piping and grooved joints.
   e. Pressure transition couplings if dissimilar pipe materials.

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SECTION 01 95 99 99o - HYDRONIC PIPING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for hydronic piping. 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 pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
   a. Hot-water heating piping.
   b. Chilled-water piping.
   c. Dual-temperature heating and cooling water piping.
   d. Condenser-water piping.
   e. Glycol cooling-water piping.
   f. Makeup-water piping.
   g. Condensate-drain piping.
   h. Blowdown-drain piping.
   i. Air-vent piping.
   j. Safety-valve-inlet and -outlet piping.

C. Definitions
1. PTFE: Polytetrafluoroethylene.
2. RTRF: Reinforced thermosetting resin (fiberglass) fittings.
3. RTRP: Reinforced thermosetting resin (fiberglass) pipe.

D. Performance Requirements
1. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:
   a. Hot-Water Heating Piping: **psig (kPa),** as directed by the Owner at 200 deg F (93 deg C).
   b. Chilled-Water Piping: **psig (kPa),** as directed by the Owner at 200 deg F (93 deg C).
   c. Dual-Temperature Heating and Cooling Water Piping: **psig (kPa),** ethylene at 200 deg F (93 deg C).
   d. Condenser-Water Piping: **psig (kPa),** as directed by the Owner at 150 deg F (66 deg C).
   e. Glycol Cooling-Water Piping: **psig (kPa),** as directed by the Owner at 150 deg F (66 deg C).
   f. Makeup-Water Piping: 80 psig (552 kPa) at 150 deg F (66 deg C).
   g. Condensate-Drain Piping: 150 deg F (66 deg C).
   h. Blowdown-Drain Piping: 200 deg F (93 deg C).
   i. Air-Vent Piping: 200 deg F (93 deg C).
   j. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

E. Submittals
1. Product Data: For each type of the following:
   a. Plastic pipe and fittings with solvent cement.
   b. RTRP and RTRF with adhesive.
   c. Pressure-seal fittings.
   d. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
   e. Air control devices.

f. Chemical treatment.
g. Hydronic specialties.

2. LEED Submittal:
   a. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.
3. Shop Drawings: Detail, at 1/4 (1:50) scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
4. Welding certificates.
5. Qualification Data: For Installer.
6. Field quality-control test reports.
7. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.
8. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

F. Quality Assurance
1. Installer Qualifications:
   a. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
   b. Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP shall be certified by the manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.
2. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
3. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
   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.
4. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1.2 PRODUCTS

A. Copper Tube And Fittings
1. Drawn-Temper Copper Tubing: ASTM B 88, Type L (ASTM B 88M, Type B) **OR** ASTM B 88, Type M (ASTM B 88M, Type C), **as directed**.
2. Annealed-Temper Copper Tubing: ASTM B 88, Type K (ASTM B 88M, Type A).
3. DWV Copper Tubing: ASTM B 306, Type DWV.
4. Wrought-Copper Fittings: ASME B16.22.
   a. Grooved-End Copper Fittings: ASTM B 75 (ASTM B 75M), copper tube or ASTM B 584, bronze casting.
   b. Grooved-End-Tube Couplings: Rigid pattern, unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, prelubricated, **as directed**, EPDM gasket rated for minimum 230 deg F (110 deg C) for use with housing, and steel bolts and nuts.
5. Copper or Bronze Pressure-Seal Fittings:
   a. Housing: Copper.
   b. O-Rings and Pipe Stops: EPDM.

c. Tools: Manufacturer's special tools.
d. Minimum 200-psig (1379-kPa) working-pressure rating at 250 deg F (121 deg C).

6. Copper, Mechanically Formed Tee Option: For forming T-branch on copper water tube.
7. Wrought-Copper Unions: ASME B16.22.

B. Steel Pipe And Fittings

1. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 1.3 "Piping Applications" Article.
2. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 1.3 "Piping Applications" Article.
3. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 1.3 "Piping Applications" Article.
4. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 1.3 "Piping Applications" Article.
5. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 1.3 "Piping Applications" Article.
6. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
7. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   a. Material Group: 1.1.
   b. End Connections: Butt welding.
   c. Facings: Raised face.
8. Grooved Mechanical-Joint Fittings and Couplings:
   a. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
   b. Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
9. Steel Pressure-Seal Fittings:
   a. Housing: Steel.
   b. O-Rings and Pipe Stop: EPDM.
   c. Tools: Manufacturer's special tool.
   d. Minimum 300-psig (2070-kPa) working-pressure rating at 230 deg F (110 deg C).
10. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

C. Plastic Pipe And Fittings

1. CPVC Plastic Pipe: ASTM F 441/F 441M, Schedules 40 and 80, plain ends as indicated in Part 1.3 "Piping Applications" Article.
2. CPVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM F 438 for Schedule 40 pipe; ASTM F 439 for Schedule 80 pipe.
3. PVC Plastic Pipe: ASTM D 1785, Schedules 40 and 80, plain ends as indicated in Part 1.3 "Piping Applications" Article.
4. PVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D 2466 for Schedule 40 pipe; ASTM D 2467 for Schedule 80 pipe.

D. Fiberglass Pipe And Fittings

1. RTRP: ASTM D 2996, filament-wound pipe with tapered bell and spigot ends for adhesive joints.
2. RTRF: Compression or spray-up/contact molded of same material, pressure class, and joining method as pipe.
3. Flanges: ASTM D 4024. Full-face gaskets suitable for the service, minimum 1/8-inch (3.2-mm) thick, 60-70 durometer. ASTM A 307, Grade B, hex head bolts with washers.

E. 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 thickness or specific material is 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.
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 joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
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. CPVC Piping: ASTM F 493.
      1) Use CPVC solvent cement that has a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
      2) Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   b. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
      1) Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
      2) Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
8. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.
   a. Use fiberglass adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

F. Transition Fittings
1. Plastic-to-Metal Transition Fittings:
   a. CPVC **OR** PVC, **as directed**, one-piece fitting with one threaded brass or copper insert and one Schedule 80 solvent-cement-joint end.
2. Plastic-to-Metal Transition Unions:
   a. MSS SP-107, CPVC **OR** PVC, **as directed**, union. Include brass or copper end, Schedule 80 solvent-cement-joint end, rubber gasket, and threaded union.

G. Dielectric Fittings
1. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
2. Insulating Material: Suitable for system fluid, pressure, and temperature.
3. Dielectric Unions:
   a. Factory-fabricated union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
4. Dielectric Flanges:
   a. Factory-fabricated companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
5. Dielectric-Flange Kits:
   a. Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

b. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure where required to suit system pressures.

6. Dielectric Couplings:
   a. Galvanized-steel coupling with inert and noncorrosive thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
7. Dielectric Nipples:
   a. Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

H. Valves
1. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 22 Section(s) "General-duty Valves For Plumbing Piping" OR Division 23 Section(s) "General-duty Valves For Hvac Piping".
2. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "Instrumentation And Control For Hvac".
3. Plastic Ball Valves:
   a. Body: One-, two-, or three-piece CPVC or PVC to match piping.
   b. Ball: Full-port CPVC or PVC to match piping.
   c. Seats: PTFE.
   d. Seals: EPDM.
   e. End Connections: Socket, union, or flanged.
   f. Handle Style: Tee shape.
   g. CWP Rating: Equal to piping service.
   h. Maximum Operating Temperature: Equal to piping service.
   i. Comply with MSS SP-122.
4. Plastic Butterfly Valves:
   a. Body: PVC or CPVC to match piping wafer type for installation between flanges.
   b. Disc: EPDM-coated steel.
   c. Seats: PTFE.
   d. Handle Style: Locking lever.
   e. CWP Rating: Equal to piping service.
   f. Maximum Operating Temperature: Equal to piping service.
5. Plastic Check Valves:
   a. Body: One-, two-, or three-piece PVC or CPVC to match piping.
   b. Ends: Socket or flanged.
   c. Seats: PTFE.
   d. Check Style: Swing or ball type.
   e. CWP Rating: Equal to piping service.
   f. Maximum Operating Temperature: Equal to piping service.
6. Bronze, Calibrated-Orifice, Balancing Valves:
   a. Body: Bronze, ball or plug type with calibrated orifice or venturi.
   b. Ball: Brass or stainless steel.
   c. Plug: Resin.
   d. Seat: PTFE.
   e. End Connections: Threaded or socket.
   f. Pressure Gage Connections: Integral seals for portable differential pressure meter.
   g. Handle Style: Lever, with memory stop to retain set position.
   h. CWP Rating: Minimum 125 psig (860 kPa).
   i. Maximum Operating Temperature: 250 deg F (121 deg C).
7. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:
   a. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
   b. Ball: Brass or stainless steel.
   c. Stem Seals: EPDM O-rings.
   d. Disc: Glass and carbon-filled PTFE.
   e. Seat: PTFE.

f. End Connections: Flanged or grooved.
g. Pressure Gage Connections: Integral seals for portable differential pressure meter.
h. Handle Style: Lever, with memory stop to retain set position.
i. CWP Rating: Minimum 125 psig (860 kPa).
j. Maximum Operating Temperature: 250 deg F (121 deg C).

8. Diaphragm-Operated, Pressure-Reducing Valves:
   a. Body: Bronze or brass.
   b. Disc: Glass and carbon-filled PTFE.
   c. Seat: Brass.
   d. Stem Seals: EPDM O-rings.
   e. Diaphragm: EPT.
   f. Low inlet-pressure check valve.
   g. Inlet Strainer: removable without system shutdown.
   h. Valve Seat and Stem: Noncorrosive.
   i. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.
9. Diaphragm-Operated Safety Valves:
   a. Body: Bronze or brass.
   b. Disc: Glass and carbon-filled PTFE.
   c. Seat: Brass.
   d. Stem Seals: EPDM O-rings.
   e. Diaphragm: EPT.
   f. Wetted, Internal Work Parts: Brass and rubber.
   g. Inlet Strainer: removable without system shutdown.
   h. Valve Seat and Stem: Noncorrosive.
   i. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.
10. Automatic Flow-Control Valves:
    a. Body: Brass or ferrous metal.
    b. Piston and Spring Assembly: Stainless steel **OR** Corrosion resistant, **as directed**, tamper proof, self cleaning, and removable.
    c. Combination Assemblies: Include bonze or brass-alloy ball valve.
    d. Identification Tag: Marked with zone identification, valve number, and flow rate.
    e. Size: Same as pipe in which installed.
    f. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
    g. Minimum CWP Rating: 175 psig (1207 kPa) **OR** 300 psig (2070 kPa), **as directed**.
    h. Maximum Operating Temperature: 200 deg F (93 deg C) **OR** 250 deg F (121 deg C), **as directed**.

I. Air Control Devices
1. Manual Air Vents:
   a. Body: Bronze.
   b. Internal Parts: Nonferrous.
   c. Operator: Screwdriver or thumbscrew.
   d. Inlet Connection: NPS 1/2 (DN 15).
   e. Discharge Connection: NPS 1/8 (DN 6).
   f. CWP Rating: 150 psig (1035 kPa).
   g. Maximum Operating Temperature: 225 deg F (107 deg C).
2. Automatic Air Vents:
   a. Body: Bronze or cast iron.
   b. Internal Parts: Nonferrous.
   c. Operator: Noncorrosive metal float.
   d. Inlet Connection: NPS 1/2 (DN 15).

e. Discharge Connection: NPS 1/4 (DN 8).
f. CWP Rating: 150 psig (1035 kPa).
g. Maximum Operating Temperature: 240 deg F (116 deg C).

3. Expansion Tanks:
   a. Tank: Welded steel, rated for 125-psig (860-kPa) working pressure and 375 deg F (191 deg C) maximum operating temperature, with taps in bottom of tank for tank fitting and taps in end of tank for gage glass. Tanks shall be factory tested with taps fabricated and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   b. Air-Control Tank Fitting: Cast-iron body, copper-plated tube, brass vent tube plug, and stainless-steel ball check, 100-gal. (379-L) unit only; sized for compression-tank diameter. Provide tank fittings for 125-psig (860-kPa) working pressure and 250 deg F (121 deg C) maximum operating temperature.
   c. Tank Drain Fitting: Brass body, nonferrous internal parts; 125-psig (860-kPa) working pressure and 240 deg F (116 deg C) maximum operating temperature; constructed to admit air to compression tank, drain water, and close off system.
   d. Gage Glass: Full height with dual manual shutoff valves, 3/4-inch- (20-mm-) diameter gage glass, and slotted-metal glass guard.
4. Diaphragm-Type **OR** Bladder-Type, **as directed**, Expansion Tanks:
   a. Tank: Welded steel, rated for 125-psig (860-kPa) working pressure and 375 deg F (191 deg C) maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   b. Diaphragm **OR** Bladder, **as directed**: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
   c. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.
5. Tangential-Type Air Separators:
   a. Tank: Welded steel; ASME constructed and labeled for 125-psig (860-kPa) minimum working pressure and 375 deg F (191 deg C) maximum operating temperature.
   b. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.
   c. Tangential Inlet and Outlet Connections: Threaded for NPS 2 (DN 50) and smaller; flanged connections for NPS 2-1/2 (DN 65) and larger.
   d. Blowdown Connection: Threaded.
   e. Size: Match system flow capacity.
6. In-Line Air Separators:
   a. Tank: One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.
   b. Maximum Working Pressure: Up to 175 psig (1207 kPa).
   c. Maximum Operating Temperature: Up to 300 deg F (149 deg C).
7. Air Purgers:
   a. Body: Cast iron with internal baffles that slow the water velocity to separate the air from solution and divert it to the vent for quick removal.
   b. Maximum Working Pressure: 150 psig (1035 kPa).
   c. Maximum Operating Temperature: 250 deg F (121 deg C).

J. Chemical Treatment
1. Bypass Chemical Feeder: Welded steel construction; 125-psig (860-kPa) working pressure; 5-gal. (19-L) capacity; with fill funnel and inlet, outlet, and drain valves.
   a. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.
2. Ethylene and Propylene Glycol: Industrial grade with corrosion inhibitors and environmental-stabilizer additives for mixing with water in systems indicated to contain antifreeze or glycol solutions.

K. Hydronic Piping Specialties
1. 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 (860 kPa).

2. 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 (860 kPa).

3. 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).

4. Stainless-Steel Bellow, Flexible Connectors:
a. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
b. End Connections: Threaded or flanged to match equipment connected.
c. Performance: Capable of 3/4-inch (20-mm) misalignment.
d. CWP Rating: 150 psig (1035 kPa).
e. Maximum Operating Temperature: 250 deg F (121 deg C).

5. Spherical, Rubber, Flexible Connectors:
a. Body: Fiber-reinforced rubber body.
b. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
c. Performance: Capable of misalignment.
d. CWP Rating: 150 psig (1035 kPa).
e. Maximum Operating Temperature: 250 deg F (121 deg C).

6. Expansion fittings are specified in Division 22 Section(s) "Expansion Fittings And Loops For Plumbing Piping" OR Division 23 Section(s) "Expansion Fittings And Loops For Hvac Piping".

1.3 EXECUTION

1. Hot-water heating piping, aboveground, NPS 2 (DN 50) and smaller, shall be any of the following:
a. Type L (B) **OR** M (C), **as directed**, drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed **OR** pressure-seal, **as directed**, joints.
b. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe; Class 125, cast-iron **OR** 150, malleable-iron **OR** 250, cast-iron **OR** 300, malleable-iron, **as directed**, fittings; cast-iron flanges and flange fittings; and threaded joints.
c. Schedule 5 steel pipe; steel, pressure-seal couplings and fittings; and pressure-seal joints.
d. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings and solvent-welded joints.

2. Hot-water heating piping, aboveground, NPS 2-1/2 (DN 65) and larger, shall be any of the following:
a. Type L (B) **OR** M (C), **as directed**, drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints.
b. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
c. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

d. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings and solvent-welded joints.
e. RTRP and RTRF with adhesive or flanged joints.

3. Hot-water heating piping installed belowground and within slabs shall be either of the following:
   a. Type K (A), annealed-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints. Use the fewest possible joints.
   b. RTRP and RTRF with adhesive or flanged joints.
4. Chilled-water piping, aboveground, NPS 2 (DN 50) and smaller, shall be any of the following:
   a. Type L (B) **OR** M (C), **as directed**, drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed **OR** pressure-seal, **as directed**, joints.
   b. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe; Class 125, cast-iron **OR** 150, malleable-iron **OR** 250, cast-iron **OR** 300, malleable-iron, **as directed**, fittings; cast-iron flanges and flange fittings; and threaded joints.
   c. Schedule 5 steel pipe; steel, pressure-seal couplings and fittings; and pressure-seal joints.
   d. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings and solvent-welded joints.
5. Chilled-water piping, aboveground, NPS 2-1/2 (DN 65) and larger, shall be any of the following:
   a. Type L (B) **OR** M (C), **as directed**, drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints.
   b. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
   c. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
   d. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings and solvent-welded joints.
   e. RTRP and RTRF with adhesive or flanged joints.
6. Chilled-water piping installed belowground and within slabs shall be either of the following:
   a. Type K (A), annealed-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints. Use the fewest possible joints.
   b. RTRP and RTRF with adhesive or flanged joints.
7. Dual-temperature heating and cooling water piping, aboveground, NPS 2 (DN 50) and smaller, shall be any of the following:
   a. Type L (B) **OR** M (C), **as directed**, drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed **OR** pressure-seal, **as directed**, joints.
   b. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe; Class 125, cast-iron **OR** 150, malleable-iron **OR** 250, cast-iron **OR** 300, malleable-iron, **as directed**, fittings; cast-iron flanges and flange fittings; and threaded joints.
   c. Schedule 5 steel pipe; steel, pressure-seal couplings and fittings; and pressure-seal joints.
   d. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings and solvent-welded joints.
8. Dual-temperature heating and cooling water piping, aboveground, NPS 2-1/2 (DN 65) and larger, shall be any of the following:
   a. Type L (B) **OR** M (C), **as directed**, drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints.
   b. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
   c. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
   d. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings and solvent-welded joints.
   e. RTRP and RTRF with adhesive or flanged joints.
9. Dual-temperature heating and cooling water piping installed belowground and within slabs shall be either of the following:
   a. Type K (A), annealed-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints. Use the fewest possible joints.
   b. RTRP and RTRF with adhesive or flanged joints.
10. Condenser-water piping, aboveground, NPS 2 (DN 50) and smaller, shall be any of the following:
    a. Type L (B) **OR** M (C), **as directed**, drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed **OR** pressure-seal, **as directed**, joints.

b. Schedule 80 **OR** 40 **OR** 30 **OR** 20, **as directed**, steel pipe; Class 125, cast-iron **OR** 150, malleable-iron **OR** 250, cast-iron **OR** 300, malleable-iron, **as directed**, fittings; cast-iron flanges and flange fittings; and threaded joints.
c. Schedule 5 steel pipe; steel, pressure-seal couplings and fittings; and pressure-seal joints.
d. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings and solvent-welded joints.

11. Condenser-water piping, aboveground, NPS 2-1/2 (DN 65) and larger, shall be any of the following:
    a. Type L (B) **OR** M (C), **as directed**,, drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints.
    b. Schedule 80 **OR** 40 **OR** 30 **OR** 20, **as directed**, steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
    c. Schedule 80 **OR** 40 **OR** 30 **OR** 20, **as directed**, steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
    d. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings and solvent-welded joints.
    e. RTRP and RTRF with adhesive or flanged joints.
12. Condenser-water piping installed belowground and within slabs shall be either of the following:
    a. Type K (A), annealed-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints. Use the fewest possible joints.
    b. RTRP and RTRF with adhesive or flanged joints.
13. Glycol cooling-water piping, aboveground, NPS 2 (DN 50) and smaller, shall be any of the following:
    a. Type L (B) **OR** M (C), **as directed**, drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed **OR** pressure-seal, **as directed**, joints.
    b. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe; Class 125, cast-iron **OR** 150, malleable-iron **OR** 250, cast-iron **OR** 300, malleable-iron, **as directed**, fittings; cast-iron flanges and flange fittings; and threaded joints.
    c. Schedule 5 steel pipe; steel, pressure-seal couplings and fittings; and pressure-seal joints.
    d. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings and solvent-welded joints.
14. Glycol cooling-water piping, aboveground, NPS 2-1/2 (DN 65) and larger, shall be any of the following:
    a. Type L (B) **OR** M (C), **as directed**, drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints.
    b. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
    c. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
    d. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings and solvent-welded joints.
    e. RTRP and RTRF with adhesive or flanged joints.
15. Glycol cooling-water piping installed belowground and within slabs shall be either of the following:
    a. Type K (A), annealed-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints. Use the fewest possible joints.
    b. RTRP and RTRF with adhesive or flanged joints.
16. Makeup-water piping installed aboveground shall be either of the following:
    a. Type L (B) **OR** M (C), **as directed**, drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints.
    b. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings, and solvent-welded joints.
17. Makeup-Water Piping Installed Belowground and within Slabs: Type K (A), annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.
18. Condensate-Drain Piping: Type M (C) **OR** DWV, **as directed**, drawn-temper copper tubing, wrought-copper fittings, and soldered joints or Schedule 40 PVC plastic pipe and fittings and solvent-welded joints, **as directed**.
    OR
    Condensate-Drain Piping: Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.

19. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.
20. Air-Vent Piping:
    a. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.
    b. Outlet: Type K (A), annealed-temper copper tubing with soldered or flared joints.
21. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.

B. Valve Applications
1. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.
2. Install throttling-duty **OR** calibrated-orifice, balancing, **as directed**, valves at each branch connection to return main.
3. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.
4. Install check valves at each pump discharge and elsewhere as required to control flow direction.
5. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
6. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

C. Piping Installations
1. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such 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 Coordination Drawings.
2. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
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 above accessible ceilings to allow sufficient space for ceiling panel removal.
5. Install piping to permit valve servicing.
6. Install piping at indicated slopes.
7. Install piping free of sags and bends.
8. Install fittings for changes in direction and branch connections.
9. Install piping to allow application of insulation.
10. Select system components with pressure rating equal to or greater than system operating pressure.
11. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
12. Install drains, consisting of a tee fitting, NPS 3/4 (DN 20) ball valve, and short NPS 3/4 (DN 20) threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
13. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
14. Reduce pipe sizes using eccentric reducer fitting installed with level side down.
15. Install branch connections to mains using mechanically formed, **as directed**, tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
16. Install valves according to Division 22 Section(s) "General-duty Valves For Plumbing Piping" OR Division 23 Section(s) "General-duty Valves For Hvac Piping".
17. Install unions in piping, NPS 2 (DN 50) and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

18. Install flanges in piping, NPS 2-1/2 (DN 65) and larger, at final connections of equipment and elsewhere as indicated.
19. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 (DN 20) nipple and ball valve in blowdown connection of strainers NPS 2 (DN 50) and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2 (DN 50).
20. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 22 Section(s) "Expansion Fittings And Loops For Plumbing Piping" OR Division 23 Section(s) "Expansion Fittings And Loops For Hvac Piping".
21. Identify piping as specified in Division 22 Section(s) "Identification For Plumbing Piping And Equipment" OR Division 23 Section(s) "Identification For Hvac Piping And Equipment".

D. Hangers And Supports
1. Hanger, support, and anchor devices are specified in Division 22 Section(s) "Hangers And Supports For Plumbing Piping And Equipment" OR Division 23 Section(s) "Hangers And Supports For Hvac Piping And Equipment". Comply with the following requirements for maximum spacing of supports.
2. Seismic restraints are specified in Division 21 Section(s) "Vibration And Seismic Controls For Fire-suppression Piping And Equipment" OR Division 22 Section(s) "Vibration And Seismic Controls For Plumbing Piping And Equipment" OR Division 23 Section(s) "Vibration And Seismic Controls For Hvac Piping And Equipment".
3. Install the following pipe attachments:
    a. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet (6 m) long.
    b. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet (6 m) or longer.
    c. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) or longer, supported on a trapeze.
    d. Spring hangers to support vertical runs.
    e. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
    f. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
4. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
    a. NPS 3/4 (DN 20): Maximum span, 7 feet (2.1 m); minimum rod size, 3/8 inch (10 mm).
    b. NPS 1 (DN 25): Maximum span, 7 feet (2.1 m); minimum rod size, 3/8 inch (10 mm).
    c. NPS 1-1/4 (DN 32): Maximum span, 7 feet (2.1 m); minimum rod size, 3/8 inch (10 mm).
    d. NPS 1-1/2 (DN 40): Maximum span, 9 feet (2.7 m); minimum rod size, 3/8 inch (10 mm).
    e. NPS 2 (DN 50): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (10 mm).
    f. NPS 2-1/2 (DN 65): Maximum span, 11 feet (3.4 m); minimum rod size, 1/2 inch (12 mm).
    g. NPS 3 (DN 80): Maximum span, 12 feet (3.7 m); minimum rod size, 1/2 inch (12 mm).
    h. NPS 3-1/2 (DN 90): Maximum span, 13 feet (4 m); minimum rod size, 1/2 inch (12 mm).
    i. NPS 4 (DN 100): Maximum span, 14 feet (4.3 m); minimum rod size, 5/8 inch (16 mm).
    j. NPS 5 (DN 125): Maximum span, 16 feet (4.9 m); minimum rod size, 5/8 inch (16 mm).
    k. NPS 6 (DN 150): Maximum span, 17 feet (5.2 m); minimum rod size, 3/4 inch (20 mm).
    l. NPS 8 (DN 200): Maximum span, 19 feet (5.8 m); minimum rod size, 3/4 inch (20 mm).
    m. NPS 10 (DN 250): Maximum span, 22 feet (6.7 m); minimum rod size, 7/8 inch (20 mm).
    n. NPS 12 (DN 300): Maximum span, 23 feet (7 m); minimum rod size, 7/8 inch (20 mm).
    o. NPS 14 (DN 350): Maximum span, 25 feet (7.6 m); minimum rod size, 1 inch (24 mm).
    p. NPS 16 (DN 400): Maximum span, 27 feet (8.2 m); minimum rod size, 1 inch (24 mm).
    q. NPS 18 (DN 450): Maximum span, 28 feet (8.5 m); minimum rod size, 1 inch (24 mm).
    r. NPS 20 (DN 500): Maximum span, 30 feet (9.1 m); minimum rod size, 1-1/4 inches (30 mm).
5. Install hangers for drawn-temper copper tubing with the following maximum spacing and minimum rod sizes:
    a. NPS 3/4 (DN 20): Maximum span, 5 feet (1.5 m); minimum rod size, 3/8 inch (10 mm).

b. NPS 1 (DN 25): Maximum span, 6 feet (1.8 m); minimum rod size, 3/8 inch (10 mm).
c. NPS 1-1/4 (DN 32): Maximum span, 7 feet (2.1 m); minimum rod size, 3/8 inch (10 mm).
d. NPS 1-1/2 (DN 40): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8 inch (10 mm).
e. NPS 2 (DN 50): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8 inch (10 mm).
f. NPS 2-1/2 (DN 65): Maximum span, 9 feet (2.7 m); minimum rod size, 1/2 inch (12 mm).
g. NPS 3 (DN 80): Maximum span, 10 feet (3 m); minimum rod size, 1/2 inch (12 mm).

6. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
7. Fiberglass Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
8. Support vertical runs at roof, at each floor, and at 10-foot (3-m) intervals between floors.

E. Pipe Joint Construction
1. Join pipe and fittings according to the following requirements and Division 21 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. 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 complying with ASTM B 32.
5. 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.
6. 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.
7. 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.
8. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
9. 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. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
   c. PVC Pressure Piping: Join ASTM D 1785 schedule number, 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.
   d. PVC Nonpressure Piping: Join according to ASTM D 2855.
10. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.
11. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.
12. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.
13. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

F. Hydronic Specialties Installation

1. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
   OR
   Install automatic air vents at high points of system piping in mechanical equipment rooms only. Manual vents at heat-transfer coils and elsewhere as required for air venting.
2. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.
3. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 (DN 50) and larger.
   OR
   Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.
4. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches (1200 mm) above the floor. Install feeder in minimum NPS 3/4 (DN 20) bypass line, from main with full-size, full-port, ball valve in the main between bypass connections. Install NPS 3/4 (DN 20) pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve.
5. Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
   a. Install tank fittings that are shipped loose.
   b. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

   OR

   Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements.

G. Terminal Equipment Connections
1. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
2. Install control valves in accessible locations close to connected equipment.
3. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
4. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 22 Section(s) "Meters And Gages For Plumbing Piping" OR Division 23 Section(s) "Meters And Gages For Hvac Piping".

H. Chemical Treatment
1. Perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling, and to sustain the following water characteristics:
   a. pH: 9.0 to 10.5.
   b. "P" Alkalinity: 100 to 500 ppm.
   c. Boron: 100 to 200 ppm.
   d. Chemical Oxygen Demand: Maximum 100 ppm. Modify this value if closed system contains glycol.
   e. Corrosion Inhibitor:
      1) Sodium Nitrate: 1000 to 1500 ppm.
      2) Molybdate: 200 to 300 ppm.
      3) Chromate: 200 to 300 ppm.
      4) Sodium Nitrate Plus Molybdate: 100 to 200 ppm each.
      5) Chromate Plus Molybdate: 50 to 100 ppm each.
   f. Soluble Copper: Maximum 0.20 ppm.
   g. Tolyiriazole Copper and Yellow Metal Corrosion Inhibitor: Minimum 10 ppm.
   h. Total Suspended Solids: Maximum 10 ppm.

i. Ammonia: Maximum 20 ppm.
j. Free Caustic Alkalinity: Maximum 20 ppm.
k. Microbiological Limits:
1) Total Aerobic Plate Count: Maximum 1000 organisms/ml.
2) Total Anaerobic Plate Count: Maximum 100 organisms/ml.
3) Nitrate Reducers: 100 organisms/ml.
4) Sulfate Reducers: Maximum 0 organisms/ml.
5) Iron Bacteria: Maximum 0 organisms/ml.

2. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.
3. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.
4. Fill systems indicated to have antifreeze or glycol solutions with the following concentrations:
a. Hot-Water Heating Piping: Minimum percent ethylene, as directed by the Owner **OR** propylene, **as directed**, glycol.
b. Chilled-Water Piping: Minimum percent ethylene, as directed by the Owner **OR** propylene, **as directed**, glycol.
c. Dual-Temperature Heating and Cooling Water Piping: Minimum percent, as directed by the Owner ethylene **OR** propylene, **as directed**, glycol.
d. Glycol Cooling-Water Piping: Minimum percent ethylene, as directed by the Owner. **OR** propylene, **as directed**, glycol.

I. Field Quality Control
1. Prepare hydronic piping according to ASME B31.9 and as follows:
a. Leave joints, including welds, uninsulated and exposed for examination during test.
b. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
c. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
d. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
e. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
2. Perform the following tests on hydronic piping:
a. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
b. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
c. Isolate expansion tanks and determine that hydronic system is full of water.
d. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
e. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
f. Prepare written report of testing.
3. Perform the following before operating the system:
a. Open manual valves fully.
b. Inspect pumps for proper rotation.
c. Set makeup pressure-reducing valves for required system pressure.
d. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).

e. Set temperature controls so all coils are calling for full flow.
f. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
g. Verify lubrication of motors and bearings.

END OF SECTION 01 95 99 99o

SECTION 01 95 99 99p - COMPRESSED-AIR PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for compressed-air piping for laboratory and healthcare facilities. 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. Compressed-air piping and specialties for nonmedical laboratory facilities, designated "laboratory air," operating at 50 psig (345 kPa) **OR** 100 psig (690 kPa) **OR** 125 psig (860 kPa), **as directed**.
   b. Medical air piping and specialties, designated "medical air," operating at 50 to 55 psig (345 to 380 kPa).
   c. Dental air piping and specialties, designated "dental air," operating at 80 to 100 psig (550 to 690 kPa).
   d. Gas-powered-tool air piping and specialties, designated "instrument air," operating at 175 psig (1200 kPa).
   e. Healthcare laboratory air piping and specialties, designated "medical laboratory air," operating at 100 psig (690 kPa).

C. Definitions
1. D.I.S.S.: Diameter-index safety system.
2. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
3. Medical Compressed-Air Piping Systems: Include medical air, dental air, instrument air, and medical laboratory air piping systems.

D. Submittals
1. Product Data: For the following:
   a. Compressed-air tubes and fittings.
   b. Compressed-air valves and valve boxes.
   c. Medical compressed-air service connections.
   d. Medical compressed-air pressure control panels.
   e. Medical compressed-air manifolds.
   f. Medical compressed-air alarm system components.
2. Shop Drawings: Diagram power, signal, and control wiring.
3. Piping Material Certification: Signed by Installer certifying that medical compressed-air piping materials comply with NFPA 99 requirements.
4. Brazing certificates.
5. Field quality-control test reports.
6. Operation and maintenance data.

E. Quality Assurance
1. Installer Qualifications:
   a. Medical Compressed-Air Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010.
   b. Pressure-Seal Joining Procedure for Copper Tubing: Qualify operators according to training provided by Viega; Plumbing and Heating Systems.

2. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization **OR** is an NRTL, **as directed**, and that is acceptable to authorities having jurisdiction.
   a. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.
3. Source Limitations: Obtain compressed-air service connections of same type and from same manufacturer as service connections provided for in Division 22 Section "Gas Piping For Laboratory And Healthcare Facilities".
4. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
5. 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.
6. ASME Compliance:
   a. Comply with ASME B31.1, "Power Piping," for laboratory compressed-air piping operating at more than 150 psig (1035 kPa).
   b. Comply with ASME B31.9, "Building Services Piping," for laboratory compressed-air piping operating at 150 psig (1035 kPa) or less.
7. Comply with NFPA 99, "Health Care Facilities," for medical compressed-air system materials and installation in healthcare facilities.

F. Project Conditions
1. Interruption of Existing Laboratory and Medical Compressed-Air Service(s): Do not interrupt laboratory or medical compressed-air service to facilities occupied by the 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 laboratory and medical compressed-air service(s).
   b. Do not proceed with interruption of laboratory and medical compressed-air service(s) without the Owner's written permission.

1.2 PRODUCTS

A. Pipes, Tubes, And Fittings
1. Copper Medical Gas Tube: ASTM B 819, Type K **OR** Type L, **as directed**, seamless, drawn temper, that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and in blue for Type L tube.
   a. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
   b. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
   c. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.
   d. Press-Type 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. Memory-Metal Couplings: Cryogenic compression fitting made of ASTM F 2063, nickel-titanium, shape-memory alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.

3. Copper Water Tube: ASTM B 88, Type M (ASTM B 88M, Type C), seamless, drawn temper.
   a. Copper Fittings: ASME B16.18, cast-copper or ASME B16.22, wrought-copper, solder-joint pressure type.
   b. Press-Type 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.
4. PVC Pipe: ASTM D 1785, Schedule 40.
   a. PVC Fittings: ASTM D 2466, Schedule 40, socket type.

B. Joining Materials
1. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
2. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
3. Threaded-Joint Tape: PTFE.
4. Solvent Cement for Joining PVC Piping: ASTM D 2564. Include primer complying with ASTM F 656.

C. Valves
1. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
2. Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
   a. Pressure Rating: 300 psig (2070 kPa) minimum.
   b. Ball: Full-port, chrome-plated brass.
   c. Seats: PTFE or TFE.
   d. Handle: Lever type with locking device, **as directed**.
   e. Stem: Blowout proof with PTFE or TFE seal.
   f. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
3. Check Valves: In-line pattern, bronze.
   a. Pressure Rating: 300 psig (2070 kPa) minimum.
   b. Operation: Spring loaded.
   c. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
4. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
   a. Pressure Rating: 300 psig (2070 kPa) minimum.
   b. Ball: Full-port, chrome-plated brass.
   c. Seats: PTFE or TFE.
   d. Handle: Lever type with locking device, **as directed**.
   e. Stem: Blowout proof with PTFE or TFE seal.
   f. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
   g. Pressure Gage: Manufacturer installed on one copper-tube extension.
5. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.
   a. Interior Finish: Factory-applied white enamel.
   b. Cover Plate: Aluminum or extruded-anodized aluminum **OR** Satin-chrome finish steel **OR** Stainless steel with NAAMM AMP 503, No. 4 finish, **as directed**, with frangible or removable windows.
   c. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

   OR

   Zone Valve Boxes: Formed or extruded aluminum with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.

a. Interior Finish: Factory-applied white enamel.
b. Cover Plate: Aluminum or extruded-anodized aluminum **OR** Stainless steel with NAAMM AMP 503, No. 4 finish, **as directed**, with frangible or removable windows.
c. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

6. Safety Valves: Bronze-body, ASME-construction, poppet, pressure-relief type with settings to match system requirements.
7. Pressure Regulators: Bronze body and trim; spring-loaded, diaphragm-operated relieving type; manual pressure-setting adjustment; rated for 250-psig (1725-kPa) minimum inlet pressure; and capable of controlling delivered air pressure within 0.5 psig for each 10-psig (5.0 kPa for each 100-kPa) inlet pressure.
8. Automatic Drain Valves: Stainless-steel body and internal parts, rated for 200-psig (1380-kPa) minimum working pressure, capable of automatic discharge of collected condensate. Include mounting bracket where wall mounting is indicated, **as directed**.

D. Medical Compressed-Air Service Connections
1. Connection Devices: For specific medical compressed-air pressure and service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.
a. Roughing-in Assembly:
1) Steel outlet box for recessed mounting and concealed piping.
2) Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed.
3) Double seals that will prevent air leakage.
4) ASTM B 819, NPS 3/8 (DN 10) copper outlet tube brazed to valve with service marking and tube-end dust cap.
b. Finishing Assembly:
1) Brass housing with primary check valve.
2) Double seals that will prevent air leakage.
3) Cover plate with gas-service label.
c. Quick-Coupler Service Connections: Pressure outlet with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.
d. D.I.S.S. Service Connections: Pressure outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
1) Medical Air Service Connections: CGA V-5, D.I.S.S. No. 1160.
2) Instrument Air Service Connections: CGA V-5, D.I.S.S. No. 1160.
e. Cover Plates: One piece, stainless steel, with NAAMM AMP 503, No. 4 finish **OR** metal, with chrome-plated finish **OR** anodized aluminum, **as directed**, and permanent, color-coded, identifying label matching corresponding service.

E. Medical Compressed-Air Pressure Control Panels
1. Description: Steel box and support brackets for recessed roughing in with stainless-steel or anodized-aluminum cover plate with printed operating instructions. Include manifold assembly consisting of inlet supply valve, inlet supply pressure gage, line-pressure control regulator, outlet supply pressure gage, D.I.S.S. service connection, and piping outlet for remote service connection.
a. Minimum Working Pressure: 200 psig (1380 kPa).
b. Line-Pressure Control Regulator: Self-relieving diaphragm type with precision manual adjustment.
c. Pressure Gages: 0- to 300-psig (0- to 2070-kPa) range.

d. Service Connection: CGA V-5, D.I.S.S. No. 1160, instrument air outlet.
e. Before final assembly, provide temporary dust shield and U-tube for testing.
f. Label cover plate "Air Pressure Control."

F. Medical Compressed-Air Manifolds
1. General Requirements for Medical Compressed-Air Manifolds: Comply with NFPA 99, Ch. 5, "Manifolds for Gas Cylinders without Reserve Supply."
2. Central Control Panel Unit: Weatherproof cabinet, supply and delivery pressure gages, electrical alarm system connections and transformer, indicator lights or devices, manifold connection, pressure changeover switch, line-pressure regulator, shutoff valves, and safety valve.
3. Manifold and Headers: Duplex, nonferrous-metal header for number of cylinders indicated, divided into two equal banks. Units include design for 2000-psig (13.8-MPa) minimum inlet pressure. Include cylinder bank headers with inlet (pigtail) connections complying with CGA V-1, individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gage.
4. Compressed-Air Cylinders: Will be furnished by the Owner **OR** Number and type of compressed-air cylinders required for complete manifold systems, **as directed**.
5. Operation: Automatic, pressure-switch-activated changeover from one cylinder bank to the other when first bank becomes exhausted, without line-pressure fluctuation or resetting of regulators and without supply interruption by shutoff of either cylinder bank header.
6. Mounting: Wall with mounting brackets for manifold control cabinet and headers **OR** Floor with support legs for manifold control cabinet, **as directed**.
7. Label manifold control unit with permanent label identifying compressed air and system operating pressure.
8. Medical Air Manifolds: For 4 cylinders and 1250-cu. ft./h (9.85-L/s) **OR** 8 cylinders and 2500-cu. ft./h (19.7-L/s), **as directed**, capacity at 55-psig (380-kPa) line pressure.
9. Instrument Air Manifolds: For 8 cylinders and 2000-cu. ft./h (15.7-L/s) **OR** 12 cylinders and 3000-cu. ft./h (23.6-L/s), **as directed**, capacity at 200-psig (1380-kPa) minimum line pressure.

G. Medical Compressed-Air-Piping Alarm Systems
1. Panels for medical compressed-air piping systems may be combined in single panels with medical vacuum and medical gas piping systems.
2. Components: Designed for continuous service and to operate on power supplied from 120 **OR** 240 **OR** 277, **as directed**,-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.
3. Dew Point Monitors: Continuous line monitoring, having panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, factory- or field-installed valved bypass, and visual and cancelable audio signal for dryer site and master alarm panels. Alarm signals when pressure dew point rises above 39 deg F (4 deg C) at 55 psig (380 kPa).
   a. Operation: Chilled-mirror method **OR** Chilled-mirror method or hygrometer moisture analyzer with sensor probe **OR** Hygrometer moisture analyzer with sensor probe, **as directed**.
4. Pressure Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
   a. Low-Pressure Operating Range: 0- to 100-psig (0- to 690-kPa).
   b. High-Pressure Operating Range: Up to 250-psig (1725-kPa).
5. Carbon Monoxide Monitors: Panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, and factory- or field-installed valved bypass. Alarm signals when carbon monoxide level rises above 10 ppm.
6. General Requirements for Medical Compressed-Air Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
   a. Mounting: Exposed, surface **OR** Recessed, **as directed**, installation.
   b. Enclosures: Fabricated from minimum 0.047-inch- (1.2-mm-) thick steel or minimum 0.05-inch- (1.27-mm-) thick aluminum, with knockouts for electrical and piping connections.
7. Master Alarm Panels: Separate trouble alarm signals, pressure gages, and indicators for medical compressed-air piping systems.

a. Include alarm signals when the following conditions exist:
   1) Medical Air: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa), backup air compressor is in operation, pressure drop across filter assembly increases more than 2 psig (13.8 kPa), dew point rises above 39 deg F (4 deg C) at 55 psig (380 kPa), carbon monoxide level rises above 10 ppm, and high water level is reached in receiver for liquid-ring, medical air compressor systems.
   2) Dental Air: Pressure drops below 65 psig (450 kPa) or rises above 110 psig (760 kPa), backup air compressor is in operation, pressure drop across filter assembly increases more than 2 psig (13.8 kPa), dew point rises above 50 deg F (10 deg C) at 125 psig (860 kPa), and carbon monoxide level rises above 10 ppm.
   3) Instrument Air: Pressure drops below 165 psig (1140 kPa) or rises above 185 psig (1275 kPa).
   4) Medical Laboratory Air: Pressure drops below 90 psig (630 kPa) or rises above 110 psig (760 kPa).

8. Anesthetizing-Area Alarm Panels: Separate trouble alarm signals, pressure gages, and indicators for medical compressed-air piping systems.
   a. Include alarm signals when the following conditions exist:
      1) Medical Air: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).
      2) Instrument Air: Pressure drops below 165 psig (1140 kPa) or rises above 185 psig (1275 kPa).
9. Area Alarm Panels: Separate trouble alarm signals, pressure gages, and indicators for medical compressed-air piping systems.
   a. Include alarm signals when the following condition exists:
      1) Medical Air: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).
10. Dental-Area Alarm Panels: Separate trouble alarm signals, pressure gages, and indicators for medical compressed-air piping systems.
   a. Include alarm signals when the following conditions exist:
      1) Dental Air: Pressure drops below 65 psig (450 kPa) or rises above 110 psig (760 kPa), backup air compressor is in operation, pressure drop across filter assembly increases more than 2 psig (13.8 kPa), dew point rises above 50 deg F (10 deg C) at 125 psig (860 kPa), and carbon monoxide level rises above 10 ppm.
      2) Instrument Air: Pressure drops below 165 psig (1140 kPa) or rises above 185 psig (1275 kPa).
11. Medical Laboratory Area Alarm Panels: Separate trouble alarm signals, pressure gages,; and indicators for medical compressed-air piping systems.
   a. Include alarm signals when the following condition exists:
      1) Medical Laboratory Air: Pressure drops below 90 psig (630 kPa) or rises above 110 psig (760 kPa).

H. Computer Interface Cabinet
   1. Description: Wall-mounting, welded-steel control cabinet with gasketed door, mounting brackets, grounding device, and white-enamel finish for connection of medical compressed-air- piping-system alarms to facility computer. Include factory-installed signal circuit boards, power transformer, circuit breaker, wiring terminal board, and internal wiring capable of interfacing 20, **as directed**, alarm signals.

I. Compressed-Air-Cylinder Storage Racks
   1. Wall Storage Racks: Fabricate racks with chain restraints for upright cylinders as indicated or provide equivalent manufactured wall racks.
   2. Freestanding Storage Racks: Fabricate racks as indicated or provide equivalent manufactured storage racks.

J. Flexible Pipe Connectors
1. Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
a. Working-Pressure Rating: 200 psig (1380 kPa) **OR** 250 psig (1725 kPa), **as directed**, minimum.
b. End Connections: Threaded copper pipe or plain-end copper tube.

K. Sleeves
1. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
2. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
a. Underdeck Clamp: Clamping ring with set screws.

L. Escutcheons
1. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and 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.
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. Nitrogen
1. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen.

1.3 EXECUTION

A. Piping Applications
1. Connect new tubing to existing tubing with memory-metal couplings.
2. Laboratory Air Piping: Use one of the following piping materials for each size range:
a. NPS 4 (DN 100) and Smaller: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
b. NPS 4 (DN 100) and Smaller: Type L, copper medical gas tube; press-type fittings; and pressure-sealed joints.
c. NPS 5 to NPS 8 (DN 125 to DN 200): Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
3. Medical Air Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

4. Dental Air Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
5. Instrument Air Piping:
   a. NPS 3 (DN 80) and Smaller: Use Type K **OR** Type L, **as directed**, copper medical gas tube; wrought-copper fittings; and brazed joints.
   b. NPS 3-1/2 (DN 90) and Larger: Use Type K, copper medical gas tube; wrought-copper fittings; and brazed joints.
6. Medical Laboratory Air Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
7. Drain Piping: Use one of the following piping materials:
   a. Copper water tube, cast- or wrought-copper fittings, and soldered **OR** press-type fittings, and pressure-sealed, **as directed**, joints.
   b. PVC pipe, PVC fittings, and solvent-cemented joints.

B. Piping Installation
1. Drawing plans, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
2. Comply with ASSE Standard #6010 for installation of compressed-air piping.
3. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
4. 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.
5. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
6. Install piping adjacent to equipment and specialties to allow service and maintenance.
7. Install air and drain piping with 1 percent slope downward in direction of flow.
8. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications below unless otherwise indicated.
9. Install eccentric reducers, if available, where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
10. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.
11. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver. Comply with requirements in Division 22 Section "Meters And Gages For Plumbing Piping".
12. Install piping to permit valve servicing.
13. Install piping free of sags and bends.
14. Install fittings for changes in direction and branch connections.
15. Install medical compressed-air piping to medical compressed-air service connections specified in this Section, to medical compressed-air service connections in equipment specified in Division 22 Section "Gas Piping For Laboratory And Healthcare Facilities", and to equipment specified in other Sections requiring medical compressed-air service.
16. Install seismic restraints on compressed-air piping. Seismic-restraint devices are specified in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment".
17. Install compressed-air service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
18. Connect compressed-air piping to air compressors and to compressed-air outlets and equipment requiring compressed-air service.
19. Install unions in copper compressed-air tubing adjacent to each valve and at final connection to each piece of equipment, machine, and specialty.

C. Valve Installation
1. Install shutoff valve at each connection to and from compressed-air equipment and specialties.
2. Install check valves to maintain correct direction of compressed-air flow from compressed-air equipment.
3. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
4. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
5. Install safety valves on compressed-air receivers where required by NFPA 99 and where recommended by specialty manufacturers.
6. Install pressure regulators on compressed-air piping where reduced pressure is required.
7. Install automatic drain valves on equipment, specialties, and piping with drain connection. Run drain piping to floor drain so contents spill over or into it.
8. Install flexible pipe connectors in discharge piping and in inlet air piping from remote air-inlet filter, **as directed**, of each air compressor.

D. Joint Construction
1. Ream ends of PVC pipes and remove burrs.
2. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
3. Threaded Joints: Apply appropriate tape to external pipe threads.
4. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free dry nitrogen during brazing.
5. Soldered Joints: Apply ASTM B 813, water-flushable flux to tube end. Join copper tube and fittings according to ASTM B 828.
6. Pressure-Sealed Joints: Join copper tube and press-type fittings with tools recommended by fitting manufacturer.
7. Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.
8. Solvent-Cemented Joints: Clean and dry joining surfaces. Join PVC pipe and fittings according to the following:
    a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
    b. Apply primer and join according to ASME B31.9 for solvent-cemented joints, and ASTM D 2672.

E. Compressed-Air Service Component Installation
1. Install compressed-air pressure control panel in walls. Attach to substrate.
2. Install compressed-air manifolds on concrete base, **as directed**, anchored to substrate.
3. Install compressed-air cylinders and connect to manifold piping.
4. Install compressed-air manifolds with seismic restraints as indicated.
5. Install compressed-air-cylinder wall storage racks attached to substrate.

F. Medical Compressed-Air-Piping Alarm System Installation
1. Alarm panels for medical compressed-air piping systems may be combined in single panels with medical vacuum piping systems and medical gas piping systems.
2. Install alarm system components for medical compressed-air-piping according to and in locations required by NFPA 99.
3. Install area and master alarm panels for medical compressed-air piping system where indicated.
4. Install computer interface cabinet with connection to medical compressed-air-piping alarm system and to facility computer.

G. Sleeve Installation
1. Sleeves are not required for core-drilled holes.
2. Permanent sleeves are not required for holes formed by removable PE sleeves.

3. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs using galvanized-steel pipe **OR** galvanized-steel sheet **OR** stack sleeve fittings **OR** PVC pipe, **as directed**.
   a. Wall Penetrations: Cut sleeves to length for mounting flush with both surfaces.
   b. Floor Penetrations: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

   OR

   Install sleeves in new walls and slabs as new walls and slabs are constructed.
4. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
   a. PVC **OR** Steel, **as directed**, Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
   b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger penetrating gypsum board partitions.
   c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim" for flashing.
      1) Seal space outside of sleeve fittings with grout.
5. 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 "Penetration Firestopping".

H. Escutcheon Installation
1. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   a. New Piping:
      1) Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
      2) Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** stamped steel with set screw **OR** stamped steel with set screw or spring clips **OR** stamped steel with spring clips, **as directed**.
      3) Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** One piece or split casting, cast brass with polished chrome-plated finish **OR** Split casting, cast brass with polished chrome-plated finish **OR** One piece, stamped steel with set screw **OR** One piece or split plate, stamped steel with set screw **OR** Split plate, stamped steel with set screw, **as directed**.
      4) Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish **OR** cast brass with rough-brass finish **OR** stamped steel with set screw **OR** stamped steel with spring clips **OR** stamped steel with set screw or spring clips, **as directed**.
      5) Bare Piping in Equipment Rooms: One piece, cast brass **OR** stamped steel with set screw **OR** stamped steel with spring clips **OR** stamped steel with set screw or spring clips, **as directed**.
      6) Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.
   b. Existing Piping:
      1) Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.
      2) Insulated Piping: Split plate, stamped steel with concealed **OR** exposed-rivet, **as directed**, hinge and spring clips.
      3) Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and spring clips, **as directed**.

4) Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and set screw, **as directed**.
5) Bare Piping in Unfinished Service Spaces: Split casting, cast brass with polished chrome-plated finish **OR** casting, cast brass with rough-brass finish **OR** plate, stamped steel with concealed hinge and set screw or spring clips **OR** plate, stamped steel with concealed or exposed-rivet hinge and set screw or spring clips **OR** plate, stamped steel with exposed-rivet hinge and set screw or spring clips, **as directed**.
6) Bare Piping in Equipment Rooms: Split casting, cast brass **OR** plate, stamped steel with set screw or spring clips, **as directed**.
7) Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.

I. Hanger And Support Installation
1. Comply with requirements in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment" for seismic-restraint devices.
2. Comply with requirements in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment" for pipe hanger and support devices.
3. Vertical Piping: MSS Type 8 or 42, clamps.
4. Individual, Straight, Horizontal Piping Runs:
   a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel, clevis hangers.
   b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable, roller hangers.
5. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment" for trapeze hangers.
6. Base of Vertical Piping: MSS Type 52, spring hangers.
7. Support horizontal piping within 12 inches (300 mm) of each fitting and coupling.
8. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
9. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 1/4 (DN 8): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
   b. NPS 3/8 and NPS 1/2 (DN 10 and DN 15): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
   c. NPS 3/4 (DN 20): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
   d. NPS 1 (DN 25): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
   e. NPS 1-1/4 (DN 32): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
   f. NPS 1-1/2 (DN 40): 10 feet (3 m) with 3/8-inch (10-mm) rod.
   g. NPS 2 (DN 50): 11 feet (3.4 m) with 3/8-inch (10-mm) rod.
   h. NPS 2-1/2 (DN 65): 13 feet (4 m) with 1/2-inch (13-mm) rod.
   i. NPS 3 (DN 80): 14 feet (4.3 m) with 1/2-inch (13-mm) rod.
   j. NPS 3-1/2 (DN 90): 15 feet (4.6 m) with 1/2-inch (13-mm) rod.
   k. NPS 4 (DN 100): 16 feet (4.9 m) with 1/2-inch (13-mm) rod.
   l. NPS 5 (DN 125): 18 feet (5.5 m) with 1/2-inch (13-mm) rod.
   m. NPS 6 (DN 150): 20 feet (6 m) with 5/8-inch (16-mm) rod.
   n. NPS 8 (DN 200): 23 feet (7 m) with 3/4-inch (19-mm) rod.
10. Install supports for vertical copper tubing every 10 feet (3 m).

J. Labeling And Identification
1. Install identifying labels and devices for nonmedical laboratory compressed-air piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification For Plumbing Piping And Equipment".
2. Install identifying labels and devices for medical compressed-air piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
   a. Medical Air: Black letters on yellow background.

b. Dental Air: Black letters on yellow-and-white diagonal stripe background.
c. Instrument Air: White letters on red background.
d. Medical Laboratory Air: Black letters on yellow-and-white checkerboard background.

K. Field Quality Control For Compressed-Air Piping In Nonmedical Laboratory Facilities
1. Perform tests and inspections of compressed-air piping in nonmedical laboratory facilities and prepare test reports.
2. Tests and Inspections:
a. Piping Leak Tests for Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry nitrogen to pressure of 50 psig (345 kPa) above system operating pressure, but not less than 150 psig (1035 kPa). Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
b. Repair leaks and retest until no leaks exist.
c. Inspect filters and pressure regulators for proper operation.

L. Field Quality Control For Medical Compressed-Air Piping In Healthcare Facilities
1. Perform tests and inspections of medical compressed-air piping systems in healthcare facilities and prepare test reports.
2. Tests and Inspections:
a. Medical Compressed-Air Testing Coordination: Perform tests, inspections, verifications, and certification of medical compressed-air piping systems concurrently with tests, inspections, and certification of medical vacuum piping and medical gas piping systems.
b. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
1) Initial blowdown.
2) Initial pressure test.
3) Cross-connection test.
4) Piping purge test.
5) Standing pressure test for positive-pressure medical compressed-air piping.
6) Repair leaks and retest until no leaks exist.
c. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical compressed-air piping systems and perform the following tests and inspections:
1) Standing pressure test.
2) Individual-pressurization **OR** Individual-pressurization or pressure-differential **OR** Pressure-differential, **as directed**, cross-connection test.
3) Valve test.
4) Master and area alarm tests.
5) Piping purge test.
6) Piping particulate test.
7) Piping purity test.
8) Final tie-in test.
9) Operational pressure test.
10) Medical air purity test.
11) Verify correct labeling of equipment and components.
d. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
1) Inspections performed.
2) Procedures, materials, and gases used.
3) Test methods used.
4) Results of tests.
3. Remove and replace components that do not pass tests and inspections and retest as specified above.

END OF SECTION 01 95 99 99p

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SECTION 01 95 99 99q - VACUUM PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for vacuum piping for laboratory and healthcare facilities. 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. Laboratory low-vacuum piping and specialties, designated "laboratory low vacuum" operating at 12 inches mercury (40.6 kPa vacuum) **OR** 20 inches mercury (67.7 kPa vacuum), **as directed**.
   b. Laboratory high-vacuum piping and specialties, designated "laboratory high vacuum" operating at 24 inches mercury (81.3 kPa vacuum) **OR** 29 inches mercury (98.2 kPa vacuum), **as directed**.
   c. Medical surgical vacuum piping and specialties, designated "medical vacuum" operating at 15 inches mercury (380 mm mercury or 50.7 kPa vacuum) **OR** 20 inches mercury (510 mm mercury or 67.7 kPa vacuum) **OR** 30 inches mercury (760 mm mercury or 101.4 kPa vacuum), **as directed**.
   d. Waste anesthetic gas disposal piping and specialties, designated "WAGD evacuation" operating at 14 inches mercury (355 mm mercury or 47.2 kPa vacuum) **OR** 15 inches mercury (380 mm mercury or 50.7 kPa vacuum), **as directed**.
   e. Dental vacuum piping and specialties, designated "dental vacuum" operating at 10 inches mercury (255 mm mercury or 33.8 kPa vacuum) **OR** 12 inches mercury (305 mm mercury or 40.6 kPa vacuum), **as directed**.
   f. Oral-evacuation piping and specialties, designated "HVE" operating at 5 inches mercury (127 mm mercury or 16.9 kPa vacuum) **OR** 8 inches mercury (203 mm mercury or 27.0 kPa vacuum), **as directed**.
   g. Healthcare laboratory vacuum piping and specialties, designated "medical laboratory vacuum" operating at 12 inches mercury (40.6 kPa vacuum) **OR** 20 inches mercury (67.7 kPa vacuum) **OR** 24 inches mercury (81.3 kPa vacuum), **as directed**.

C. Definitions
1. D.I.S.S.: Diameter-index safety system.
2. HVE: High-volume (oral) evacuation.
3. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
4. WAGD: Waste anesthetic gas disposal.
5. Medical vacuum piping systems include medical vacuum, WAGD evacuation, dental vacuum, HVE, and medical laboratory vacuum piping systems.

D. Submittals
1. Product Data: For the following:
   a. Vacuum pipes **OR** tubes, **as directed**, and fittings.
   b. Vacuum valves and valve boxes.
   c. Medical vacuum service connections and vacuum-bottle brackets.
2. LEED Submittal:
   a. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.
3. Shop Drawings: Diagram power, signal, and control wiring.

4. Piping Material Certification: Signed by Installer certifying that medical vacuum piping materials comply with NFPA 99 requirements.
5. Qualification Data: For Installer and testing agency.
6. Brazing certificates.
7. Field quality-control test reports.
8. Operation and maintenance data.

E. Quality Assurance
1. Installer Qualifications:
   a. Medical Vacuum Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010.
   b. Extruded-Tee Outlet Procedure: Qualify operators according to training provided by T-DRILL Industries Inc., for making branch outlets.
   c. Pressure-Seal Joining Procedure for Copper Tubing: Qualify operators according to training provided by Viega; Plumbing and Heating Systems.
2. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL, and that is acceptable to authorities having jurisdiction.
   a. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.
3. Source Limitations: Obtain vacuum service connections of same type and from same manufacture as service connections provided for in Division 22 Section "Gas Piping For Laboratory And Healthcare Facilities".
4. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
5. 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.
6. Comply with ASME B31.9, "Building Services Piping," for vacuum piping in laboratory facilities.
7. NFPA Compliance: Comply with NFPA 99, "Health Care Facilities," for medical vacuum system materials and installation in healthcare facilities.

F. Project Conditions
1. Interruption of Existing Laboratory or Medical Vacuum Service(s): Do not interrupt laboratory or medical vacuum service to facilities occupied by the 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 laboratory or medical vacuum service(s).
   b. Do not proceed with interruption of laboratory or medical vacuum service(s) without the Owner's written permission.

1.2 PRODUCTS

A. Pipes, Tubes, And Fittings
1. Copper Medical Gas Tube: ASTM B 819, Type L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in blue.
   a. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.

b. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
c. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.
d. Press-Type 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. Copper Water Tube: ASTM B 88, Type M (ASTM B 88M, Type C), seamless, drawn temper.
a. Cast-Copper Fittings: ASME B16.18, solder-joint pressure type.
b. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type.
c. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150.
d. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.
e. Press-Type 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. Extruded-Tee Outlets: ASTM F 2014 procedure for making branch outlets in copper tube.
4. Memory-Metal Couplings: Cryogenic compression fitting made of ASTM F 2063, nickel-titanium, shape-memory alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.
5. PVC Pipe: ASTM D 1785, Schedule 40 and Schedule 80.
a. PVC Pressure Fittings: ASTM D 2466, Schedule 40 and ASTM D 2467, Schedule 80; socket type.

B. Joining Materials
1. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
2. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
3. Threaded-Joint Tape: PTFE.
4. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness, full-face type.
5. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.
6. Solvent Cement for Joining PVC Piping: ASTM D 2564. Include primer complying with ASTM F 656.
a. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
b. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Valves
1. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
a. Exception: Factory cleaning and bagging are not required for valves for WAGD service.
2. Copper-Alloy Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
a. Pressure Rating: 300 psig (2070 kPa) minimum.
b. Ball: Full-port, chrome-plated brass.
c. Seats: PTFE or TFE.
d. Handle: Lever type with locking device, **as directed**.
e. Stem: Blowout proof with PTFE or TFE seal.
f. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
3. Bronze Check Valves: In-line pattern.
a. Pressure Rating: 300 psig (2070 kPa) minimum.
b. Operation: Spring loaded.

c. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

4. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
   a. Pressure Rating: 300 psig (2070 kPa) minimum.
   b. Ball: Full-port, chrome-plated brass.
   c. Seats: PTFE or TFE.
   d. Handle: Lever type with locking device, **as directed**.
   e. Stem: Blowout proof with PTFE or TFE seal.
   f. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
   g. Vacuum Gage: Manufacturer installed on one copper-tube extension.
5. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with vacuum gages and in sizes required to permit manual operation of valves.
   a. Interior Finish: Factory-applied white enamel.
   b. Cover Plate: Aluminum or extruded-anodized aluminum **OR** Satin-chrome finish steel **OR** Stainless steel with NAAMM AMP 503, No. 4 finish, **as directed**, with frangible or removable windows.
   c. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.
6. Zone Valve Boxes: Formed or extruded aluminum with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with vacuum gages and in sizes required to permit manual operation of valves.
   a. Interior Finish: Factory-applied white enamel.
   b. Cover Plate: Aluminum or extruded-anodized aluminum **OR** Stainless steel with NAAMM AMP 503, No. 4 finish, **as directed**, with frangible or removable windows.
   c. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.
7. PVC Ball Valves: MSS SP-122, with union ends and 150-psig (1035-kPa) minimum working-pressure rating and suitable for vacuum service.
8. PVC Butterfly Valves: Lug type with lever handle and 150-psig (1035-kPa) minimum working-pressure rating and suitable for vacuum service.
9. PVC Check Valves: Ball-, in-line-, piston-, or swing-check design with flanged or union ends and 70-psig (480-kPa) **OR** 100-psig (690-kPa), **as directed**, minimum working-pressure rating and suitable for vacuum service.
10. Safety Valves: Bronze-body, ASME-construction, pressure-relief type with settings to match system requirements.
11. Automatic Drain Valves: Stainless-steel body and internal parts, rated for 200-psig (1380-kPa) minimum working pressure, capable of automatic discharge of collected condensate. Include mounting bracket where wall mounting is indicated.

D. Medical Vacuum Service Connections
   1. Connection Devices: For specific medical vacuum service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.
      a. Roughing-in Assembly:
         1) Steel outlet box for recessed mounting and concealed piping.
         2) Brass-body inlet block.
         3) Seals that will prevent vacuum leakage.
         4) ASTM B 819, NPS 3/8 (DN 10) copper outlet tube brazed to valve with service marking and tube-end dust cap.
      b. Finishing Assembly:
         1) Brass housing with primary check valve.
         2) Seals that will prevent vacuum leakage.
         3) Cover plate with gas-service label.

c. Quick-Coupler Service Connections: Suction inlets for medical vacuum **OR** medical vacuum and WAGD evacuation **OR** WAGD evacuation, **as directed**, service outlets with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.

d. D.I.S.S. Service Connections: Suction inlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
   1) Medical Vacuum Service Connections: CGA V-5, D.I.S.S. No. 1220.
   2) WAGD Evacuation Service Connections: CGA V-5, D.I.S.S. No. 2220.

e. Vacuum Bottle Brackets: One piece, with pattern and finish matching corresponding service cover plate.

f. Cover Plates: One piece, stainless steel, with NAAMM AMP 503, No. 4 finish **OR** metal, with chrome-plated finish **OR** anodized aluminum, **as directed**, and permanent, color-coded, identifying label matching corresponding service.

E. Medical Vacuum Piping Alarm Systems

1. Panels for medical vacuum piping systems may be combined in single panels with medical compressed-air and medical gas piping systems.
2. Components: Designed for continuous service and to operate on power supplied from 120-V **OR** 240-V **OR** 277-V, **as directed**, ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.
3. Vacuum Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
   a. Vacuum Operating Range: 0- to 30-in. Hg (0- to 101-kPa vacuum).
4. General Requirements for Medical Vacuum Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
   a. Mounting: Exposed, surface **OR** Recessed, **as directed**, installation.
   b. Enclosures: Fabricated from minimum 0.047-inch- (1.2-mm-) thick steel or minimum 0.05-inch- (1.27-mm-) thick aluminum, with knockouts for electrical and piping connections.
5. Master Alarm Panels: With separate trouble alarm signals, vacuum gages, and indicators for medical vacuum piping systems.
   a. Include alarm signals when the following conditions exist:
      1) Medical Vacuum: Vacuum drops below 12-in. Hg (40 kPa vacuum) and backup vacuum pump is in operation.
      2) WAGD Evacuation: Vacuum drops below 12-in. Hg (40 kPa vacuum).
      3) Dental Vacuum: Vacuum drops below 6-in. Hg (20 kPa vacuum) and backup vacuum producer is in operation.
      4) HVE: 4-in. Hg (13 kPa vacuum) and backup vacuum producer is in operation.
      5) Medical Laboratory Vacuum: Vacuum drops below 10-in. Hg (34 kPa vacuum).
6. Anesthetizing-Area Alarm Panels: Separate trouble alarm signals; vacuum gages; and indicators for medical vacuum piping systems.
   a. Include alarm signals when the following conditions exist:
      1) Medical Vacuum: Vacuum drops below 12-in. Hg (40 kPa vacuum).
      2) WAGD Evacuation: Vacuum drops below 12-in. Hg (40 kPa vacuum).
7. Area Alarm Panels: Separate trouble alarm signals; vacuum gages; and indicators for medical vacuum piping systems.
   a. Include alarm signals when the following condition exists:
      1) Medical Vacuum: Vacuum drops below 12-in. Hg (40 kPa vacuum).
8. Dental Area Alarm Panels: Separate trouble alarm signals; vacuum gages; and indicators for medical vacuum piping systems.
   a. Include alarm signals when the following conditions exist:
      1) Dental Vacuum: Vacuum drops below 6-in. Hg (20 kPa vacuum) and backup vacuum producer is in operation.
      2) HVE: 4-in. Hg (13 kPa vacuum) and backup vacuum producer is in operation.

9. Medical Laboratory Area Alarm Panels: Separate trouble alarm signals; vacuum gages; and indicators for medical vacuum piping systems.
    a. Include alarm signals when the following condition exists:
        1) Medical Vacuum: Vacuum drops below 12-in. Hg (40 kPa vacuum).

F. Computer Interface Cabinet
1. Description: Wall-mounting, welded-steel, control cabinet with gasketed door, mounting brackets, grounding device, and white-enamel finish for connection of medical vacuum piping system alarms to facility computer. Include factory-installed signal circuit boards, power transformer, circuit breaker, wiring terminal board, and internal wiring capable of interfacing 20 alarm signals.

G. Flexible Pipe Connectors
1. Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
    a. Working-Pressure Rating: 200 psig (1380 kPa) **OR** 250 psig (1725 kPa), **as directed**, minimum.
    b. End Connections: Threaded copper pipe or plain-end copper tube.

H. Sleeves
1. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
2. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
    a. Underdeck Clamp: Clamping ring with set screws.

I. Escutcheons
1. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and 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 **OR** Polished chrome-plated and rough brass, **as directed**.
4. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.
    a. Finish: Polished chrome-plated **OR** Rough brass **OR** Polished chrome-plated and 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.
8. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

J. 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.

K. Nitrogen
1. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen.

1.3 EXECUTION

A. Preparation
1. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:
   a. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
   b. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb (0.453 kg) of chemical to 3 gal. (11.3 L) of water.
      1) Scrub to ensure complete cleaning.
      2) Rinse with clean, hot water to remove cleaning solution.

B. Piping Applications
1. Connect new copper tubing to existing tubing with memory-metal couplings.
2. Nonhealthcare Laboratory Low Vacuum Piping: Use one of the following piping materials for each size range:
   a. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.
   b. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; press-type fittings; and pressure-sealed joints.
   c. NPS 5 to NPS 8 (DN 125 to DN 200): Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.
3. Nonhealthcare Laboratory High Vacuum Piping: Use one of the following piping materials for each size range:
   a. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.
   b. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; press-type fittings; and pressure-sealed joints.
   c. NPS 5 to NPS 8 (DN 125 to DN 200): Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.
4. Medical Vacuum Piping: Use one of the following piping materials for each size range:
   a. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed joints.
   b. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; press-type fittings; and pressure-sealed joints.
   c. NPS 5 to NPS 8 (DN 125 to DN 200): Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed joints.
5. WAGD Evacuation Piping: Use one of the following piping materials for each size range:
   a. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed joints.
   b. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; press-type fittings; and pressure-sealed joints.
   c. NPS 5 to NPS 8 (DN 125 to DN 200): Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed joints.
6. Dental Vacuum Piping: Use one of the following piping materials for each size range:
   a. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.
   b. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; press-type fittings; and pressure-sealed joints.
   c. NPS 5 to NPS 8 (DN 125 to DN 200): Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.
7. HVE Piping: Use one of the following piping materials for each size range:

a. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.
b. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; press-type fittings; and pressure-sealed joints.
c. NPS 4 (DN 100) and Smaller: Schedule 40 PVC pipe, Schedule 40 PVC fittings **OR** Schedule 80 PVC pipe, Schedule 80 PVC fittings, **as directed**, and solvent-cemented joints.
d. NPS 5 to NPS 8 (DN 125 to DN 200): Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.
e. NPS 5 to NPS 8 (DN 125 to DN 200): Schedule 40 PVC pipe, Schedule 40 PVC fittings **OR** Schedule 80 PVC pipe, Schedule 80 PVC fittings, **as directed**, and solvent-cemented joints.

8. Medical Laboratory Vacuum Piping: Use one of the following piping materials for each size range:
   a. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed joints.
   b. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; press-type fittings; and pressure-sealed joints.
   c. NPS 5 to NPS 8 (DN 125 to DN 200): Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed joints.
9. Drain Piping: Use one of the following piping materials:
   a. Copper water tube, cast- or wrought-copper fittings, and soldered **OR** press-type fittings, and pressure-sealed, **as directed**, joints.
   b. PVC pipe, PVC fittings, and solvent-cemented joints.

C. Piping Installation
1. Drawing plans, schematics, and diagrams indicate general location and arrangement of vacuum piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
2. Comply with ASSE Standard #6010 for installation of vacuum piping.
3. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
4. 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.
5. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
6. Install piping adjacent to equipment and specialties to allow service and maintenance.
7. Install vacuum and drain piping with 1 percent slope downward in direction of flow.
8. Install nipples, unions, and special fittings, and valves with pressure ratings same as or higher than piping pressure rating used in applications below unless otherwise indicated.
9. Install eccentric reducers, if available, where vacuum piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
10. Provide drain leg and drain trap at end of each main and branch and at low points.
11. Install thermometer and vacuum gage on inlet piping to each vacuum producer and on each receiver and separator, **as directed**. Comply with requirements in Division 22 Section "Meters And Gages For Plumbing Piping".
12. Install piping to permit valve servicing.
13. Install piping free of sags and bends.
14. Install fittings for changes in direction and for branch connections. Extruded-tee branch outlets in copper tubing may be made where specified.
15. Install medical vacuum piping to medical vacuum service connections specified in this Section and to equipment specified in other Sections requiring medical vacuum service.

16. Install seismic restraints on vacuum piping. Seismic-restraint devices are specified in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment".
17. Install medical vacuum service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
18. Install medical vacuum bottle bracket adjacent to each wall-mounted medical vacuum service connection suction inlet.
19. Connect vacuum piping to vacuum producers and to equipment requiring vacuum service.
20. Install unions, in copper vacuum tubing adjacent to each valve and at final connection to each piece of equipment, machine, and specialty.
21. Install unions, in PVC vacuum piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment, machine, and specialty.
22. Install flanges, in PVC vacuum piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment, machine, and specialty.

D. Valve Applications
1. Valves for Copper Vacuum Tubing: Use copper alloy ball and bronze check types.
2. Valves for PVC Vacuum Piping:
   a. NPS 4 (DN 100) and Smaller: Use copper alloy ball and bronze **OR** PVC ball, butterfly, and, **as directed**, check types.
   b. NPS 5 (DN 125) and Larger: Use PVC butterfly and check types.

E. Valve Installation
1. Install shutoff valve at each connection to and from vacuum equipment and specialties.
2. Install check valves to maintain correct direction of vacuum flow to vacuum-producing equipment.
3. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
4. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
5. Install safety valves on vacuum receivers, where required by NFPA 99, and where recommended by specialty manufacturers.
6. Install automatic drain valves on equipment, specialties, and piping with drain connection. Run drain piping to floor drain, so contents spill over or into it.
7. Install flexible pipe connectors in suction inlet piping to each vacuum producer.

F. Joint Construction
1. Ream ends of pipes and tubes and remove burrs.
2. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
3. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
4. Threaded Joints: Apply appropriate tape to external pipe threads.
5. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free dry nitrogen during brazing.
6. Soldered Joints: Apply ASTM B 813, water-flushable flux to tube end. Join copper tube and fittings according to ASTM B 828.
7. Extruded-Tee Outlets: Form branches in copper tube according to ASTM F 2014, with tools recommended by procedure manufacture.
8. Flanged Joints:
   a. Copper Tubing: Install flange on copper tubes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.
   b. PVC Piping: Install PVC flange on PVC pipes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.
9. Pressure-Sealed Joints: Join copper tube and copper and copper-alloy fittings with tools recommended by fitting manufacturer.
10. Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.
11. Solvent-Cemented Joints: Clean and dry joining surfaces. Join PVC pipe and fittings according to the following:

a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
b. Apply primer and join according to ASME B31.9 for solvent-cemented joints and to ASTM D 2672.

G. Medical Vacuum Piping Alarm System Installation
1. Panels for medical vacuum piping systems may be combined in single panels with medical compressed-air piping systems and medical gas piping systems.
2. Install medical vacuum piping system alarm system components in locations required by and according to NFPA 99.
3. Install medical vacuum piping system area and master alarm panels where indicated.
4. Install computer interface cabinet with connection to medical vacuum piping alarm system and to facility computer.

H. Sleeve Installation
1. Sleeves are not required for core-drilled holes.
2. Permanent sleeves are not required for holes formed by removable PE sleeves.
3. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs using galvanized-steel pipe **OR** galvanized-steel sheet **OR** stack sleeve fittings **OR** PVC pipe, **as directed**.
   a. Wall Penetrations: Cut sleeves to length for mounting flush with both surfaces.
   b. Floor Penetrations: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

   OR

   Install sleeves in new walls and slabs as new walls and slabs are constructed.
4. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
   a. PVC **OR** Steel, **as directed**, Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
   b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum board partitions.
   c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim" for flashing.
      1) Seal space outside of sleeve fittings with grout.
5. 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 "Penetration Firestopping".

I. Escutcheon Installation
1. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   a. New Piping:
      1) Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
      2) Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** stamped steel with set screw **OR** stamped steel with set screw or spring clips **OR** stamped steel with spring clips, **as directed**.
      3) Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** One piece or split casting, cast brass with polished chrome-plated finish **OR** Split casting, cast brass with polished chrome-plated finish **OR** One-piece, stamped steel with set screw **OR** One piece or split plate, stamped steel with set screw **OR** Split plate, stamped steel with set screw, **as directed**.

4) Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish **OR** cast brass with rough-brass finish **OR** stamped steel with set screw **OR** stamped steel with spring clips **OR** stamped steel with set screw or spring clips, **as directed**.
5) Bare Piping in Equipment Rooms: One piece, cast brass **OR** stamped steel with set screw **OR** stamped steel with spring clips **OR** stamped steel with set screw or spring clips, **as directed**.
6) Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

b. Existing Piping:
1) Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.
2) Insulated Piping: Split plate, stamped steel with concealed **OR** exposed-rivet, **as directed**, hinge and spring clips.
3) Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and spring clips, **as directed**.
4) Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and set screw, **as directed**.
5) Bare Piping in Unfinished Service Spaces: Split casting, cast brass with polished chrome-plated finish **OR** casting, cast brass with rough-brass finish **OR** plate, stamped steel with concealed hinge and set screw or spring clips **OR** plate, stamped steel with concealed or exposed-rivet hinge and set screw or spring clips **OR** plate, stamped steel with exposed-rivet hinge and set screw or spring clips, **as directed**.
6) Bare Piping in Equipment Rooms: Split casting, cast brass **OR** plate, stamped steel with set screw or spring clips, **as directed**.
7) Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.

J. Hanger And Support Installation
1. Comply with requirements in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment" for pipe hanger and support devices.
2. Vertical Piping: MSS Type 8 or 42, clamps.
3. Individual, Straight, Horizontal Piping Runs:
a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel, clevis hangers.
b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable, roller hangers.
4. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment" for trapeze hangers.
5. Base of Vertical Piping: MSS Type 52, spring hangers.
6. Support horizontal piping within 12 inches (300 mm) of each fitting and coupling.
7. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
8. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
a. NPS 1/4 (DN 8): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
b. NPS 3/8 and NPS 1/2 (DN 10 and DN 15): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
c. NPS 3/4 (DN 20): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
d. NPS 1 (DN 25): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
e. NPS 1-1/4 (DN 32): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
f. NPS 1-1/2 (DN 40): 10 feet (3 m) with 3/8-inch (10-mm) rod.
g. NPS 2 (DN 50): 11 feet (3.4 m) with 3/8-inch (10-mm) rod.
h. NPS 2-1/2 (DN 65): 13 feet (4 m) with 1/2-inch (13-mm) rod.
i. NPS 3 (DN 80): 14 feet (4.3 m) with 1/2-inch (13-mm) rod.
j. NPS 3-1/2 (DN 90): 15 feet (4.6 m) with 1/2-inch (13-mm) rod.
k. NPS 4 (DN 100): 16 feet (4.9 m) with 1/2-inch (13-mm) rod.
l. NPS 5 (DN 125): 18 feet (5.5 m) with 1/2-inch (13-mm) rod.

m. NPS 6 (DN 150): 20 feet (6 m) with 5/8-inch (16-mm) rod.
n. NPS 8 (DN 200): 23 feet (7 m) with 3/4-inch (19-mm) rod.

9. Install supports for vertical copper tubing every 10 feet (3 m).
10. Install hangers **OR** vinyl-coated hangers, **as directed**, for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
    a. NPS 1 (DN 25) and Smaller: 30 inches (760 mm) with 3/8-inch (10-mm) rod.
    b. NPS 1-1/2 to NPS 2 (DN 40 to DN 50): 36 inches (900 mm) with 3/8-inch (10-mm) rod.
    c. NPS 2-1/2 and NPS 3 (DN 65 and DN 80): 42 inches (1150 mm) with 1/2-inch (13-mm) rod.
    d. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1220 mm) with 1/2-inch (13-mm) rod.
    e. NPS 6 and NPS 8 (DN 150 and DN 200): 54 inches (1350 mm) with 5/8-inch (16-mm) rod.
11. Install supports for vertical PVC piping every 48 inches (1220 mm).

K. Labeling And Identification
1. Install identifying labels and devices for laboratory vacuum piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification For Plumbing Piping And Equipment".
2. Install identifying labels and devices for medical vacuum piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
    a. Medical Vacuum: Black letters on white background.
    b. WAGD: White letters on violet background.
    c. Dental Vacuum: Black boxed letters on white-and-black diagonal stripe background.
    d. HVE: Black boxed letters on white-and-black diagonal stripe background.
    e. Medical Laboratory Vacuum: Black boxed letters on white-and-black checkerboard background.

L. Field Quality Control For Laboratory Facility Nonmedical Vacuum Piping
1. Perform tests and inspections of vacuum piping in nonmedical laboratory facilities.
2. Tests and Inspections:
    a. Piping Leak Tests for Vacuum Piping: Test new and modified parts of existing piping. Cap and fill vacuum piping with oil-free, dry nitrogen. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
        1) Test Pressure for Copper Tubing: 100 psig (690 kPa) **OR** 150 psig (1035 kPa), **as directed**.
        2) Test Pressure for PVC Piping: 50 psig (345 kPa) **OR** 100 psig (690 kPa), **as directed**.
    b. Repair leaks and retest until no leaks exist.
    c. Inspect filters for proper operation.
3. Prepare test reports.

M. Field Quality Control For Healthcare Facility Medical Vacuum Piping
1. Perform tests and inspections of medical vacuum piping systems in healthcare facilities and prepare test reports.
2. Tests and Inspections:
    a. Medical Vacuum Testing Coordination: Perform tests, inspections, verifications, and certification of medical vacuum piping systems concurrently with tests, inspections, and certification of medical compressed-air piping and medical gas piping systems.
    b. Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
        1) Initial blow down.
        2) Initial pressure test.
        3) Cross-connection test.
        4) Piping purge test.

5) Standing pressure test for vacuum systems.
6) Repair leaks and retest until no leaks exist.

c. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical vacuum piping systems and perform the following tests and inspections:
1) Standing pressure test.
2) Individual-pressurization **OR** Pressure-differential, **as directed**, cross-connection test.
3) Valve test.
4) Master and area alarm tests.
5) Piping purge test.
6) Final tie-in test.
7) Operational vacuum test.
8) Verify correct labeling of equipment and components.

d. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
1) Inspections performed.
2) Procedures, materials, and gases used.
3) Test methods used.
4) Results of tests.

3. Remove and replace components that do not pass tests and inspections and retest as specified above.

N. Demonstration
1. Train the Owner's maintenance personnel to adjust, operate, and maintain medical vacuum alarm systems.

END OF SECTION 01 95 99 99q

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SECTION 01 95 99 99r - GAS PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for gas piping for laboratory and healthcare facilities. 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. Carbon dioxide piping and specialties designated "medical carbon dioxide" operating at 50 to 55 psig (345 to 380 kPa).
   b. Helium piping, designated "medical helium" operating at 50 to 55 psig (345 to 380 kPa).
   c. Nitrogen piping and specialties designated "medical nitrogen" operating at 160 to 185 psig (1100 to 1275 kPa) **OR** higher than 200 psig (1380 kPa), **as directed**.
   d. Nitrous oxide piping and specialties designated "medical nitrous oxide" operating at 50 to 55 psig (345 to 380 kPa).
   e. Oxygen piping and specialties designated "medical oxygen" operating at 50 to 55 psig (345 to 380 kPa).

C. Definitions
1. CR: Chlorosulfonated polyethylene synthetic rubber.
2. D.I.S.S.: Diameter-index safety system.
3. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
4. Medical gas piping systems include medical carbon dioxide, medical helium, medical nitrogen, medical nitrous oxide, and medical oxygen nonflammable gas for healthcare facility patient care or for healthcare laboratory applications.
5. Specialty Gas: Gas, other than medical gas, for nonmedical laboratory facility applications.

D. Performance Requirements
1. Seismic Performance: Gas manifolds, Bulk gas storage tanks, Gas manifolds and bulk gas storage tanks, and piping 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 the following:
   a. Tubes and fittings.
   b. Valves and valve boxes.
   c. Medical gas service connections.
   d. Electrical service connections.
   e. Patient service consoles.
   f. Medical nitrogen pressure control panels.
   g. Ceiling columns. Include integral service connections.
   h. Ceiling hose assemblies. Include integral service connections.
   i. Gas manifolds.
   j. Bulk gas storage tanks. Include rated capacities and operating weights.
   k. Medical gas alarm system components.
   l. Gas cylinder storage racks.
2. Shop Drawings: Diagram power, signal, and control wiring.

3. Piping Material Certification: Signed by Installer certifying that medical gas piping materials comply with NFPA 99 requirements.
4. Brazing certificates.
5. Manufacturer Seismic Qualification Certification: Submit certification that gas manifolds and bulk gas storage tanks, accessories, and components will withstand seismic forces defined in Division 22 Section "Vibration And Seismic Controls For Plumbing 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.
6. Certificates of Shop Inspection and Data Report for Bulk Gas Storage Tanks: As required by ASME Boiler and Pressure Vessel Code.
7. Field quality-control test reports.
8. Operation and maintenance data.

F. Quality Assurance
1. Installer Qualifications:
   a. Medical Gas Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010 for installers.
2. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the medical gas piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   a. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.
3. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications"; or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
4. 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.
5. ASME Compliance: Fabricate and label bulk medical gas storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
6. NFPA Compliance:
   a. Comply with NFPA 50, "Bulk Oxygen Systems at Consumer Sites," for bulk oxygen storage tanks.
   b. Comply with NFPA 99, "Health Care Facilities," for medical gas piping system materials and installation.
7. CGA Compliance: Comply with CGA G-8.1, "Nitrous Oxide Systems at Consumer Sites," for bulk nitrous oxide storage tanks.
8. UL Compliance:
   a. Comply with UL 498, "Attachment Plugs and Receptacles," for electrical service connections.
   b. Comply with UL 544, "Medical and Dental Equipment," for medical gas specialties.

G. Project Conditions
1. Interruption of Existing Specialty and Medical Gas Service(s): Do not interrupt specialty or medical gas service to facilities occupied by the 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 specialty and medical gas service(s).
   b. Do not proceed with interruption of specialty and medical gas service(s) without the Owner's written permission.

1.2 PRODUCTS

A. Pipes, Tubes, And Fittings
   1. Copper Medical Gas Tube: ASTM B 819, Type K **OR** Type L, **as directed**, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and blue for Type L tube.
      a. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
      b. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
      c. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.
      d. Press-Type 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.
      e. Memory-Metal Couplings: Cryogenic compression fitting made of ASTM F 2063, nickel-titanium, shape-memory-alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.
   2. PVC Pipe: ASTM D 1785, Schedule 40 and Schedule 80.
      a. PVC Fittings: ASTM D 2466, Schedule 40 **OR** ASTM D 2467, Schedule 80, **as directed**; socket type.

B. Joining Materials
   1. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.
   2. Threaded-Joint Tape: PTFE.
   3. Solvent Cement for Joining PVC Piping: ASTM D 2564. Include primer complying with ASTM F 656.

C. Valves
   1. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
   2. Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
      a. Pressure Rating: 300 psig (2070 kPa) minimum.
      b. Ball: Full-port, chrome-plated brass.
      c. Seats: PTFE or TFE.
      d. Handle: Lever type with locking device, **as directed**.
      e. Stem: Blowout proof with PTFE or TFE seal.
      f. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
   3. Check Valves: In-line pattern, bronze.
      a. Pressure Rating: 300 psig (2070 kPa) minimum.
      b. Operation: Spring loaded.
      c. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
   4. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
      a. Pressure Rating: 300 psig (2070 kPa) minimum.
      b. Ball: Full-port, chrome-plated brass.
      c. Seats: PTFE or TFE.
      d. Handle: Lever type with locking device, **as directed**.
      e. Stem: Blowout proof with PTFE or TFE seal.
      f. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
      g. Pressure Gage: Manufacturer-installed on one copper-tube extension.
   5. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.
      a. Interior Finish: Factory-applied white enamel.

b. Cover Plate: Aluminum or extruded-anodized aluminum **OR** Satin-chrome finish steel **OR** Stainless steel with NAAMM AMP 503, No. 4 finish, **as directed**, with frangible or removable windows.
c. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

OR

Zone Valve Boxes: Formed or extruded aluminum with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.
a. Interior Finish: Factory-applied white enamel.
b. Cover Plate: Aluminum or extruded-anodized aluminum **OR** Stainless steel with NAAMM AMP 503, No. 4 finish, **as directed**, with frangible or removable windows.
c. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

6. Emergency Oxygen Connections: Low-pressure oxygen inlet assembly for connection to building oxygen piping systems.
   a. Enclosure: Weatherproof hinged locking cover with caption similar to "Emergency Low-Pressure Gaseous Oxygen Inlet."
   b. Inlet: Manufacturer-installed, NPS 1 or NPS 1-1/4 (DN 25 or DN 32), ASTM B 819, copper tubing with NPS 1 (DN 25) minimum ball valve and plugged inlet.
   c. Safety Valve: Bronze-body, pressure relief valve set at 75 or 80 psig (520 or 550 kPa).
   d. Instrumentation: Pressure gage.
7. Safety Valves: Bronze-body, ASME-construction, poppet, pressure-relief type with settings to match system requirements.
8. Pressure Regulators: Bronze **OR** Stainless-steel, **as directed**, body and trim; spring-loaded, diaphragm-operated, relieving type; manual pressure-setting adjustment; rated for 250-psig (1725-kPa) minimum inlet pressure; and capable of controlling delivered gas pressure within 0.5 psig for each 10-psig (5.0 kPa for each 100-kPa) inlet pressure.

D. Medical Gas Service Connections
1. General Requirements for Medical Gas Service Connections: For specific medical gas pressure and suction service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.
   a. Roughing-in Assembly:
      1) Steel outlet box for recessed mounting and concealed piping.
      2) Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed. Suction inlets to be without secondary valve.
      3) Double seals that will prevent gas leakage.
      4) ASTM B 819, NPS 3/8 (DN 10) copper outlet tube brazed to valve with service marking and tube-end dust cap.
   b. Finishing Assembly:
      1) Brass housing with primary check valve.
      2) Double seals that will prevent gas leakage.
      3) Cover plate with gas-service label.
   c. Quick-Coupler Service Connections: Pressure outlets for carbon dioxide, nitrous xide, oxygen, and <**Insert medical gas**> service connections with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.
   d. D.I.S.S. Service Connections: Pressure outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
      1) Medical Carbon Dioxide Service Connections: D.I.S.S. No. 1080.

2) Medical Helium Service Connections: D.I.S.S. No. 1060.
3) Medical Nitrogen Service Connections: D.I.S.S. No. 1120.
4) Medical Nitrous Oxide Service Connections: D.I.S.S. No. 1040.
5) Medical Oxygen Service Connections: D.I.S.S. No. 1240.

e. Cover Plates: One piece, stainless steel, with NAAMM AMP 503, No. 4 finish **OR** metal, with chrome-plated finish **OR** anodized aluminum, **as directed**, and permanent, color-coded, identifying label matching corresponding service.

E. Electrical Service Connections

1. Power Outlets: UL 498, Hospital Grade, 125-V receptacles; color selected. Include the following configurations complying with NEMA WD 1:
   a. L5-20R, locking type, 20 A, single or duplex.
   b. L5-20R, isolated ground, locking type, 20 A, single or duplex.
   c. Explosion proof, 20 A, 2 pole, 3 wire, single; suitable for Class I, Group C hazardous location and interchangeable with receptacles used in nonhazardous areas; flush mounted.
   d. 5-20R, straight blade, 20 A, duplex.
   e. 5-20R, isolated ground, straight blade, 20 A, duplex.
2. Electrical Accessory Outlets: Provide the following configured receptacles in color selected:
   a. Patient Equipment Ground Jack: Single pole, 30 A.
   b. Patient Monitoring: Single, 5 and 37 pin.
3. Wall Outlet Cover Plates: One piece, stainless steel, with NAAMM AMP 503, No. 4 finish **OR** metal, with chrome-plated finish **OR** anodized aluminum, **as directed**, and permanent identifying label.

F. Patient Service Consoles

1. General Requirements for Patient Service Consoles: Recessed- or semirecessed-mounting wall units with medical gas service connections as specified in "Medical Gas Service Connections" Article and electrical service connections as specified in "Electrical Service Connections" Article, **as directed**. Include labels indicating services, and the following:
   a. Recessed- or semirecessed-mounting steel console box or mounting bracket.
   b. Concealed supplies.
   c. Cover Plate: One piece, anodized aluminum **OR** stainless steel, **as directed**, and permanent identifying label with service connections for the following:
      1) Medical Air: Quick-coupler pressure outlet.
      2) Medical Oxygen: Quick-coupler pressure outlet.
      3) Medical Vacuum: Quick-coupler suction inlet.
      4) Medical vacuum bottle bracket.
      5) L5-20R, locking type, 20 A, single **OR** duplex, **as directed**.

G. Medical Nitrogen Pressure Control Panels

1. Description: Steel box and support brackets for recessed roughing-in with stainless-steel or anodized-aluminum cover plate with printed operating instructions. Include manifold assembly consisting of inlet supply valve, inlet supply pressure gage, line-pressure control regulator, outlet supply pressure gage, D.I.S.S. service connection, and piping outlet for remote service connection.
   a. Minimum Working Pressure: 200 psig (1380 kPa).
   b. Line-Pressure Control Regulator: Self-relieving diaphragm type with precision manual adjustment.
   c. Pressure Gages: 0- to 300-psig (0- to 2070-kPa) range.
   d. Service Connection: CGA V-5, D.I.S.S. No. 1120, nitrogen outlet.
   e. Before final assembly, provide temporary dust shield and U-tube for testing.
   f. Label cover plate "Nitrogen Pressure Control."

H. Ceiling Columns

1. General Requirements for Ceiling Columns: Ceiling-mounting units with medical gas service connections as specified in "Medical Gas Service Connections" Article and electrical service

connections as specified in "Electrical Service Connections" Article, **as directed**. Include labels indicating services, and the following:

a. Ceiling-Mounting Plate: Manufacturer's standard plate or roughing-in assembly.
b. Exposed Surfaces: Minimum 0.0375-inch- (0.95-mm-) thick stainless steel with NAAMM AMP 503, No. 4 directional polish.
c. Servicing: Include access panels or means of removing shroud.
d. Blank cover plates for cutouts not having service connections.
e. ASTM B 819, NPS 3/8 (DN 10) copper-tube extensions for connection to medical gas systems.
f. Service Connections: Type and number indicated.
g. Dust Covers: For medical gas service connection.

2. Rigid Ceiling Columns: 44-inch- (1120-mm-) long, rectangular fixed column section with 2 **OR** 4, **as directed**, double intravenous medication hooks. Include 0.078-inch- (2.0-mm-) thick, stainless-steel bottom plate with the following service connections:
   a. Instrument Air: One D.I.S.S. No. 1160 pressure outlet(s).
   b. Medical Air: One quick-coupler **OR** D.I.S.S. No. 1160, **as directed**, pressure outlet(s).
   c. Medical Carbon Dioxide: One quick-coupler **OR** D.I.S.S. No. 1080, **as directed**, pressure outlet(s).
   d. Medical Helium: One D.I.S.S. No. 1060, pressure outlet(s).
   e. Medical Nitrogen: One D.I.S.S. No. 1120 pressure outlet(s).
   f. Medical Nitrous Oxide: One quick-coupler **OR** D.I.S.S. No. 1040, **as directed**, pressure outlet(s).
   g. Medical Oxygen: Two quick-coupler **OR** D.I.S.S. No. 1240, **as directed**, pressure outlets.
   h. Medical Vacuum: Two quick-coupler **OR** D.I.S.S. No. 1220, **as directed**, suction inlets.
   i. Vacuum Bottle Brackets: Two.
   j. WAGD Evacuation: One quick-coupler **OR** D.I.S.S. No. 2220, **as directed**, suction inlet(s).
   k. Power: 2 **OR** 4, **as directed**, L5-20R, locking-type, 20-A, single receptacles.
   l. Patient Equipment: 2 **OR** 4, **as directed**, ground-jack, single-pole, 30-A receptacles.
3. Retractable Ceiling Columns: Manually adjustable using release and lock handles capable of locking column in all positions from fully retracted to fully extended; 15-inch- (380-mm-) long, rectangular counterbalanced telescoping section with 2 **OR** 4, **as directed**, double intravenous medication hooks; and 36-inch- (915-mm-) long, fixed column section. Include 0.078-inch- (2.0-mm-) thick, stainless-steel bottom plate with the following service connections:
   a. Instrument Air: One D.I.S.S. No. 1160 pressure outlet(s).
   b. Medical Air: One quick-coupler **OR** D.I.S.S. No. 1160, **as directed**, pressure outlet(s).
   c. Medical Carbon Dioxide: One quick-coupler **OR** D.I.S.S. No. 1080, **as directed**, pressure outlet(s).
   d. Medical Helium: One D.I.S.S. No. 1060, pressure outlet(s).
   e. Medical Nitrogen: One D.I.S.S. No. 1120 pressure outlet(s).
   f. Medical Nitrous Oxide: One quick-coupler **OR** D.I.S.S. No. 1040, **as directed**, pressure outlet(s).
   g. Medical Oxygen: Two quick-coupler **OR** D.I.S.S. No. 1240, **as directed**, pressure outlets.
   h. Medical Vacuum: Two quick-coupler **OR** D.I.S.S. No. 1220, **as directed**, suction inlets.
   i. Vacuum Bottle Brackets: Two.
   j. WAGD Evacuation: One quick-coupler **OR** D.I.S.S. No. 2220, **as directed**, suction inlet(s).
   k. Power: 2 **OR** 4, **as directed**, L5-20R, locking-type, 20-A, single receptacles.
   l. Patient Equipment: 2 **OR** 4, **as directed**, ground-jack, single-pole, 30-A receptacles.

I. Ceiling Hose Assemblies
1. Ceiling Hose Assemblies, General: Ceiling-mounting units with medical gas service connections as specified in "Medical Gas Service Connections" Article and electrical service connections as specified in "Electrical Service Connections" Article, **as directed**. Include labels indicating services, and the following:
   a. Ceiling-Mounting Plate: Manufacturer's standard plate or roughing-in assembly.

b. Exposed Surfaces: Minimum 0.0375-inch- (0.95-mm-) thick stainless steel with NAAMM AMP 503, No. 4 directional polish.
c. Servicing: Include access panels or means of removing shroud.
d. Blank cover plates for cutouts not having service connections.
e. ASTM B 819, NPS 3/8 (DN 10) copper-tube extensions for connection to medical gas systems.
f. Service Connections: Type and number indicated.
g. Dust Covers: For medical gas service connection.

2. Hose-Reel Service Assemblies: Individual, concealed, retractable hose-reel units with stainless-steel face plates, steel mounting boxes, factory- or field-fabricated mounting brackets, and color-coded service hoses with adjustable stops and service connections matching hoses. Include 15 feet (4.5 m) minimum of conductive, CR, 1/4- or 5/16-inch- (6.4- or 7.9-mm-) ID, medical gas hoses rated for 200-psig (1380-kPa) minimum working pressure, and the following service connections:
   a. Instrument Air Hose: D.I.S.S. No. 1160 pressure outlet.
   b. Medical Air Hose: Quick-coupler **OR** D.I.S.S. No. 1160, **as directed**, pressure outlet.
   c. Medical Carbon Dioxide Hose: Quick-coupler **OR** D.I.S.S. No. 1080, **as directed**, pressure outlet.
   d. Medical Nitrogen Hose: D.I.S.S. No. 1120 pressure outlet.
   e. Medical Nitrous Oxide Hose: Quick-coupler **OR** D.I.S.S. No. 1040, **as directed**, pressure outlet.
   f. Medical Oxygen Hose: Quick-coupler **OR** D.I.S.S. No. 1240, **as directed**, pressure outlet.
   g. Medical Vacuum Hose: Quick-coupler **OR** D.I.S.S. No. 1220, **as directed**, suction inlet.
   h. WAGD Evacuation Hose: Quick-coupler **OR** D.I.S.S. No. 2220, **as directed**, suction inlet.
   i. Power: L5-20R, locking-type, 20-A, single, power receptacle.
3. Fixed Hose Service Assemblies: Individual, concealed hose connection with stainless-steel face plates, steel mounting boxes, factory- or field-fabricated mounting brackets, and color-coded service hoses with retractor device and service connections matching hoses. Include 72 inches (1830 mm) of conductive, CR, 1/4- or 5/16-inch- (6.4- or 7.9-mm-), ID, medical gas hoses rated for 200-psig (1380-kPa) minimum working pressure, and the following service hose connections:
   a. Instrument Air Hose: D.I.S.S. No. 1160 pressure outlet.
   b. Medical Air Hose: Quick-coupler **OR** D.I.S.S. No. 1160, **as directed**, pressure outlet.
   c. Medical Carbon Dioxide Hose: Quick-coupler **OR** D.I.S.S. No. 1080, **as directed**, pressure outlet.
   d. Medical Nitrogen Hose: D.I.S.S. No. 1120 pressure outlet.
   e. Medical Nitrous Oxide Hose: Quick-coupler **OR** D.I.S.S. No. 1040, **as directed**, pressure outlet.
   f. Medical Oxygen Hose: Quick-coupler **OR** D.I.S.S. No. 1240, **as directed**, pressure outlet.
   g. Medical Vacuum Hose: Quick-coupler **OR** D.I.S.S. No. 1220, **as directed**, suction inlet.
   h. WAGD Evacuation Hose: Quick-coupler **OR** D.I.S.S. No. 2220, **as directed**, suction inlet.
   i. Power: L5-20R, locking-type, 20-A, single, power receptacle.

J. Gas Manifolds
1. Simplex Specialty Gas Manifolds:
   a. Control Panel Unit: Weatherproof cabinet, supply and delivery pressure gages, electrical alarm system connections and transformer, indicator lights or devices, manifold connection, line-pressure regulator, shutoff valves, and safety valve.
   b. Manifold and Header: Nonferrous-metal header for number of cylinders indicated. Units include design for 2000-psig (13.8-MPa) minimum inlet pressure. Include cylinder bank header with inlet (pigtail) connections complying with CGA V-1, individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gage.
   c. <**Insert specialty gas**> Manifold: For <**Insert number cylinders**> capacity at 55-psig (380-kPa) line pressure, with electric heater or orifice design that will prevent freezing during high demand.
   d. Specialty Gas Cylinders: Will be furnished by the Owner **OR** Number and type of medical gas cylinders required for complete manifold systems, **as directed**.

e. Label manifold control unit with permanent label identifying specialty gas type and system operating pressure.
f. Mounting: Wall with mounting brackets for manifold control cabinet and header **OR** Floor with support legs for manifold control cabinet, **as directed**.

2. Duplex Specialty Gas Manifolds:
   a. Central Control Panel Unit: Weatherproof cabinet, supply and delivery pressure gages, electrical alarm system connections and transformer, indicator lights or devices, manifold connection, line-pressure regulator, shutoff valves, and safety valve.
   b. Manifold and Headers: Duplex, nonferrous-metal header for number of cylinders indicated, divided into two equal banks. Units include design for 2000-psig (13.8-MPa) minimum inlet pressure. Include cylinder bank headers with inlet (pigtail) connections complying with CGA V-1, individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gage.
   c. Operation: Automatic, pressure-switch-activated changeover from one cylinder bank to the other when first bank becomes exhausted, without line-pressure fluctuation or resetting of regulators and without supply interruption by shutoff of either cylinder bank header.
   d. <**Insert specialty gas**> Manifold: For <**Insert number cylinders**> capacity at 55-psig (380-kPa) line pressure, with electric heater or orifice design that will prevent freezing during high demand.
   e. Specialty Gas Cylinders: Will be furnished by the Owner **OR** Number and type of medical gas cylinders required for complete manifold systems, **as directed**.
   f. Label manifold control unit with permanent label identifying specialty gas type and system operating pressure.
   g. Mounting: Wall with mounting brackets for manifold control cabinet and headers **OR** Floor with support legs for manifold control cabinet, **as directed**.
3. Medical Gas Manifolds: Comply with NFPA 99, Ch. 5, for high-pressure medical gas cylinders.
   a. Central Control Panel Unit: Weatherproof cabinet, supply and delivery pressure gages, electrical alarm system connections and transformer, indicator lights or devices, manifold connection, pressure changeover switch, line-pressure regulator, shutoff valves, and safety valve.
   b. Manifold and Headers: Duplex, nonferrous-metal header for number of cylinders indicated, divided into two equal banks. Units include design for 2000-psig (13.8-MPa) minimum inlet pressure, except nitrous oxide manifolds may be designed for 800 psig (5520 kPa) and carbon dioxide manifolds may be designed for 1500 psig (10.35 MPa). Include cylinder bank headers with inlet (pigtail) connections complying with CGA V-1, individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gage.
   c. Operation: Automatic, pressure-switch-activated changeover from one cylinder bank to the other when first bank becomes exhausted, without line-pressure fluctuation or resetting of regulators and without supply interruption by shutoff of either cylinder bank header.
   d. Medical Carbon Dioxide Manifolds: For 2 cylinders and 250-cfh (1.97-L/s) **OR** 4 cylinders and 500-cfh (3.94-L/s), **as directed**, capacity at 55-psig (380-kPa) line pressure.
   e. Medical Helium Manifolds: For 2 cylinders and 250-cfh (1.97-L/s) **OR** 4 cylinders and 500-cfh (3.94-L/s), **as directed**, capacity at 55-psig (380-kPa) line pressure.
   f. Medical Nitrous Oxide Manifolds: For 8 cylinders and 1333-cfh (10.5-L/s) **OR** 12 cylinders and 2000-cfh (15.7-L/s), **as directed**, capacity at 55-psig (380-kPa) line pressure, with electric heater or orifice design that will prevent freezing during high demand.
   g. Medical Nitrogen Manifolds: For 8 cylinders and 2000-cfh (15.7-L/s) **OR** 12 cylinders and 3000-cfh (23.6-L/s), **as directed**, capacity at 180-psig (1240-kPa) **OR** higher than 200-psig (1380-kPa), **as directed**, line pressure.
   h. Medical Oxygen Manifolds: For 12 cylinders and 1500-cfh (11.8-L/s) **OR** 20 cylinders 2500-cfh (19.7-L/s), **as directed**, capacity at 55-psig (380-kPa), **as directed**, line pressure.
   i. Medical Gas Cylinders: Will be furnished by the Owner **OR** Number and type of medical gas cylinders required for complete manifold systems, **as directed**.
   j. Label manifold control unit with permanent label identifying medical gas type and system operating pressure.

k. Mounting: Wall with mounting brackets for manifold control cabinet and headers **OR** Floor with support legs for manifold control cabinet, **as directed**.

K. Bulk Gas Storage Tanks
1. Bulk Specialty Gas Storage Tanks:
2. Bulk Medical Gas Storage Tanks:
   a. Bulk Medical Gas Storage Tank Systems: Bulk storage tank with connections for alarm system, continuous supply, and reserve supply that will operate only during emergencies, complying with NFPA 99, "Health Care Facilities."
   b. Controls: Include actuating switch for alarm system connection and means for automatic actuating of reserve supply.
   c. Bulk Medical Gas Storage Tanks: Vertical mounting, double-wall construction with inner vessel fabricated according to ASME Boiler and Pressure Vessel Code for unfired pressure vessels and suitable for medical gas service. Include insulation and vacuum seal between walls. Fabricate outer shell from carbon steel with factory-applied manufacturer's standard protective paint finish suitable for exterior installation. Include the following features, specialties, and components:
      1) Safety Valves: ASME construction with pressure setting to correspond to tank working pressure and as required for component or system being protected.
      2) Pressure Gages: For tank pressure and facility service line pressure.
      3) Contents Gage: High- and low-level indicator with electric signal circuit connection.
      4) Drain Valves: For piping, inner vessel, and outer shell.
      5) Fill Assembly: Fill connection, piping, valves, relief devices, and controls.
      6) Facility Service Assembly: Piping, valves, relief devices, vaporizer, shutoff valve, pressure regulator, line shutoff valve or check valve, and reserve supply connection for connection to building service piping.
      7) Include permanent label showing medical gas type, storage tank capacity, tank pressure rating, vaporizer capacity, and operating instructions.
      8) Liquid Oxygen Storage Tank: Nickel-steel or stainless-steel inner vessel with 250-psig (1725-kPa) minimum working pressure. Include electric **OR** steam **OR** ambient vaporizer, **as directed**.
      9) Liquid Nitrous Oxide Storage Tank: Steel-alloy inner vessel with 300-psig (2070-kPa) minimum working pressure. Include electric **OR** steam, **as directed**, vaporizer.
   d. Oxygen Reserve Supply: Manifold header for high-pressure cylinders, fabricated from copper-tube or brass pipe and fittings and suitable for pressures up to 4000 psig (27.6 MPa). Include header inlet connections complying with CGA V-1, with individual inlet check valves, header shutoff valve, header pressure regulator, line shutoff valve or check valve, pressure gage, and inlet connections for number of cylinders indicated.
   e. Nitrous Oxide Reserve Supply: Manifold header for high-pressure cylinders, fabricated from copper-tube or brass pipe and fittings and suitable for pressures up to 4000 psig (27.6 MPa). Include header inlet connections complying with CGA V-1, with individual inlet check valves, header shutoff valve, header pressure regulator, line shutoff valve or check valve, pressure gage, inlet connections for number of cylinders indicated, and electric heater.

L. Medical Gas Piping Alarm Systems
1. Panels for medical gas piping systems may be combined in single panels with medical compressed-air and medical vacuum piping systems.
2. Components: Designed for continuous service and to operate on power supplied from 120 **OR** 240 **OR** 277, **as directed**,-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.
3. Pressure Switches or Pressure Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
   a. Low-Pressure Operating Range: 0- to 100-psig (0- to 690-kPa).
   b. High-Pressure Operating Range: Up to 250-psig (1725-kPa).

4. General Requirements for Medical Gas Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
   a. Mounting: Exposed, surface **OR** Recessed, **as directed**, installation.
   b. Enclosures: Fabricated from minimum 0.047-inch- (1.2-mm-) thick steel or minimum 0.05-inch- (1.27-mm-) thick aluminum, with knockouts for electrical and piping connections.
5. Master Alarm Panels: With separate trouble alarm signals, pressure gages, and indicators for medical gas piping systems.
   a. Include alarm signals when the following conditions exist:
      1) Medical Carbon Dioxide: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa) and changeover is made to alternate bank.
      2) Medical Helium: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa) and changeover is made to alternate bank.
      3) Medical Nitrogen: Pressure drops below 145 psig (1000 kPa) or rises above 200 psig (1380 kPa) and changeover is made to alternate bank.
      4) Medical Nitrous Oxide (for bulk oxygen storage tank system with cylinder reserve): Liquid level is low, pressure downstream from main shutoff valve drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa), changeover is made to reserve, reserve is in use, and reserve level is low.
      5) Medical Nitrous Oxide (for nitrous oxide manifold system): Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa) and changeover is made to alternate bank.
      6) Medical Oxygen (for bulk oxygen storage tank system with cylinder reserve): Liquid level is low, pressure downstream from main shutoff valve drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa), changeover is made to reserve, reserve is in use, reserve level is low, and reserve pressure is low.
      7) Medical Oxygen (for oxygen manifold system): Pressure downstream from main shutoff valve drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa) and changeover is made to alternate bank.
6. Anesthetizing-Area Alarm Panels: Separate trouble alarm signals; pressure gages; and indicators for medical gas piping systems.
   a. Include alarm signals when the following conditions exist:
      1) Medical Carbon Dioxide: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).
      2) Medical Helium: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).
      3) Medical Nitrous Oxide: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).
      4) Medical Nitrogen: Pressure drops below 145 psig (1000 kPa) or rises above 200 psig (1380 kPa).
      5) Medical Oxygen: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).
7. Area Alarm Panels: Separate trouble alarm signals; pressure and vacuum gages; and indicators for medical gas piping systems.
   a. Include alarm signals when the following conditions exist:
      1) Oxygen: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).
8. Dental Area Alarm Panels: Separate trouble alarm signals; pressure and vacuum gages; and indicators for medical gas piping systems.
   a. Include alarm signals when the following conditions exist:
      1) Medical Nitrogen: Pressure drops below 145 psig (1000 kPa) or rises above 200 psig (1380 kPa) and changeover is made to alternate bank.
      2) Medical Nitrous Oxide (for bulk nitrous oxide storage tank system with cylinder reserve): Liquid level is low, pressure downstream from main shutoff valve drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa), changeover is made to reserve, reserve is in use, and reserve level is low.

3) Medical Nitrous Oxide (for nitrous oxide manifold system): Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa) and changeover is made to alternate bank.
4) Medical Oxygen (for bulk oxygen storage tank system with cylinder reserve): Liquid level is low, pressure downstream from main shutoff valve drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa), changeover is made to reserve, reserve is in use, reserve level is low, and reserve pressure is low.
5) Medical Oxygen (for nitrous oxide manifold system): Pressure downstream from main shutoff valve drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa) and changeover is made to alternate bank.

9. Medical Laboratory Area Alarm Panels: Separate trouble alarm signals; pressure and vacuum gages; and indicators for medical gas piping systems.
   a. Include alarm signals when the following conditions exist:
      1) Medical Carbon Dioxide: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).
      2) Medical Helium: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).
      3) Medical Oxygen: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).

M. Computer Interface Cabinet
   1. Description: Wall-mounting, welded-steel, control cabinet with gasketed door, mounting brackets, grounding device, and white-enamel finish for connection of medical gas system alarms to facility computer. Include factory-installed signal circuit boards, power transformer, circuit breaker, wiring terminal board, and internal wiring capable of interfacing 20, **as directed**, alarm signals.

N. Gas Cylinder Storage Racks
   1. Wall Storage Racks: Fabricate racks with chain restraints for upright cylinders as indicated or provide equivalent manufactured wall racks.
   2. Freestanding Storage Racks: Fabricate racks as indicated or provide equivalent manufactured storage racks.

O. Sleeves
   1. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
   2. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
      a. Underdeck Clamp: Clamping ring with set screws.

P. Escutcheons
   1. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and 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.
   8. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

Q. 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.

R. Nitrogen
1. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen.

1.3 EXECUTION

A. Earthwork
1. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling and for underground warning tapes.

B. Piping Applications
1. Nonhealthcare, Specialty Gas Piping: Type L, copper medical gas tube; wrought-copper fittings; and brazed **OR** press-type fittings and pressure-sealed, **as directed**, joints.
2. Nonhealthcare, Specialty Gas Piping NPS 2-1/2 (DN 65) and Smaller: Type K **OR** Type L, **as directed**, copper medical gas tube; wrought-copper fittings; and brazed **OR** press-type fittings and pressure-sealed, **as directed**, joints.
3. Nonhealthcare, Specialty Gas Piping NPS 3 (DN 80) and Larger: Type K, copper tube; wrought-copper fittings; and brazed **OR** press-type fittings and pressure-sealed, **as directed**, joints.
4. Medical Gas Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
5. Medical Gas Piping Except Nitrogen: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
6. Medical Nitrogen Piping: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
7. Medical Nitrogen Piping NPS 2-1/2 (DN 65) and Smaller: Type K **OR** Type L, **as directed**, copper medical gas tube; wrought-copper fittings; and brazed joints.
8. Medical Nitrogen Piping NPS 3 (DN 80) and Larger: Type K, copper tube; wrought-copper fittings; and brazed joints.
9. Protective Conduit: Use PVC pipe, PVC fittings, and solvent-cemented joints.

C. Piping Installation
1. Drawing plans, schematics, and diagrams indicate general location and arrangement of gas piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
2. Comply with ASSE Standard #6010 for installation of medical gas piping.
3. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
4. 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.
5. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
6. Install piping adjacent to equipment and specialties to allow service and maintenance.
7. Install nipples, unions, and special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications below unless otherwise indicated.
8. Install piping to permit valve servicing.
9. Install piping free of sags and bends.
10. Install fittings for changes in direction and branch connections.

11. Install medical gas piping to medical gas service connections specified in this Section, to medical gas service connections in equipment specified in this Section, and to equipment specified in other Sections requiring medical gas service.
12. Install exterior, buried medical gas piping in protective conduit fabricated with PVC pipe and fittings. Do not extend conduit through foundation wall.
13. Install seismic restraints on gas piping. Seismic-restraint devices are specified in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment".
14. Install medical gas service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
15. Connect gas piping to gas sources and to gas outlets and equipment requiring gas service.
16. Install unions, in copper tubing adjacent to each valve and at final connection to each piece of equipment and specialty.

D. Valve Installation
1. Install shutoff valve at each connection to gas laboratory and healthcare equipment and specialties.
2. Install check valves to maintain correct direction of gas flow from laboratory and healthcare gas supplies.
3. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
4. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
5. Install pressure regulators on gas piping where reduced pressure is required.
6. Install emergency oxygen connection with pressure relief valve and full-size discharge piping to outside, with check valve downstream from pressure relief valve and with ball valve and check valve in supply main from bulk oxygen storage tank.

E. Joint Construction
1. Ream ends of PVC pipes and remove burrs.
2. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
3. Threaded Joints: Apply appropriate tape to external pipe threads.
4. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free, dry nitrogen during brazing.
5. Pressure-Sealed Joints: Join copper tube and press-type fittings with tools recommended by fitting manufacturer.
6. Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.
7. Solvent-Cemented Joints: Clean and dry joining surfaces. Join PVC pipe and fittings according to the following:
    a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
    b. Apply primer and join according to ASME B31.9 for solvent-cemented joints and to ASTM D 2672.

F. Gas Service Component Installation
1. Assemble patient service console with service connections. Install with supplies concealed, in walls. Attach console box or mounting bracket to substrate.
2. Install nitrogen pressure-control panels in walls. Attach to substrate.
3. Assemble ceiling columns and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.
4. Assemble ceiling assemblies and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.
5. Install gas manifolds on concrete base, **as directed**, anchored to substrate.
6. Install gas cylinders and connect to manifold piping.

7. Install gas manifolds with seismic restraints as indicated.
8. Install bulk gas storage tanks and reserve supply tanks level on concrete bases. Set tanks and connect gas piping to tanks according to applicable requirements in NFPA 50 for bulk oxygen storage systems, **as directed**. Install tanks level and plumb, firmly anchored to concrete bases; maintain NFPA 50 and tank manufacturer's recommended clearances. Orient tanks so controls and devices are accessible for servicing.
9. Install bulk gas storage tanks and reserve supply tanks with seismic restraints.

G. Medical Gas Piping Alarm System Installation
1. Install medical gas alarm system components in locations required by and according to NFPA 99.
2. Install medical gas area and master alarm panels where indicated.
3. Install computer interface cabinet with connection to medical gas piping alarm system and facility computer.

H. Sleeve Installation
1. Sleeves are not required for core-drilled holes.
2. Permanent sleeves are not required for holes formed by removable PE sleeves.
3. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs using galvanized-steel pipe **OR** galvanized-steel sheet **OR** stack sleeve fittings **OR** PVC pipe, **as directed**.
   a. Wall Penetrations: Cut sleeves to length for mounting flush with both surfaces.
   b. Floor Penetrations: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

   OR

   Install sleeves in new walls and slabs as new walls and slabs are constructed.
4. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
   a. PVC **OR** Steel, **as directed**, Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
   b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum board partitions.
   c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim" for flashing.
      1) Seal space outside of sleeve fittings with grout.
5. 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 "Penetration Firestopping".

I. Escutcheon Installation
1. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   a. New Piping:
      1) Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
      2) Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** stamped steel with set screw **OR** stamped steel with set screw or spring clips **OR** stamped steel with spring clips, **as directed**.
      3) Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** One piece or split casting, cast brass with polished chrome-plated finish **OR** Split casting, cast brass with polished chrome-plated finish **OR** One piece, stamped steel with set screw **OR** One piece or split plate, stamped steel with set screw **OR** Split plate, stamped steel with set screw, **as directed**.

4) Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish **OR** cast brass with rough-brass finish **OR** stamped steel with set screw **OR** stamped steel with spring clips **OR** stamped steel with set screw or spring clips, **as directed**.
5) Bare Piping in Equipment Rooms: One piece, cast brass **OR** stamped steel with set screw **OR** stamped steel with spring clips **OR** stamped steel with set screw or spring clips, **as directed**.
6) Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

b. Existing Piping:
1) Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.
2) Insulated Piping: Split plate, stamped steel with concealed **OR** exposed-rivet, **as directed**, hinge and spring clips.
3) Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and spring clips, **as directed**.
4) Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and set screw, **as directed**.
5) Bare Piping in Unfinished Service Spaces: Split casting, cast brass with polished chrome-plated finish **OR** casting, cast brass with rough-brass finish **OR** plate, stamped steel with concealed hinge and set screw or spring clips **OR** plate, stamped steel with concealed or exposed-rivet hinge and set screw or spring clips **OR** plate, stamped steel with exposed-rivet hinge and set screw or spring clips, **as directed**.
6) Bare Piping in Equipment Rooms: Split casting, cast brass **OR** plate, stamped steel with set screw or spring clips, **as directed**.
7) Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.

J. Hanger And Support Installation
1. Comply with requirements in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment" for seismic-restraint devices.
2. Comply with requirements in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment" for pipe hanger and support devices.
3. Vertical Piping: MSS Type 8 or 42, clamps.
4. Individual, Straight, Horizontal Piping Runs:
a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel, clevis hangers.
b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable, roller hangers.
5. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment" for trapeze hangers.
6. Base of Vertical Piping: MSS Type 52, spring hangers.
7. Support horizontal piping within 12 inches (300 mm) of each fitting and coupling.
8. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
9. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
a. NPS 1/4 (DN 8): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
b. NPS 3/8 and NPS 1/2 (DN 10 and DN 15): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
c. NPS 3/4 (DN 20): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
d. NPS 1 (DN 25): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
e. NPS 1-1/4 (DN 32): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
f. NPS 1-1/2 (DN 40): 10 feet (3 m) with 3/8-inch (10-mm) rod.
g. NPS 2 (DN 50): 11 feet (3.4 m) with 3/8-inch (10-mm) rod.
h. NPS 2-1/2 (DN 65): 13 feet (4 m) with 1/2-inch (13-mm) rod.
i. NPS 3 (DN 80): 14 feet (4.3 m) with 1/2-inch (13-mm) rod.
j. NPS 3-1/2 (DN 90): 15 feet (4.6 m) with 1/2-inch (13-mm) rod.

k. NPS 4 (DN 100): 16 feet (4.9 m) with 1/2-inch (13-mm) rod.
l. NPS 5 (DN 125): 18 feet (5.5 m) with 1/2-inch (13-mm) rod.
m. NPS 6 (DN 150): 20 feet (6 m) with 5/8-inch (16-mm) rod.
n. NPS 8 (DN 200): 23 feet (7 m) with 3/4-inch (19-mm) rod.

10. Install supports for vertical copper tubing every 10 feet (3 m).

K. Labeling And Identification

1. Install identifying labels and devices for specialty gas piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification For Plumbing Piping And Equipment".
2. Install identifying labels and devices for healthcare medical gas piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
   a. Carbon Dioxide: Black or white letters on gray background.
   b. Helium: White letters on brown background.
   c. Nitrogen: White letters on black background.
   d. Nitrous Oxide: White letters on blue background.
   e. Oxygen: White letters on green background or green letters on white background.

L. Field Quality Control For Laboratory Facility Specialty Gas

1. Perform field tests and inspections of specialty gas piping for nonhealthcare laboratory facilities and prepare test reports.
2. Tests and Inspections:
   a. Piping Leak Tests for Specialty Gas Piping: Test new and modified parts of existing piping. Cap and fill specialty gas piping with oil-free, dry nitrogen to pressure of 50 psig (345 kPa) above system operating pressure, but not less than 150 psig (1035 kPa). Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
   b. Repair leaks and retest until no leaks exist.
   c. Inspect specialty gas regulators for proper operation.

M. Field Quality Control For Healthcare Facility Medical Gas

1. Perform tests and inspections of medical gas piping systems in healthcare facilities and prepare test reports.
2. Tests and Inspections:
   a. Medical Gas Piping Testing Coordination: Perform tests, inspections, verifications, and certification of medical gas piping systems concurrently with tests, inspections, and certification of medical compressed-air piping and medical vacuum piping systems.
   b. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
      1) Initial blow down.
      2) Initial pressure test.
      3) Cross-connection test.
      4) Piping purge test.
      5) Standing pressure test for positive pressure medical gas piping.
      6) Standing pressure test for vacuum systems.
      7) Repair leaks and retest until no leaks exist.
   c. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical gas piping systems and perform the following tests and inspections:
      1) Standing pressure test.
      2) Individual-pressurization **OR** Pressure-differential, **as directed**, cross-connection test.
      3) Valve test.
      4) Master and area alarm tests.
      5) Piping purge test.

6) Piping particulate test.
7) Piping purity test.
8) Final tie-in test.
9) Operational pressure test.
10) Medical gas concentration test.
11) Medical air purity test.
12) Verify correct labeling of equipment and components.
13) Verify the following source equipment:
    a) Medical gas supply sources.

d. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
1) Inspections performed.
2) Procedures, materials, and gases used.
3) Test methods used.
4) Results of tests.

3. Remove and replace components that do not pass tests and inspections and retest as specified above.

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SECTION 01 95 99 99s - RACEWAYS AND BOXES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of raceways and boxes. 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 raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

C. Definitions
1. EMT: Electrical metallic tubing.
2. ENT: Electrical nonmetallic tubing.
3. EPDM: Ethylene-propylene-diene terpolymer rubber.
4. FMC: Flexible metal conduit.
5. IMC: Intermediate metal conduit.
6. LFMC: Liquidtight flexible metal conduit.
7. LFNC: Liquidtight flexible nonmetallic conduit.
8. NBR: Acrylonitrile-butadiene rubber.
9. RNC: Rigid nonmetallic conduit.

D. Submittals
1. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
2. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
   a. Custom enclosures and cabinets.
   b. For handholes and boxes for underground wiring, including the following:
      1) Duct entry provisions, including locations and duct sizes.
      2) Frame and cover design.
      3) Grounding details.
      4) Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
      5) Joint details.
3. Samples: For each type of exposed finish required for wireways, nonmetallic wireways and surface raceways, prepared on Samples of size indicated below.
4. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   a. Structural members in the paths of conduit groups with common supports.
   b. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.
5. Manufacturer Seismic Qualification Certification: Submit certification that enclosures and cabinets and their mounting provisions, including those for internal components, will withstand seismic forces defined in Division 26 Section(s) "Hangers And Supports For Electrical Systems" AND "Vibration And Seismic Controls For Electrical Systems". Include the following:
   a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      1) The term "withstand" means "the cabinet or enclosure will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will retain its enclosure characteristics, including its interior accessibility, after the seismic event."

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.

6. Qualification Data: For professional engineer and testing agency.
7. Source quality-control test reports.

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.
2. Comply with NFPA 70.

1.2 PRODUCTS

A. Metal Conduit And Tubing
1. Rigid Steel Conduit: ANSI C80.1.
2. Aluminum Rigid Conduit: ANSI C80.5.
3. IMC: ANSI C80.6.
4. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit **OR** IMC, **as directed**.
a. Comply with NEMA RN 1.
b. Coating Thickness: 0.040 inch (1 mm), minimum.
5. EMT: ANSI C80.3.
6. FMC: Zinc-coated steel **OR** Aluminum **OR** Zinc-coated steel or aluminum, **as directed**.
7. LFMC: Flexible steel conduit with PVC jacket.
8. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
a. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
b. Fittings for EMT: Steel **OR** Die-cast, **as directed**, set-screw **OR** compression, **as directed**, type.
c. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
9. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

B. Nonmetallic Conduit And Tubing
1. ENT: NEMA TC 13.
2. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.
3. LFNC: UL 1660.
4. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.
5. Fittings for LFNC: UL 514B.

C. Optical Fiber/Communications Cable Raceway And Fittings
1. Description: Comply with UL 2024; flexible type, approved for plenum **OR** riser **OR** general-use, **as directed**, installation.

D. Metal Wireways
1. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1 **OR** 12 **OR** 3R, **as directed**, unless otherwise indicated.
2. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

3. Wireway Covers: Hinged type **OR** Screw-cover type **OR** Flanged-and-gasketed type **OR** As indicated, **as directed**.
4. Finish: Manufacturer's standard enamel finish.

E. Nonmetallic Wireways
1. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.
   OR
   Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.
2. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

F. Surface Raceways
1. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected **OR** Prime coating, ready for field painting, **as directed**.
2. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected from manufacturer's standard **OR** custom, **as directed**, colors.

G. Boxes, Enclosures, And Cabinets
1. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
2. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy **OR** aluminum, **as directed**, Type FD, with gasketed cover.
3. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
4. Metal Floor Boxes: Cast metal **OR** Sheet metal, **as directed**, fully adjustable **OR** semi-adjustable, **as directed**, rectangular.
5. Nonmetallic Floor Boxes: Nonadjustable, round.
6. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
7. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum **OR** galvanized, cast iron, **as directed**, with gasketed cover.
8. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
   a. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
   b. Nonmetallic Enclosures: Plastic, finished inside with radio-frequency-resistant paint, **as directed**.
9. Cabinets:
   a. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
   b. Hinged door in front cover with flush latch and concealed hinge.
   c. Key latch to match panelboards.
   d. Metal barriers to separate wiring of different systems and voltage.
   e. Accessory feet where required for freestanding equipment.

H. Handholes And Boxes For Exterior Underground Wiring
1. Description: Comply with SCTE 77.
   a. Color of Frame and Cover: 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. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
g. 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.

2. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with 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**.

I. Sleeves For Raceways
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.
3. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch (1.3- or 3.5-mm) thickness as indicated and of length to suit application.
4. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping".

J. Sleeve Seals
1. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
a. Sealing Elements: EPDM **OR** NBR, **as directed**, interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
b. Pressure Plates: Plastic **OR** Carbon steel **OR** Stainless steel, **as directed**. Include two for each sealing element.
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 for each sealing element.

K. Source Quality Control For Underground Enclosures
1. Handhole and Pull-Box Prototype Test: Test prototypes of handholes 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 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. Raceway Application
1. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
a. Exposed Conduit: Rigid steel conduit **OR** IMC **OR** RNC, Type EPC-40-PVC **OR** RNC, Type EPC-80-PVC, **as directed**.
b. Concealed Conduit, Aboveground: Rigid steel conduit **OR** IMC **OR** EMT **OR** RNC, Type EPC-40-PVC, **as directed**.
c. Underground Conduit: RNC, Type EPC-40 **OR** 80, **as directed**,-PVC, direct buried.

d. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC **OR** LFNC, **as directed**.
e. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R **OR** 4, **as directed**.
f. Application of Handholes and Boxes for Underground Wiring:
1) Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete **OR** Fiberglass enclosures with polymer-concrete frame and cover **OR** Fiberglass-reinforced polyester resin, **as directed**, SCTE 77, Tier 15 structural load rating.
2) Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer-concrete units **OR** Heavy-duty fiberglass units with polymer-concrete frame and cover, **as directed**, SCTE 77, Tier 8 structural load rating.
3) Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf (13 345-N) vertical loading.

2. Comply with the following indoor applications, unless otherwise indicated:
a. Exposed, Not Subject to Physical Damage: EMT **OR** ENT **OR** RNC, **as directed**.
b. Exposed, Not Subject to Severe Physical Damage: EMT **OR** RNC identified for such use, **as directed**.
c. Exposed and Subject to Severe Physical Damage: Rigid steel conduit **OR** IMC, **as directed**. Includes raceways in the following locations:
1) Loading dock.
2) Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
3) Mechanical rooms.
d. Concealed in Ceilings and Interior Walls and Partitions: EMT **OR** ENT **OR** RNC, Type EPC-40-PVC, **as directed**.
e. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
f. Damp or Wet Locations: Rigid steel conduit **OR** IMC, **as directed**.
g. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical fiber/communications cable raceway **OR** EMT, **as directed**.
h. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: Riser-type, optical fiber/communications cable raceway **OR** EMT, **as directed**.
i. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: General-use, optical fiber/communications cable raceway **OR** Riser-type, optical fiber/communications cable raceway **OR** Plenum-type, optical fiber/communications cable raceway **OR** EMT, **as directed**.
j. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel **OR** nonmetallic, **as directed**, in damp or wet locations.

3. Minimum Raceway Size: 1/2-inch (16-mm) **OR** 3/4-inch (21-mm), **as directed**, trade size.
4. Raceway Fittings: Compatible with raceways and suitable for use and location.
a. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
b. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.
5. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
6. Do not install aluminum conduits in contact with concrete.

B. Installation
1. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
2. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

3. Complete raceway installation before starting conductor installation.
4. Support raceways as specified in Division 26 Section(s) "Hangers And Supports For Electrical Systems" AND "Vibration And Seismic Controls For Electrical Systems".
5. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
6. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
7. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
8. Raceways Embedded in Slabs:
    a. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
    b. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
    c. Change from ENT to RNC, Type EPC-40-PVC, rigid steel conduit, or IMC before rising above the floor.
9. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
10. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
11. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire.
12. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:
    a. 3/4-Inch (19-mm) Trade Size and Smaller: Install raceways in maximum lengths of 50 feet (15 m).
    b. 1-Inch (25-mm) Trade Size and Larger: Install raceways in maximum lengths of 75 feet (23 m).
    c. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
13. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
    a. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
    b. Where otherwise required by NFPA 70.
14. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F (17 deg C), and that has straight-run length that exceeds 25 feet (7.6 m).
    a. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:
        1) Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
        2) Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
        3) Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
        4) Attics: 135 deg F (75 deg C) temperature change.
    b. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change.

c. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.

15. Flexible Conduit Connections: Use maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed lighting fixtures, **as directed**, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
    a. Use LFMC in damp or wet locations subject to severe physical damage.
    b. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
16. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.
17. Set metal floor boxes level and flush with finished floor surface.
18. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

C. Installation Of Underground Conduit
1. Direct-Buried Conduit:
    a. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.
    b. Install backfill as specified in Division 31 Section "Earth Moving"
    c. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving".
    d. 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.
        OR
        For stub-ups at 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.
    e. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits, placing them 24 inches (600 mm) o.c. Align planks along the width and along the centerline of conduit.

D. Installation Of Underground Handholes And Boxes
1. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
2. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
3. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 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 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.

E. Sleeve Installation For Electrical Penetrations
1. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping".
2. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
3. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
4. Rectangular Sleeve Minimum Metal Thickness:
   a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side greater than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
   b. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches (1270 mm) and 1 or more sides equal to, or greater than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).
5. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
6. Cut sleeves to length for mounting flush with both surfaces of walls.
7. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.
8. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway unless sleeve seal is to be installed or unless seismic criteria require different clearance.
9. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies, **as directed**.
10. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
11. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 07 Section "Penetration Firestopping".
12. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.
13. Aboveground, Exterior-Wall 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.
14. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway and sleeve for installing mechanical sleeve seals.

F. Sleeve-Seal Installation
1. Install to seal underground, exterior wall penetrations.
2. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

G. Firestopping
1. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping".

H. Protection
1. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Final Completion.

a. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
b. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

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SECTION 01 95 99 99t - UNDERFLOOR RACEWAYS FOR ELECTRICAL SYSTEMS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of underfloor raceways for electrical 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. Flat-top, single-channel, underfloor raceways.
   b. Flat-top, multichannel, underfloor raceways.
   c. Flush, flat-top underfloor raceways.
   d. Cellular metal underfloor raceways.
   e. Trench-type underfloor raceways.
   f. Electrical connection components for precast concrete, hollow-core, floor decks.
   g. Electrical connection components for electrified cellular steel floor decks.
   h. Service fittings.

C. Definitions
1. Flush Outlet: Underfloor raceway outlet installed so the top of the fixed portions of the receptacles, jacks, and connector assemblies is located approximately at the surface of the floor or floor covering, and with the bodies of connected plugs exposed above the surface of the floor.
2. Flush Underfloor Raceway: Rectangular cross-section, flat-top raceway installed with the top of the raceway flush with the surface of the concrete in which it is embedded.
3. Header Raceway: Rectangular cross-section, single-channel or multichannel, underfloor raceway arranged as feeder raceway to bring wires and cables to service raceways from panelboards and communication terminal components.
4. Recessed Outlet: Underfloor raceway outlet installed with the top of the fixed portion of the connector assemblies located below the surface of the floor or floor covering and arranged to receive plug connectors with the bodies of the plugs concealed below the floor level.
5. Service Raceway: Underfloor distribution raceway providing direct connection to service fittings using preset or afterset inserts.
6. Trench Header: Trench-type raceway arranged as feeder raceway to bring wires and cables to service raceways from panelboards and communication terminal equipment.
7. Underfloor Raceway: A conduit, duct, or cell assembly, or trench located within the floor material or with its top at the floor surface.

D. Submittals
1. Product Data: For underfloor raceway components, fittings, and accessories.
2. Shop Drawings: For underfloor raceways. Include floor plans, assembly drawings, sections, and details.
   a. Identify components and accessories such as expansion-joint assemblies, straight raceway lengths, preset and afterset inserts, and service fittings.
   b. Provide dimensions locating raceway header and distribution elements. Include spacing between preset inserts and between preset inserts and ends of duct runs, walls, columns, junction boxes, and header duct connections.
   c. Show connections between raceway elements and relationships between components and adjacent structural and architectural elements including slab reinforcement, floor finish work, permanent partitions, architectural module lines, and pretensioning or post-tensioning components.

d. Indicate height of preset inserts, junction boxes, and raceways coordinated with depth of concrete slab and floor fill.
e. Indicate thickening of slabs where required for adequate encasement of raceway components.
f. Document coordination of exposed components with floor-covering materials to ensure that fittings and trim are suitable for indicated floor-covering material.
g. Revise locations from those indicated in the Contract Documents, as required to suit field conditions and to ensure a functioning layout. Identify proposed deviations from the Contract Documents.
h. Show details of connections and terminations of underfloor raceways at panelboards and communication terminal equipment in equipment rooms, wire closets, and similar spaces.
i. Identify those cells of cellular floor deck that are to be connected and fitted for the following underfloor distribution:
1) Power.
2) Voice.
3) Data.
4) Signal.
5) Communications.

3. Samples: For typical underfloor raceway products, in specified finish, including the following:
a. Service fittings and flush and recessed outlet and junction-box covers.
b. A section of each service raceway configuration with specified preset insert and service fitting installed.
c. A junction box of each size and type for use with underfloor raceway.
d. A section of each header raceway configuration, complete with provisions for connection with service raceway.
e. A section of trench-type raceway, complete with cover and required trim.
f. A junction box of each size and type, complete with cover and trim.

4. Operation and Maintenance Data: For underfloor raceways, to include in emergency, operation, and maintenance manuals. Include the following:
a. Manufacturer's written instructions for locating preset inserts and for installing afterset inserts.

E. Quality Assurance
1. 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.
2. Comply with NFPA 70.

1.2 PRODUCTS

A. Flat-Top, Single-Channel, Underfloor Raceways
1. Description:
a. Material: Steel.
b. Cross-Section Shape: Rectangular.
c. Number of Levels: One **OR** Two, **as directed**.
d. Minimum Bending Radius for Communication Cables: Combination of raceways, fittings, inserts, junction boxes, service fittings, and mounting and connection arrangements for wiring devices and jacks shall provide a 2-inch- (50-mm-) minimum bending radius for communication cables.
2. Service Raceways: Fitted with preset inserts.
a. Nominal Raceway Dimensions:
1) Depth: 1-1/2 inches (38 mm).
2) Power Service Raceway Width: 3-1/2 inches (90 mm).
3) Communication Service Raceway Width: 3-1/2 inches (90 mm) **OR** 6-1/2 inches (165 mm), **as directed**.

b. Number of Single-Channel Raceways per Run: One **OR** Two **OR** Three **OR** Four **OR** Five, **as directed**, unless otherwise indicated.
c. Preset Inserts: Rectangular **OR** Round, **as directed**.
1) Spacing: 24 inches (600 mm) **OR** 12 inches (300 mm), **as directed,** o.c.
2) Size: Rectangular dimensions as required to accommodate mounting and connection of flush-mounted, duplex receptacle or dual communication-jack or connector service fitting.
3) Size: 2 inches (50 mm) in diameter.
4) Equip each insert with a disposable cover and select insert height so cover is 1/8 inch (3 mm) below surface of concrete.
5) Arrange insert for optional attachment of flush-, surface-, or wiring- extension service fitting to replace disposable cover.

3. Header Raceways: Single channel, without preset inserts (blank raceway).
a. Nominal Raceway Dimensions:
1) Depth: 1-1/2 inches (38 mm).
2) Power Header Raceway Width: 3-1/2 inches (90 mm).
3) Communication Header Raceway Width: 3-1/2 inches (90 mm) **OR** 6-1/2 inches (165 mm), **as directed**.
b. Arrangement: In same plane as **OR** Below, **as directed**, service raceways.
c. Connections: Arranged to connect with service raceways at single-level **OR** two-level, **as directed**, junction boxes.

B. Flat-Top, Multichannel, Underfloor Raceways
1. Description:
a. Material: Steel.
b. Cross-Section Shape: Rectangular.
c. Number of Longitudinal Channels: Two **OR** Three **OR** Four, **as directed**, separated by steel wall(s).
d. Number of Levels: One **OR** Two, **as directed**.
e. Minimum Bending Radius for Communication Cables: Combination of raceways, fittings, inserts, junction boxes, service fittings, and mounting and connection arrangements for wiring devices and jacks shall provide a 2-inch- (50-mm-) minimum bending radius for communication cables.
2. Service Raceways: Fitted with preset inserts.
a. Nominal Raceway Dimensions:
1) Depth: 1-3/8 inches (35 mm).
2) Power Service Channel Width: 3-1/2 inches (90 mm) **OR** 4-3/8-inches (111 mm), **as directed**.
3) Communication Service Channel Width: 3-1/2 inches (90 mm) **OR** 4 inches (102 mm) **OR** 6-1/2 inches (165 mm), **as directed**.
b. Preset Inserts:
1) Spacing: 24 inches (600 mm) **OR** 12 inches (300 mm), **as directed,** o.c.
2) Size: Dimensions as required to accommodate mounting and connection of flush- and surface-mounted, single- and multiple-system service fittings or to connect to wiring extensions for feeding wall outlets for power **OR** communications **OR** power and communications, **as directed**.
3) Equip each insert with a disposable cover arranged for installation with top 1/8 inch (3 mm) below surface of concrete.
4) Arrange inserts for optional attachment of flush-, surface-, or wiring-extension service fitting to replace disposable cover. Arrange brackets, mountings, barriers, and floor access covers to support, isolate, and provide access to flush or surface outlet-mounting connector, jack, and receptacle devices.
3. Header Raceways: Multichannel, without preset inserts (blank raceway).
a. Nominal Raceway Dimensions:
1) Header Raceway Depth: Same as service raceways **OR** 2-1/2 inches (64 mm) **OR** 2-3/4 inches (70 mm) **OR** 3 inches (76 mm) **OR** 3-1/2 inches (90 mm), **as directed**.

2) Power Header Channel Width: 3-1/2 inches (90 mm) **OR** 4-3/8-inches (111 mm), **as directed**.
3) Communication Header Channel Width: 3-1/2 inches (90 mm) **OR** 4 inches (102 mm) **OR** 6-1/2 inches (165 mm), **as directed**.

b. Arrangement: In same plane as **OR** Below, **as directed**, service raceways.
c. Connections: Arranged to connect with service raceways at single-level **OR** two-level, **as directed**, junction boxes.

C. Flush, Flat-Top Underfloor Raceways
1. Description:
a. Material: Steel.
b. Cross-Section Shape: Rectangular, single channel and multichannel, separated by steel wall(s).
c. Listed and labeled for installation with top flush with concrete floor.
d. Number of Levels: One.
2. Service Raceways: Fitted with preset inserts.
a. Number of Longitudinal Channels per Multichannel Raceway: Two **OR** Three, **as directed**.
b. Number of Single-Channel Raceways per Run: One **OR** Two **OR** Three, **as directed**, unless otherwise indicated.
c. Nominal Channel Dimensions: 3 inches (76 mm) wide by 1-1/4 inches (32 mm) deep.
d. Preset Inserts: Threaded opening with removable steel plug that is flush with top of raceway when screwed in place.
1) Spacing: 24 inches (600 mm) **OR** 12 inches (300 mm), **as directed**, o.c., full length of each service raceway.
2) Arrangement: Stagger insert locations on parallel raceways or channels to accommodate placement of adjacent service fittings.
3) Size: 1-5/8-inch (41-mm) diameter.
3. Header Raceways: Raceways same as service raceways except without preset inserts (blank raceway).
a. Nominal Channel Dimensions: Same as service raceways.
b. Arrangement: In same plane as service raceways.
c. Connections: Arranged to connect with service raceways at junction boxes.

D. Cellular Metal Underfloor Raceways
1. Service Raceways: Fitted with preset inserts.
a. Material: Steel.
b. Number of Longitudinal Cells: Three, separated by steel walls.
c. Nominal Dimensions of Cells:
1) Overall Depth: 1-1/4 inches (32 mm) unless otherwise indicated.
2) Cross-Sectional Area of Cells: Power cells: 5-1/2 sq. in. (35.5 sq. cm); communication system cells: 16 sq. in. (103 sq. cm).
d. Minimum Bending Radius for Communication Cables: Combination of raceways, fittings, inserts, junction boxes, service fittings, and mounting and connection arrangements for wiring devices and jacks shall provide a 2-inch- (50-mm-) minimum bending radius for communication cables.
e. Preset Inserts: Rectangular-shaped metal housing assemblies arranged to provide electrical outlet access to each cell of each raceway designated for service raceway use. Inserts shall be provided throughout the entire length of each such raceway.
1) Spacing: 30 inches (762 mm) **OR** 24 inches (600 mm) **OR** 12 inches (300 mm), **as directed,** o.c.
2) Include housing and connecting provisions for a flush or recessed, single-, double-, or triple-system service fitting.
3) Include mounting and connecting provisions for a surface, single- or multiple-system service fitting.

4) Include connecting provisions for a wiring-extension service fitting to feed wall outlets.
5) Equip each insert with a disposable cover plate arranged for installation with top 1/8 inch (3 mm) below surface of concrete. Arrange insert to receive a flush-, recessed-, or wiring-extension service fitting to replace disposable top.

2. Header Assembly: A junction box and raceway arrangement arranged to feed wires and cables to service raceways.
   a. Three-compartment junction box connecting blank, multicell cellular header raceway (no inserts) with cellular service raceways.
      1) Arrange junction box in the center of a 60-inch (152-cm) length of header raceway.
      2) Cellular header raceway shall have same dimensions as service raceways.
      3) Provide capability for service raceways to be run in both directions from intersection with header raceway.
   b. Three-compartment junction box preassembled with blank, flat-top, multichannel header raceway (no inserts) and fitted to connect with cellular service raceway at right angles to header raceway.
      1) Arrange junction box in the center of a 60-inch (152-cm) length of header raceway.
      2) Provide capability for service raceways to be run in both directions from intersection with header raceway.

E. Trench-Type Underfloor Raceways
1. Trench: Steel, shop or factory welded and fabricated to indicated sizes. Include the following features:
   a. Slab Depth Adjustment: Minimum of minus 1/8 inch (3 mm) to plus 5/8 inch (16 mm) before and during concrete placement.
   b. Cover Supports: Height adjustable, with leveling screws to rigidly support cover assembly.
   c. Screed Strip: Extruded aluminum along both edges at proper elevation without requiring shim material.
   d. Trim Strip: Select to accommodate floor finish material.
   e. Partitions: Arranged to separate channels and isolate wiring of different systems.
   f. Grommeted openings in active floor cells or service raceways.
   g. Manufacturer's standard corrosion-resistant finish, applied after fabrication.
2. Cover Plates: Removable, steel plates, 1/4 inch (6 mm) thick, each weighing 60 lb (27 kg) or less with full gasket attached to side units. Fabricate intermediate supports to limit unsupported spans to 15 inches (380 mm) or less. Fabricate covers with appropriate depth recess to receive indicated floor finish.

F. Electrical Connection Components For Cellular Steel Floor Deck
1. Preset Inserts: Rectangular metal-housing assemblies.
   a. Spacing: 30 inches (762 mm) **OR** 24 inches (600 mm) **OR** 12 inches (300 mm), **as directed,** o.c.
   b. Size: As required to provide electrical outlet access to each cell of each group of three cells that is designated for electrical service raceway use.
   c. Equip each insert with a disposable cover arranged for installation with top 1/8 inch (3 mm) below surface of concrete. Arrange insert to receive a flush-, recessed-, or wiring-extension service fitting to replace disposable cover.
   d. Include housing and connecting provisions for a flush or recessed, single-, double-, or triple-system service fitting.
   e. Include mounting and connecting provisions for a surface, single-, double-, or triple-system service fitting.
   f. Include connecting provisions for a wiring-extension service fitting to feed wall outlets.

G. Electrical Connection Components For Cellular Concrete Floor Deck
1. Afterset Inserts: Round metal-nipple assembly with internal and external threading, arranged to screw into plug driven into 1-7/8-inch (48-mm) hole drilled through floor fill, where present, and deck-cell wall into floor raceway cell.

a. Inserts shall be compatible with floor-mounting service fittings.
b. Inserts shall provide wiring path from cell to power **OR** communication **OR** power and communication, **as directed**, wall and ceiling outlets.
c. Inserts shall provide wiring path from cell to header raceway.

H. Supports, Fittings, And Hardware
1. Supports, fittings, and hardware shall be compatible with raceway and outlet system and shall be listed for use with raceway systems and components specified.
2. Supports: Adjustable for height and arranged to maintain alignment and spacing of raceways during concrete placement. Include hold-down straps.
3. Raceway Fittings: Couplings, expansion-joint sleeves, cross-under offsets, vertical and horizontal elbows, grounding screws, adapters, end caps, and other fittings suitable for use with basic components to form a complete installation.

I. Junction Boxes
1. Description: Manufacturer's standard enclosure for indicated type, quantity, arrangement, and configuration of raceways at each raceway junction, intersection, and access location. Include the following accessories and features:
a. Mounting brackets.
b. Escutcheons and holders to accommodate surrounding floor covering.
c. Means for leveling and height adjustment more than 3/8 inch (10 mm) before and after concrete is placed.
d. Raceway Openings: For underfloor raceways and conduits arranged to accommodate raceway layout.
e. Covers shall have appropriate depth recess to receive specific floor finish material.
f. Partitions to separate wiring of different systems.

J. Service Fittings
1. Exposed Parts Finish: Brass **OR** Brushed Aluminum, **as directed**.
2. Flush, Single-System Service Fitting for Round Inserts: Include mounting and cover to support and provide access to single connector, jack, or receptacle device; mounted flush with floor within body of insert.
a. Connector, Jack, and Receptacle Devices: Single modular type; complying with Division 26 Section(s) "Wiring Devices" AND Division 27 Section(s) "Communications Horizontal Cabling".
b. Power Receptacle Outlet: Suitable for 20-A device.
3. Flush, Single- or Multiple-System Service Fitting for Rectangular Inserts: Include mounting, hinged cover, and trim to support and provide access to connector, jack, or receptacle devices mounted flush with floor within insert.
a. Connector, Jack, and Receptacle Devices: Modular type; complying with Division 26 Section(s) "Wiring Devices" AND Division 27 Section(s) "Communications Horizontal Cabling".
b. Power Receptacle Rating: 20 A, 120 V unless otherwise indicated.
4. Recess-Mounted Service Fitting: Modular fittings compatible with preset inserts and shall include covers; provisions for receptacles, jacks, and connectors; and associated device plates for indicated systems. Include hinged flush handhole covers with recessed depth to match thickness of floor finish material. Provide for internally mounted receptacle- and communication-jack and connector assemblies complying with requirements in Division 26 Section(s) "Wiring Devices" AND Division 27 Section(s) "Communications Horizontal Cabling".
a. Duplex receptacle.
b. Duplex telephone-data jacks.
c. Double duplex receptacles.
d. Duplex receptacle and duplex telephone-data jacks.
e. Double duplex telephone-data jacks, Category 5 **OR** Category 5e **OR** Category 6, **as directed**.

f. Fiber-optic cable connector.

5. Surface-Mounted Service Fitting: Modular pedestal type, with locking attachment matched to insert floor opening.
   a. Power-outlet, double-faced, surface-mounted unit for duplex receptacle on both sides.
   b. Power-outlet, single-faced, surface-mounted unit for duplex receptacle on one side.
   c. Communication-outlet, double-faced, surface-mounted unit.
      1) Include bushed openings on both sides; 1-inch (25-mm) minimum diameter; insulated with nonconducting material.
      2) Include provisions for modular dual fiber-optic connector assembly on both sides.
      3) Include provisions for modular dual jack-connector assembly, rated for Category 5 **OR** Category 5e **OR** Category 6, **as directed**, on both sides.
   d. Communication-outlet, single-faced, surface-mounted unit with bushed opening on one side; 1-inch (25-mm) minimum diameter; insulated with nonconducting material.
   e. Combination surface-mounted unit for duplex receptacle on one side and with communication cable connection provision on opposite side.
      1) Communication Side: Include bushed opening; 1-inch (25-mm) minimum diameter; insulated with nonconducting material.
      2) Communication Side: Include provisions for modular dual fiber-optic connector assembly.
      3) Communication Side: Include provisions for modular dual jack-connector assembly, rated for Category 5 **OR** Category 5e **OR** Category 6, **as directed**.
6. Flush-Mounted Service Fittings: Modular fittings compatible with preset inserts and shall include covers, provisions for receptacles jacks and connector assemblies and wiring extensions to wall-mounted outlets, and associated device plates for indicated systems. Include flush handhole covers, recessed to suit floor finish material. Internally mounted, modular, receptacle, jack and connector assemblies shall comply with requirements in Division 26 Section(s) "Wiring Devices" AND Division 27 Section(s) "Communications Horizontal Cabling".
   a. Duplex convenience receptacle.
   b. Duplex telephone-data outlets.
   c. Double duplex convenience receptacles.
   d. Duplex convenience receptacle and duplex telephone-data outlets.
   e. Double duplex telephone-data outlets.
   f. Duplex communication jack, rated for Category 5 **OR** Category 5e **OR** Category 6, **as directed**.
   g. Duplex fiber-optic communication connector.
   h. Wiring-Extension Service Fittings: Arrangement of brackets and mountings to support, and provide access to wiring or cabling of a cell, and to connect the cable or raceway that extends the system to an individual wall outlet. Provide for connection of FMC **OR** ENT **OR** Type MC cable, **as directed**, for power extensions, and FMC **OR** ENT **OR** optical fiber/communication cable raceway, **as directed**, for communication system extensions.

1.3 EXECUTION

A. Installation
   1. Install raceways aligned and leveled and, unless otherwise indicated, parallel or perpendicular to building walls.
   2. Provide a concrete base for support of cellular metal raceway.
   3. Arrange supports to attain proper elevation, alignment, and spacing of raceways. Install supports securely at ends and at intervals not to exceed 60 inches (1500 mm), to prevent movement during concrete pour.
   4. Level raceway components with finished slab and make adjustments for floor finishes.
   5. Adjust supports to maintain a 1/16- to 3/8-inch (1.6- to 10-mm) finished concrete cover over preset inserts.
   6. Remove burrs, sharp edges, dents, and mechanical defects.
   7. Cap or plug boxes, insert- and service-fitting openings, and open ends of raceways.

8. Seal raceways, cells, junction boxes, and inserts to prevent water, concrete, or foreign matter from entering raceways before and during pouring slab or placing fill. Tape joints, or seal with compound, as recommended in writing by underfloor raceway manufacturer.
9. Junction Boxes: Install tops level and flush with finished floor. Install blank closure plates or plugs to close unused junction-box openings. Grout boxes in place to prevent movement during construction. Place top covers in inverted position during construction to prevent damage to surface of cover. Reinstall covers in proper position prior to final acceptance of Work.
10. Afterset Inserts: Cut, hole saw, and drill slab and raceways to allow for installation.
11. Ground underfloor raceway components.
12. Install a marker at the center of the last insert of each cell and channel of each straight run of metal underfloor service raceway to locate the insert and identify the system.
    a. Install markers at last inserts on both sides of permanent walls and at first inserts adjacent to each junction box.
    b. Install markers flush at screed line before pouring slab or placing fill. Extend marker with grommeted screw when floor covering is placed. Do not extend through carpet.
    c. Use slotted-head screw to identify electrical power; use Phillips-head screw to identify conventional communications.
    d. Use another distinctive screw head to identify third system such as special-purpose wiring.
13. Level raceway components with finished slab and make adjustments in raceway component elevation to accommodate indicated floor finishes.

B. Field Quality Control
    1. 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.
    2. Tests and Inspections:
        a. Perform visual inspection of interior of each junction box **OR** section of trench raceway, **as directed**, to verify absence of dirt, dust, construction debris, and moisture. Replace damaged and malfunctioning components.
        b. Perform point-to-point tests of ground continuity and resistance of ground path between the most remote accessible fitting on each branch of each underfloor raceway system and the main electrical distribution grounding system.
            1) Determine cause and perform correction of any point-to-point resistance value that exceeds 0.05 ohms.
            2) Comply with NETA Acceptance Testing Specifications about safety, suitability of test equipment, test instrument calibration, and test report and records.

C. Cleaning
    1. Clean and swab out underfloor raceways, inserts, and junction boxes after finish has been applied to floor slab, and remove foreign material, dirt, and moisture. Leave interiors clean and dry.

END OF SECTION 01 95 99 99t

Task	Specification	Specification Description
01 95 99 99	01 22 16 00	No Specification Required
01 95 99 99	09 65 23 00	Resilient Sheet Flooring
01 95 99 99	01 95 26 00a	Interior Lighting

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SECTION 02 41 13 13 - 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 it finds it and shall inform itself 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 spalling 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 02 41 13 13

SECTION 02 41 16 13 - 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 the 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 the Owner that may be encountered during selective demolition remain the Owner's property. Carefully remove and salvage each item or object in a manner to prevent damage and deliver promptly to the Owner.
a. Coordinate with the 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 the 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 the Owner's continuing occupancy of portions of existing building and of the 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 And Disposal".

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. the Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so the Owner's operations will not be disrupted.
2. Conditions existing at time of inspection for bidding purpose will be maintained by the 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 the Owner before start of the Work **OR** have been removed by the Owner under a separate contract, **as directed**.
    b. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify the Owner. the 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 the Owner. the 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 And Disposal".
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 the Owner.
   d. Transport items to the Owner's storage area on-site **OR** off-site **OR** designated by the 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 the 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 And Disposal".
2. Burning: Do not burn demolished materials.

   OR

   Burning: Burning of demolished materials will be permitted only at designated areas on the 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 the Owner's property.

   OR

   Disposal: Transport demolished materials off the 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 02 41 16 13

SECTION 02 41 16 13a - 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 the Owner.

C. Definitions
1. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged.
2. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to the 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 the Owner that may be uncovered during demolition remain the property of the Owner.
a. Carefully salvage in a manner to prevent damage and promptly return to the Owner.

E. Informational 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. Inventory: Submit a list of items to be removed and salvaged and deliver to the Owner prior to start of demolition.
5. 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.
6. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.
7. 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/ASSE A10.6 and NFPA 241.
4. Predemolition Conference: Conduct conference at Project site.
   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 the 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. the 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 the Owner as far as practical.
   b. Before building demolition, the 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 the Owner before start of the Work.
   b. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and the Owner. Hazardous materials will be removed by the 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. the 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 the 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 31 Section "Earth Moving".

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 the Owner. the 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. the 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 22 AND Division 26 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 the Owner.
   d. Transport items to storage area designated by the 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 the Owner and authorities having jurisdiction.
   b. Provide temporary services during interruptions to existing utilities, as acceptable to the 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 the 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 31 Section "Earth Moving".
   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 THE 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 31 Section "Earth Moving".
   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 and legally dispose of them in EPA approved landfill acceptable to authorities having jurisdiction. See Division 01 Section "Construction Waste Management And Disposal" for recycling and disposal of demolition waste.
      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.
      a. Clean roadways of debris caused by debris transport.

END OF SECTION 02 41 16 13a

Task	Specification	Specification Description
02 41 16 13	02 41 13 13	Portland Cement Concrete Removal
02 41 19 13	01 71 23 16	Cutting and Patching
02 41 19 13	02 41 16 13	Selective Demolition
02 41 19 13	02 41 16 13a	Building Demolition
02 41 19 13	02 41 13 13	Portland Cement Concrete Removal
02 41 19 16	02 41 16 13	Selective Demolition
02 41 19 16	02 41 16 13a	Building Demolition
02 41 19 16	02 41 13 13	Portland Cement Concrete Removal

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SECTION 02 58 13 00 - 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 02 58 13 00

SECTION 02 58 13 00a - 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 02 58 13 00a

SECTION 02 61 00 00 - 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 the Owner.
2. Air Emissions: Air emissions shall be monitored and controlled in accordance with the 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 02 61 00 00

SECTION 02 61 13 00 - 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 02 61 13 00

SECTION 02 61 13 00a - 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, it 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 02 61 13 00a

SECTION 02 61 13 00b - 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 02 61 13 00b

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Task	Specification	Specification Description
02 61 13 00	02 41 16 13	Selective Demolition
02 61 13 00	02 61 00 00	Excavation And Handling Of Contaminated Material
02 65 00 00	02 41 16 13	Selective Demolition
02 65 00 00	02 61 00 00	Excavation And Handling Of Contaminated Material
02 65 00 00	02 61 13 00	Underground Storage Tank Removal
02 65 00 00	02 61 13 00a	Precision Testing Of Underground Fuel Oil Tanks
02 65 00 00	02 61 13 00b	Hydrostatic Pressure Testing Of Air Receiving Tanks

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SECTION 02 81 00 00 - DISPOSAL OF HAZARDOUS MATERIALS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for disposal of hazardous 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. Definition
1. Hazardous materials shall be defined as asbestos containing materials, lead-based paint, PCBs, bird waste, and other materials categorized as hazardous by the EPA.

C. Submittals
1. Before start of work: At the pre-construction meeting, the Contractor shall submit the following to the Owner's Representative for review. Do not start work until these submittal are returned with Owner's Representative stamp indicating that the submittal is returned for unrestricted use.
   a. Copy of State or local license for hazardous waste hauler.
   b. Certificate of at least one on-site supervisor which has satisfactorily completed the OSHA 40 hour Health and Safety course for handling hazardous materials.
   c. Certificates of workers which have successfully completed the OSHA 40-Hour Health and Safety Course for Hazardous Materials.
   d. List of the employees scheduled to perform this work.
   e. Schedule of start and finish times and dates for this work.
   f. Name and address of landfill where these waste materials are to be deposited. Include contact person and telephone number.
   g. Material Safety Data Sheet (MSDS) for all materials to be removed.
   h. If contractor introduces any chemical into the work environment, a MSDS for that chemical must be presented to the Owner's Representative prior to use.
   i. Transporter must have notified the EPA and/or other appropriate local government agency in advance of its intentions to transport hazardous materials and, if applicable, receive an identification number.
   j. Contingency Plan for handling emergencies with spills or leaks.
   k. Certificates of workers which have successfully completed the OSHA 24-Hour Health and Safety Course for Hazardous Materials.

1.2 PRODUCTS

A. Materials
1. Drums: Recovery or salvage drums acceptable for disposal of hazardous waste. Prior approval of drums is required. Drums or containers must meet the required OSHA, EPA (40 CFR Parts 264-264 and 300), and DOT Regulations (49 CFR Parts 171-178). Use of damaged containers shall not be allowed.
2. Labels: As required by the EPA and OSHA for handling, transportation, and disposal of hazardous waste.
3. Absorbent Material: Clay, soil or any commercially available absorbent used for the purpose of absorbing hazardous or potentially hazardous materials.

1.3 EXECUTION

A. All waste shall be transported and disposed of in accordance with all federal, state and local guidelines and regulations. The contractor is to obtain all permits, licenses, etc., which are necessary for the transporting and disposal of hazardous waste.

B. Waste haulers shall maintain waste manifest and shipment record forms.

END OF SECTION 02 81 00 00

Task	Specification	Specification Description
02 81 00 00	02 61 00 00	Excavation And Handling Of Contaminated Material

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SECTION 02 82 16 00 - ENCAPSULATION (LOCK-DOWN) OF ASBESTOS-CONTAINING MATERIALS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for encapsulation (lock-down) of asbestos-containing 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. Submittals
1. Product Data: Manufacturers technical information including label analysis and application instructions for each material proposed for use.
2. Installation Instructions: Manufacturer's installation instructions with specific project requirements noted.
3. Performance Warrantee: Manufacturers performance guarantee.
4. Material Safety Data Sheet: Material Safety Data Sheet in accordance with the OSHA Hazard Communication Standard (29 CFR 1910.1200) for each surfactant and encapsulating material proposed for use on the work. Include a separate attachment for each sheet indicating the specific worker protective equipment proposed for use with the material indicated.

C. Delivery And Storage: Deliver materials to the job site in original, new and unopened packages and containers bearing manufacturer's name and label, and following information:
1. Name or title of material
2. Manufacturer's stock number and date of manufacture
3. Manufacturer's name
4. Thinning instructions
5. Application instructions
6. Deliver materials together with a copy of the OSHA Material
7. Safety Data Sheet for the material.

D. Job Conditions: Apply encapsulating materials only when environmental conditions in the work area are as required by the manufacturer's instructions.

E. Quality Assurance
1. Testing: Test material to be encapsulated using methods set forth in ASTM E1494 “Standard Practice for Encapsulants for Spray-or-Trowel-Applied Friable Asbestos- Containing Building Materials."

F. Warranty
1. Performance Warranty: Contractor shall submit written Performance Warranty, executed by the contractor, agreeing to repair/replace spray-on work which has cracked, fallen from substrate, or otherwise deteriorated to a condition where it would not perform effectively for its intended purposes due substantially to defective materials or workmanship and not due to abuse by occupants, improper maintenance, unforeseeable ambient exposures or other causes beyond anticipated conditions and contractors control. Warranty period shall be for at least one year after date of Final Completion.

1.2 PRODUCTS

A. Materials

1. Encapsulant system shall be an acrylic, elastomeric type, spray, brush or roller-applied, tinted penetrating or tinted bridging type, specifically designed for application to asbestos-containing material. System shall be equal to Global Encasement System as manufactured by GLOBAL Encasement Inc., 132-32nd Street, Union City, NJ 07087 U.S.A., Tel. (800) 266-3982/(201) 902-9770.
   a. All encasement topcoat materials shall be warranted to be heavy-bodied, from the same manufacturer, and shall be long lasting, highly-pure (low VOC) materials that remain flexible, chalk resistant and resist cracking, peeling, algae and fungus that can cause future indoor air quality concerns.
   b. To allow for building movement without cracking or disturbing fibrous materials, coating systems shall have passed testing to ASTM standards for adhesion, permeability, aged flexibility and with aged elasticity for the encasement system of over 250%.
   c. Coatings shall be Class A Fire Rated, water-based, non-toxic, safe and easy to use, contain no hazardous ingredients by OSHA definition, comply with all known building codes and be non-flammable.
   d. Coating materials shall have low VOC (Volatile Organic Compound) content.
   e. Coating materials shall not release health threatening toxic smoke and fumes in a fire and shall comply with all known building codes.
   f. Coating materials shall have passed the following testing standards:
      1) ASTM E 119 fire tests demonstrating that applying a multi-layer system over fireproofing does not adversely affect the fireproof rating of the fireproofing (3 hour test).
      2) UPITT Combustion Toxicity Test proving nothing toxic is released in a fire.
      3) ASTM E 84 and E162 fire tests for "Class A" - Surface Flammability and Burning Characteristics (Flame Spread = 0, Smoke Developed = 5).
      4) "Pull-off Adhesion" test per ASTM E736 equals or exceeds 9,950 lbs./sq. ft. (89.1 lbs./sq. in.).
      5) ASTM D 1653 and E96 "Water Vapor Permeability" (showing the rate that water vapor can pass through the system).
      6) Impact Resistance, "Tensile Strength" shall exceed 150 psi; "Elongation" shall exceed 250%.
      7) System shall be mildew resistant, impact resistant, scrub resistant, non-yellowing, non-chalking, highly blister resistant, rust resistant, highly chemical resistant and shall remain flexible after 1000 hour ASTM Accelerated Weather testing.
      8) Water-Based materials (low VOC) Volatile Organic Content of Primer-Sealer-Neutralizer = 0.1 g/L (0.001 lb./gal.) and Encasement Top Coat = 0.1 g/L (0.001 lb./gal.) as tested by EPA Method 24.
      9) Materials comply with applicable standards for installation on interior and/or exterior surfaces of a building.
      10) Encasement Systems shall provide additional water-proofing protection.

B. Related Materials:
   1. Elastomeric architectural sealants, caulking compounds, primers, and similar materials shall be approved by the manufacturer of the encasement coatings. All materials used shall be applied in accordance with its manufacturer's recommendations.

C. Applicable Standards
   1. Product shall be rated as acceptable for use intended when field tested in accordance with ASTM E 1494.

1.3 EXECUTION

A. General

1. Prior to applying any encapsulating material in Work Areas, Contractor shall obtain final visual inspection approval by the Project Administrator.
2. Prior to applying any encapsulating material, Contractor shall ensure that application of the sealer will not cause the base material to fail and allow the sealed material to fall of its own weight or separate from the substrate. Should Contractor doubt the ability of the installation to support the sealant, request direction from the Owner's Representative before proceeding with the encapsulating work.
3. Do Not Commence Application of encapsulating materials until all removal work within the work area has been completed.

B. Worker Protection
1. Before beginning work with any material for which a Material Safety Data Sheet has been submitted provide workers with the required protective equipment. Require that appropriate protective equipment be used at all times.

C. Application
1. Comply with all manufacturer's instructions for particular conditions of installation. Consult with manufacturer's technical representative for conditions not covered.
2. Encapsulate all surfaces in full compliance with manufacturer's procedures.
3. At completion of Encapsulation and before removal of Work Area enclosures and Pressure Differential System, decontaminate space in accordance with requirements of manufacturer’s instructions.
4. Remove all debris from the project site and restore area to proper conditions by cleaning all surfaces in accordance with manufacturer’s written recommendations.
5. At completion of work submit manufacturer’s record of inspection of completed work and Manufacturers Performance Guarantee executed by both manufacturer and Contractor.

END OF SECTION 02 82 16 00

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SECTION 02 82 33 00 - REMOVAL OF FRIABLE ASBESTOS-CONTAINING MATERIALS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for removal of friable asbestos-containing 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. Description
1. Furnish all labor, materials, facilities, equipment, services, employee training and testing, permits and agreements necessary to perform the work required for asbestos removal, encapsulation, repair, clean-up, decontamination, re-insulation and all other work in accordance with these specifications, in accordance with the latest regulations from the U.S. Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), the recommendations of National Institute of Occupational Safety and Health (NIOSH), and any other applicable federal, state and local government regulations. Whenever there is a conflict or overlap of the above references, the most stringent provision is applicable.
2. The work specified herein shall be performed by competent persons trained, knowledgeable and qualified in the state-of-the-art techniques of asbestos abatement, handling and subsequent cleaning of contaminated areas.

C. Scope
1. The quantities of materials and limits of abatement work area(s) shall be verified by the asbestos contractor.

D. Asbestos Hazard
1. Asbestos-containing material when damaged or disturbed is subject to fiber releases. Wet methods are a primary means of controlling fiber release.
2. Strict compliance with each of the provisions outlined in these specifications for the encapsulation, repair and handling of asbestos-containing material is of great importance, because:
   a. The inhalation of airborne asbestos fibers can cause a very serious and often fatal disease.
   b. Workers may not be aware they are inhaling asbestos fibers.
   c. Symptoms of the disease do not appear for many years.
   d. Only the Contractor and its employees can prevent the inhalation of asbestos fibers, which can lead to the development of asbestos-related disease.
   e. No insurance is available to provide for asbestos-related disease.

E. Other Hazardous Material
1. Contractor shall comply with OSHA 29 CFR 1926.62 - Lead in Construction when demolishing any equipment or architectural component identified as lead-containing or lead-based paint. The work of this project is considered a demolition activity.
2. the Owner anticipates that a substantial amount of the Project will involve lead paint.

F. Qualifications
1. the Owner and the Owner's Representative will verify and approve the experience of the Asbestos Abatement Contractor based upon submission at the time of bidding by Contractor evidence of the following:
   a. Experience: Provide the names and locations of at least three asbestos abatement projects of comparable size and complexity comparable with this work. Provide the names and telephone numbers of contact person at previous projects. Provide the final air monitoring decontamination fiber levels achieved.

b. Personnel: Provide the name(s) of "Competent Person" as defined by OSHA 29 CFR 1926.32(f) - Asbestos. Demonstrate the education and specialized training with successful completion of examination of an EPA approved course. Provide evidence of participation in five projects of complexity comparable with this project.
c. Licensing and Certification: The Contractor must hold a current, valid asbestos license issued by the State in which the work is to be performed.

G. Notices And Record Keeping
1. Contractor shall maintain for at least 30 years, a record for each asbestos project in which the Contractor engages. Each record shall include the following information: name, address, and social security number of all personnel involved with the project, the name address and social security number of the OSHA "Competent Person" who will supervise the work, the amount of asbestos material that was removed, repaired, encapsulated or disturbed, the commencement and completion date of the work, copies of Hazardous Waste Manifest(s), personal air monitoring results and any other appropriate information.
2. The Contractor shall send written notification as required by USEPA National Emission Standards for Hazardous Air Pollutants (NESHAPS) Asbestos Regulations (40 CFR 61, Subpart M) to the Owner, at least 10 working days prior to beginning any work on asbestos-containing materials.
3. Include the following information:
   a. Name and address of the Owner or operator.
   b. Description of the facility being demolished or renovated, including the size, age, and prior use of the facility.
   c. Estimate of the approximate amount of asbestos material present in the facility in terms of linear feet of pipe, and surface area on other facility components. For facilities in which the amount of asbestos materials is less than 80 linear meters (260 linear feet) on pipes and less than 15 square meters (160 square feet) on other facility components, explain techniques of estimation.
   d. Location of the facility being demolished or renovated.
   e. Scheduled starting and completion dates of demolition or renovation.
   f. Nature of planned demolition or renovation and method(s) to be used.
   g. Procedures to be used to comply with the requirements of USEPA National Emission Standards for Hazardous Air Pollutants (NESHAPS) Asbestos Regulations (40 CFR 61 Subpart M).
   h. Name and location of the waste disposal site where the asbestos waste material will be deposited.
4. Prior to commencement of work, the Contractor shall submit the following documents to the Owner's Representative. No work will be allowed to start until these documents have been approved:
   a. The schedule of the work, including manpower, length and number of work shifts. Schedule shall be coordinated with the Owner's full occupancy of all areas of the building.
   b. Satisfactory proof that written notification has been provided to the EPA regional office and the Owner.
   c. Proof that all required permits, disposal site locations, and arrangements for transportation and disposal of asbestos-contaminated materials, supplies and the like have been obtained.
   d. Complete a worker certificate indicating that all employees have had instruction and training on the hazards of asbestos exposure, the use and fitting of respirators, protective dress, wet and dry decontamination procedures, entry and exit from work areas, and all aspects of work procedures and protective measures.
   e. Documentation indicating that all employees have received appropriate medical examinations and have successfully passed fit testing for the respirator to be worn. As a minimum, medical exams must be consistent with OSHA 29 CFR 1926.1101(K)(9)(viii)(G)-Asbestos Regulation.

f. Samples of signs to be used in and around the work area to comply with 0SHA 29 CFR 1926.1101(K)(9)(viii)(I)- Asbestos regulations and as required by federal, state and municipal regulations.
g. Material Safety Data Sheets (OSHA form 174 or equivalent) for all chemicals used during work performed under this section.
h. Encapsulation data and encapsulation procedures.
i. Design of pressure differential system including calculation used to arrive at the number of machines necessary to achieve one air change per every 10 minutes.
j. Location of personnel and material decontamination units for each work area.

5. Contractor shall provide written notification to the Owner's Representative of its intent to start work at least five days in advance. In no case will the Contractor start work until authorization to proceed is given.
6. During the work, Contractor shall maintain a daily log which will be kept at the job site. Items to be included in the daily log shall include but are not limited to the following:
   a. Meetings, purpose, attendees, discussions, items of resolution.
   b. Visitations, authorized and unauthorized.
   c. Sign-in sheets of all personnel entering and leaving the work area.
   d. Special or unusual events (i.e., barrier breeching equipment failures).
   e. Personal air monitoring results.
   f. Two copies of the daily log are required for Project Closeout.

H. Terminology (Definitions)

1. Abatement - Procedures to control fiber release from asbestos-containing materials. Includes removal, enclosure or encapsulation.
2. Air Lock - A system for permitting ingress or egress without permitting air movement between any two adjacent areas consisting of two curtained doorways. The air lock must be maintained in an uncontaminated condition at all times.
3. Air Monitoring; - The process of measuring the asbestos fiber content of a specific volume of air in a stated period of time using methods approved or recommended by OSHA, EPA, NIOSH or other method approved by the Owner or the Owner's Representative.
4. Amended water - Water to which a surfactant has been added.
5. Asbestos - A generic name given to a number of naturally occurring hydrated mineral silicates that possess a unique crystalline structure, are incombustible in air, and are separable into fibers. Asbestos includes the asbestiform varieties of Chrysotile (serpentine), Crocidolite (Riebeckite), Amosite (Cummingtonite-Grunente), Anthophyllite, Actinolite, and Tremolite.
6. Asbestos-containing. material (ACM) - Any material that contains more than 1 percent asbestos by weight as determined by Polarized Light Microscopy (PLM).
7. Authorized Visitor - the Owner or its designated representative, or a representative of any regulatory or other agency having jurisdiction over the project.
8. Class I - Asbestos work means activities involving the removal of thermal systems insulation (TSI) and surfacing ACM and PACM.
9. Class II - Asbestos work means activities involving the removal of ACM which is not TSI or surfacing material. This includes, but is not limited to, the removal of asbestos-containing wallboard, floor tile and sheeting, roofing and siding shingles, and construction mastics.
10. Class III - Asbestos work means repair and maintenance operations where "ACM" including TSI and surfacing ACM and PACM is likely to be disturbed.
11. Class IV - Asbestos work means maintenance and custodial activities during which employees contact but do not disturb ACM or PACM and activities to clean-up dust, waste and debris resulting from Class I, II and III activities.
12. Critical Barrier - A unit of temporary construction which provides the only separation between an asbestos work area and an adjacent, potentially occupied, space. The critical barrier is composed of at least one intact sheet of polyethylene sheeting.
13. Decontamination Enclosure System - A series of connected rooms with curtained doorways between any two adjacent rooms, for the decontamination of workers or of materials and equipment. A decontamination system contains at least two air locks.

14. Disposal - All procedures necessary to transport and deposit the asbestos-contaminated material stripped and removed from the building in a waste disposal site in compliance with applicable federal, state, and local regulations.
15. Disposal Site - A site approved by the EPA for the disposal of asbestos-containing wastes.
16. Encapsulant - A liquid which can be applied to asbestos-containing materials and which controls the possible release of fibers from the materials.
17. Encapsulation - The use of an agent to seal the surface (bridging encapsulant) or penetrate the bulk (penetrating encapsulant) of the asbestos-containing material.
18. HEPA -High Efficiency Particulate Air - A type of filter which is 99.97% efficient at filtering particles of 0.3 micrometers in diameter.
19. HEPA Vacuum Equipment - Vacuuming equipment equipped with a HEPA filter in the exhaust outlet, and so designed and maintained that 99.97% of all particles of 0.3 micrometer in diameter in the inlet air are collected and retained.
20. Negative Pressure Respirators - Respirators which function by the wearer breathing in air through a filter.
21. NIOSH - National Institute of Occupational Safety and Heath.
22. the Owner's Representative - Authorized Consultants
23. Permissible Exposure Level (PEL) - A level of airborne fibers specified by OSHA as an occupational exposure standard for asbestos. It is 0.1 f/cc of air, eight-hour TWA, as measured by Phase Contrast Microscopy.
24. Repair - The restoration of damaged or deteriorated asbestos-containing material to intact condition.
25. Respirator Protection Program - A set of procedures and equipment required by OSHA if employees wear negative pressure respirators or if fiber levels are above the PEL.
26. Surfactant - Chemical wetting agent added to water to improve penetration, thus reducing the amount of water required for a given operation or area, and enhancing the effect of the water in reducing fiber release.
27. Thermal Systems Insulation - Material applied to pipes, fittings, boilers, breeching, tanks, ducts or other interior structural components to prevent heat loss or gain, or water condensation, or for other purposes.
28. Wet Cleaning - The process of eliminating asbestos contamination from building surfaces and objects by using cloths and mops or other cleaning tools that have been dampened with clean water and afterwards disposing of these cleaning tools as asbestos-contaminated waste.

I. Permits And Licenses:
1. The Contractor must maintain current licenses as required by applicable state or local jurisdictions for the removal, transporting, disposal or other regulated activity relative to the work of this contract.

J. Regulations
1. This section sets forth governmental regulations and industry standards which are included and incorporated herein by reference and made a part of the specifications. This section also sets forth those notices and permits which are known to the Owner and which either must be applied for and received, or which must be given to governmental agencies before start of work.
2. Except to the extent that more explicit or more stringent requirements are written directly into the contract documents, all applicable codes, regulations, and standards have the same force and effect (and are made a part of the contract documents by reference) as if copied directly into the contract documents, or as if published copies are bound herewith.
3. The Contractor shall assume full responsibility and liability for the compliance with all applicable federal, state, and local regulations pertaining to work practices, hauling, disposal, and protection of workers, visitors to the site, and persons occupying areas adjacent to the site. The Contractor is responsible for providing medical examinations and maintaining medical records of personnel as required by the applicable federal, state, and local regulations. The Contractor shall hold the Owner and the Owner's Representative harmless for failure to comply with any applicable work,

hauling, disposal, safety, health or other regulation on the part of itself, its employees, or its Sub-Contractors.

4. Federal requirements which govern asbestos abatement work or hauling and disposal of asbestos waste materials include but are not limited to the following regulations:
   a. U.S. Department of Labor, Occupational Safety and Health Administration, (OSHA), including but not limited to:
      1) U.S. Department of Labor, OSHA, including, but not limited to:
         a) Occupational Exposure to Asbestos, Tremolite, Anthophyllite and Actinolite; Final Rules
            Title 29, Part 1910, Section 1001
            Part 1926, Section 1101 of the Code of Federal Regulations
         b) Respiratory Protection
            Title 29, Part 1910, Section 134 of the Code of Federal Regulations
         c) Construction Industry
            Title 29, Part 1926.1011, of the Code of Federal Regulation
         d) Access to Employee Exposure and Medical Records
            Title 29, Part 1910, Section 2 of the Code of Federal Regulations
         e) Hazard Communication
            Title 29, Part 1910, Section 1200 of the Code of Federal Regulations
         f) Specifications for Accident Prevention Signs and Tags
            Title 29, Part 1910, Section 145 of the Code of Federal Regulations
      2) U.S. Environmental Protection Agency (EPA) including, but not limited to:
         a) Asbestos Abatement Projects Rule
            40 CFR Part 762
            CPTS 62044, FRL 2843-9
            Federal Register, Vol. 50 No. 134, July 12,1985
            P28530-28540
         b) Regulation for Asbestos
            Title 40, Part 61, Subpart A of the Code of Federal Regulations
         c) National Emission Standard for Asbestos
            Title 40, Part 61, Subpart M (Revised Subpart B) of the Code of Federal Regulations
      3) State requirements which govern asbestos abatement work and/or hauling and disposal of asbestos waste materials.
      4) Contractor shall abide by all local requirements which govern asbestos abatement work or hauling and disposal of asbestos waste materials including the following:
         a) American National Standards Institute (ANSI)
            1430 Broadway
            New York, NY 10018
            (212) 354-3300
         b) Fundamentals Governing the Design and Operation of Local Exhaust Systems Publication Z9.2-79
         c) Practices for Respiratory Protection Publication Z288.2-80
         d) American Society for Testing and Materials (ASTM)
            1916 Race Street
            Philadelphia, PA 19103
            (215) 299-5400
         e) Specification for Encapsulants for Friable Asbestos-Containing Building Materials
         f) Safety and Health Requirements Relating to Occupational Exposure to Asbestos

K. the Owner's Representative
   1. the Owner's Representative is authorized by the Owner to perform the following:
      a. Have free access to all asbestos work areas.

b. To assist in interpretation of procedures.
c. To advise on all provisions of the contract documents pertaining to the control of asbestos.
d. To stop work if, in the course of performing their monitoring duties, an instance of substantial nonconformance with the contract documents is observed.
e. To stop work if a situation presenting a health hazard to workers or the Owner's employees or occupants of the building is observed.
f. To act as the Owner's liaison in technical matters involving the asbestos-related work.
g. To perform air sampling inside and outside the asbestos work area during the project. The Contractor shall cooperate fully with the Owner's Representative, its agents and employees, and ensure cooperation of its workers during collection of air samples and work area inspections.
h. the Owner's Representative role in advising the Owner on environmental health matters does not relieve the Contractor's obligation to comply with all applicable health and safety regulations. Air monitoring results generated by the Owner's Representative shall not be used by the Contractor to represent compliance with regulatory agency requirements for monitoring of worker's exposure to airborne asbestos, nor shall any other activity on the part of the Owner's Representative represent the Contractor's compliance with applicable health and safety regulations.

L. Pre-Construction Conference
1. An initial progress meeting recognized as "Pre-Construction Conference" shall be held prior to start of any work. Contractor shall meet at project site, with General Superintendent, the Owner, the Owner's Representative, and other entities concerned with asbestos abatement work. Record discussions and agreements and furnish copy to each participant. Provide at least 72 hours advance notice to all participants prior to convening Pre-Construction Conference.
2. This is an organizational meeting, to review responsibilities and personnel assignments, to locate the containment and decontamination areas; and temporary facilities including power, light, water, etc.
3. Submit waivers on forms, and executed in a manner acceptable to the Owner. Administrative requirements that must proceed or coincide with Contractor's submittal for final payment shall consist of the following:
a. Completion of project closeout requirements.
b. Completion of items specified for completion beyond time of Final Completion (regardless of whether special payment application was previously made).
c. Assurance, satisfactory to the Owner, that unsettled claims will be settled and that work not actually completed and accepted will be completed without undue delay.
d. Transmittal of required project construction records to the Owner.
e. Landfill receipts for all asbestos-containing material.
f. Proof, satisfactory to the Owner, that taxes, fees and similar obligations of Contractor have been paid.
g. Removal of temporary facilities, services, surplus materials, rubbish and similar elements.
h. Consent of surety for final payment.

M. Project Closeout
1. Project closeout is the term used to describe certain collective project requirements that indicate completion of the work to be fulfilled near the end of the contract time. Also, in preparation for final acceptance of the work by the Owner, as well as, final payment to the Contractor and the normal termination of the Contract.
2. Include supporting documentation for completion as indicated in these contract documents.
3. Submit a statement on accounting of changes to the Contract Sum.
4. Advise the Owner of pending insurance change-over requirements.
5. Submit specific warranties, workmanship and maintenance bonds, maintenance agreements, final certifications and similar documents.

6. Obtain and submit releases enabling the Owner's full, unrestricted use of the work area and access to services and utilities. Where required, include occupancy permits, operating certificates and similar releases.
7. Results of the completed inspection will form the initial "punch-list" for final acceptance.
8. A complete record, certified by the testing laboratory, of all personal air monitoring results.
9. Complete the following cleaning operations as outlined in Paragraph “Decontamination Procedures” before requesting the Owner's Representative inspection for certification of Final Completion.
    a. Remove exposed labels in finished spaces which are not required as permanent labels on materials supplied as part of the work, except for "Asbestos", "Asbestos Free", or Thermal Insulation Labels specified elsewhere.
    b. Clean transparent materials, affected by the work including mirrors and window/door glass, to a polished condition, removing substances which are noticeably vision-obscuring materials. Replace broken glass and damaged transparent materials.
    c. Clean exposed hard-surfaced finishes affected by the work, to a dirt-free condition, free of dust, stains, films and similar distracting substances. Except as otherwise indicated, avoid disturbance of natural weathering of exterior surfaces. Restore reflective surfaces to original reflective condition.
    d. Clean plumbing fixtures affected by the work to a sanitary condition, free of stains including those resulting from water exposure.
    e. Replace all HVAC filters using materials supplied by the Owner or clean non-replaceable filters after minimum of two days of operation of HVAC equipment.
    f. Clean light fixtures and lamps, which have been affected by the work so as to function with full efficiency. Replace lamps where inoperable.
    g. Repair any damage to wall, ceiling and floor surfaces caused by installation and removal of the polyethylene sheeting.

N. Personnel Protection
1. Prior to commencement of work, the workers shall be instructed and be knowledgeable in the areas described in Paragraph "Submittals and Notices" having to do with employees.
2. Worker Protection - shall comply with 29 CFR 1910.134 (Respiratory Protection).
    a. Because there is no known safe level of exposure to asbestos, it is prudent to reduce worker's exposures to as low a level as possible. Proper respiratory protection is critical in minimizing exposure.
    b. Workers shall be provided, as a minimum, with personally issued and marked respirators equipped with high efficiency particulate filters approved by NIOSH to be worn in the designated work area and/or whenever a potential exposure to asbestos exists. Sufficient filters shall be provided for replacement as required by the workers or applicable regulations. Disposable respirators shall not be used.
    c. No worker shall be exposed to levels greater than 0.01 f/cc as determined by the protection factor of the respirator worn and the work area fiber levels.
    d. Whenever powered purifying respirator protection is used, a sufficient supply of replacement batteries and HEPA filter cartridges shall be provided to the workers.
    e. Air monitoring required by OSHA is work of the Contractor and not covered in this specification. Contractor shall post, on a daily basis, results of the air monitoring results from the previous shift. A complete record, certified by the testing laboratory, of all personal air monitoring tests and results will be furnished to the Owner and the Owner's Representative prior to Contractor's Request for Final Payment.
    f. During encapsulation operations or usage of other organic base aerosols (e.g., spray glue, expanding foam), workers shall be provided with combination cartridges consisting of organic vapor and HEPA sections.
    g. Workers shall be provided with sufficient sets of protective full-body clothing to be worn in the designated work area and/or whenever potential exposure to asbestos exists. Such clothing shall include, but not be limited to, full-body coveralls, headgear and gloves. Workers shall assure that hoods covering their hair are worn in the designated work areas

at all times. Eye protection and hard hats shall be provided as required by applicable safety regulations. Eye protection shall be worn during encapsulation operations. Non-disposable type protective clothing and footwear shall be left in the work area until the end of the asbestos abatement work, at which time such items will be disposed of as asbestos waste.

h. Non-skid footwear shall be provided to all abatement workers. Disposable clothing shall be adequately sealed to the footwear to prevent body contamination.

i. Protective clothing shall not be worn in lieu of street clothing outside the work area.

j. Visitor Clothing: The Contractor shall provide authorized visitors with suitable respirator, protective clothing, headgear, eye protection, and footwear as described herein, whenever they enter the work area.

3. Decontamination and Work Procedures: The decontamination and work procedures to be followed by workers shall be posted as described in these specifications.

4. Worker and Authorized Visitor Protection Procedures:

a. Each worker and authorized visitor shall, upon entering the job site, remove street clothes in a designated clean change area and put on a respirator with new filters and clean protective clothing before entering the work area.

b. The Contractor's employees shall perform a positive/negative respirator fit test each time it enters the work area. If leakage occurs, the respirator must be re-adjusted or replaced.

c. Workers shall maintain their respirators in a safe operating condition. The condition of respirators shall be checked daily.

d. Workers and visitors shall complete the decontamination procedures as outlined in the specification upon exiting the work area.

e. Workers shall not eat, drink, smoke, or chew gum or tobacco in or near the asbestos work areas.

f. Workers shall be fully protected with respirators and protective clothing immediately prior to the first disturbance of asbestos-containing or contaminated materials and until final cleanup is completed.

O. Air Monitoring

1. The airborne fiber counts outside the work area will be monitored to detect faults in the work area isolation such as contamination of the building outside of the work areas with airborne asbestos fibers, failure of filtration or rupture in the negative pressure system.
   Should any of the above occur, the Contractor shall immediately cease asbestos abatement activities until the fault is corrected. Work shall not recommence until authorized by the Owner's Representative. In the case of mini-enclosures the Owner's Representative will monitor air in a remote location of the residence to determine the baseline of asbestos.

2. The airborne fiber counts in the work area will be monitored. The purpose of this air monitoring will be to detect airborne fiber counts which may significantly challenge the ability of the work area isolation procedures to protect the balance of the building or outside of the building from contamination by airborne fibers. In the case of mini-enclosures the Owner's representative may monitor air outside of several enclosures if they are in close proximity.

3. Contractor shall maintain an average airborne count inside the work area of less than 0.5 f/cc. If the fiber counts rise above this figure for any sample taken, revise work procedures to lower fiber counts. If the TWA fiber count for any work shift or eight-hour period exceeds 0.5 f/cc, stop all work, leave pressure differential system in operation and notify the Owner's Representative. Do not recommence work until authorized in writing by the Owner's Representative.

4. If airborne fiber counts exceed 1.0 f/cc for any period of time cease all work until fiber counts fall below 0.5 f/cc and notify the Owner's Representative. Do not recommence work until authorized in writing by the Owner's Representative.

5. If any air sample taken outside of the work area exceeds the 0.01 f/cc of air, Contractor shall immediately and automatically stop all work. If this air sample was taken inside the building and outside of critical barriers around the work area, immediately erect new critical barriers to isolate the affected area from the balance of the building. Erect Critical Barriers at the next existing structural isolation of the involved space (e.g., wall, ceiling, and floor). Leave Critical Barriers in

place until completion of work and insure that the operation of the negative pressure system in the work area results in a flow of air from the balance of the building into the affected area.

6. If the exit from the clean room of the personnel decontamination unit enters the affected area, establish a temporary decontamination facility consisting of a shower room and changing room. After cleaning and decontamination of the affected area remove the shower room and leave the changing room in place as an air lock.
7. After certification of visual inspection in the work area, remove critical barriers separating the work area from the affected area. Final air samples will be taken within the entire area.
8. The following procedure will be used to resolve any disputes regarding fiber types when a project has been stopped due to excessive airborne fiber counts. "Airborne Fibers" referred to above include all fibers regardless of composition as counted in the Phase Contrast Microscopy (PCM) NIOSH 7400 Method procedures. If work has stopped due to high airborne fiber counts, air samples will be secured in the same area by the Owner's Representative for analysis by electron microscopy. "Airborne fibers" counted in samples analyzed by Scanning or Transmission Electron Microscopy (TEM) shall be only asbestos fibers, but of any diameter and length. Subsequent to analysis by Electron Microscopy the number of airborne fibers shall be determined by multiplying the number of fibers, regardless of composition, counted by the PCM NIOSH 7400 Method procedure by a number equal to asbestos fibers counted divided by all fibers counted in the electron microscopy analysis.
9. If electron microscopy is used to arrive at the basis for determining airborne fiber counts in accordance with the above paragraph, and if the average of airborne asbestos fibers in all samples taken exceeds 0.1 f/cc, or if any one sample exceeds 0.2 f/cc, then the cost of such analysis will be born by the Contractor, at no additional cost to the Owner.
10. the Owner's Representative will secure at least the following air samples to establish a base line before start of work involving large enclosures:

Location Sampled	**Number of Samples**	**Analysis Method**	**Detection Limit f/cc**	**Minimum Volume Liters**	**Rate LPM**
Each Work Area	1	PCM	0.01	1,900	2-16
Outside Each Work Area	1-3	PCM	0.01	1,900	2-16

11. Base Line is an action level expressed in f/cc, which is ten percent greater than the largest of the following:
    a. Average of the samples collected on cellulose ester filters outside each work area.
    b. Average of the samples collected on cellulose ester filters outside the building.
    c. 0.01 fibers per cubic centimeter.
12. Daily: From start of work of Paragraph "Temporary Enclosure" through the work of Paragraph "Project Decontamination," the Owner may be taking the following samples on a daily basis. The location of each air sample will be determined by the Owner's Representative.
    a. Baseline
    b. Work Area
13. For larger enclosures samples will be collected on 25 mm cassettes with the following filter medial:
    PCM: 0.8 micrometer mixed cellulose ester.

Location Sampled	Number of Samples	Analysis Method	Detection Limit f/cc	Minimum Volume Liters	Rate LPM
Each Work Area	2	PCM	0.01	1,900 as required by conditions	2-16
Outside Each Work Area Critical Barrier	1	PCM	0.01	1,900	2-16
Clean Room	1	PCM	0.01	1,900	2-16
Equip Decon	1	PCM	0.01	1,900	2-16

14. Additional samples may be taken at the Owner or the Owner's Representative discretion. If airborne fiber counts exceed allowed limits, additional samples will be taken as necessary to monitor fiber levels.
15. The services of a testing laboratory will be employed by the Owner to perform laboratory analysis of the air samples. Samples will be sent daily so that verbal reports on air samples can be obtained in a timely manner. A complete record, certified by the testing laboratory, of all air monitoring tests and results will be furnished to the Owner's Representative, the Owner and the Contractor.
16. Air samples may be analyzed on site by the Owner's Representative, if they are to be analyzed by the NIOSH 7400 Method.
17. Cellulose ester filters will be analyzed using the PCM NIOSH 7400 Method. Thus analysis will be carried out at a laboratory located off the job site.
18. At the completion of the work in occupied areas and prior to the dismantling of the isolation system, final air clearance will be conducted by the Owner's Representative.
19. Decontamination of the work area will be considered complete when all samples indicate fiber levels are less than 0.0l f/cc of air as analyzed by PCM NIOSH 7400 Method or an average of less than 70 structures per square millimeter of filter area as analyzed by TEM; Level II AHERA Method.
20. The Contractor may conduct its own air monitoring and laboratory testing. If it elects to do this the cost of such air monitoring and laboratory testing shall be included in the Contract Sum.

P. Equipment Removal Procedures
1. Clean all external surfaces of contaminated waste containers and equipment thoroughly by wet sponging or HEPA vacuuming before moving such items into the equipment decontamination enclosure system washroom for final cleaning and removal to uncontaminated areas. Ensure that personnel do not leave the work areas through the equipment decontamination enclosure system.

Q. Disposal Activities
1. It is the responsibility of the Contractor to comply with current federal, state and local regulations concerning the waste handling, transportation, and disposal of asbestos-containing material (ACM) and accompanying solvents or residues.
2. The Contractor will document actual disposal of the waste at the designated landfill by completing Disposal Certificate or submitting proof of landfill receipt.

1.2 PRODUCTS

A. Materials
1. All Contractor's equipment delivered to the site shall be free of asbestos contamination.
2. Store all materials subject to damage off the ground, away from wet or damp surfaces, and under cover sufficient to prevent damage or contamination.
3. Damaged or deteriorating materials shall not be used and shall be removed from the premises. Materials that become contaminated shall be disposed of in accordance with applicable regulations.
4. Polyethylene flame retardant sheet of 6-mil thickness shall be used unless otherwise specified. Polyethylene sheeting shall be sized to minimize the frequency of joints. Polyethylene sheeting must satisfy the National Fire Prevention Association Standard 701, "Small Scale Fire Test for Flame Resistant Textile and Film."
5. Adhesive tape shall be capable of sealing joints of adjacent sheets of polyethylene and for use in attachment of polyethylene sheet to finished or unfinished surfaces of similar materials and shall be capable of adhering under dry and wet conditions, including use of amended water. Contractor shall use adhesive tape compatible with finished surfaces.

6. Protective devices such as, but not limited to, disposable clothing, respirators, gloves, hard hats, etc. shall be used.
7. Wetting agent shall be a mixture of 50/50 polyoxyethylene ether and polyglycol ester or equivalent commercial product.
8. Encapsulant materials shall be the bridging and penetrating type and conform with the following characteristics:
   a. Encapsulants shall not be solvent-based or utilize a hydrocarbon in the liquid in which the solid parts of the encapsulant are suspended.
   b. Encapsulant shall not be flammable.
9. A non-hardening lagging sealer for enclosing and sealing raw exposed edges and surfaces of asbestos-containing materials.
10. Pre-mixed or job mixed insulating plaster manufactured for use on plumbing equipment shall be used when repairing damaged thermal insulation material.
11. Non-woven fibrous glass mat and open weave glass fiber mat cloth for repair of thermal systems insulation.
12. Fire retardant sealant shall prevent fire, smoke, water and toxic fumes from penetrating through sealants. Sealant shall have a flame spread, smoke and fuel contribution of zero, and shall be ASTM and Underwriter's Laboratory (UL) rated for three hours for standard method of fire test for fire stop systems.

B. Tools And Equipment
1. Provide suitable tools for repair and encapsulation of asbestos-containing materials and for removal of asbestos-containing materials that are beyond repair. Wire brushes shall not be used as a means of removing or cleaning asbestos-containing materials from surfaces, if they are used as the surface is being sprayed with water or amended water.
2. Provide sufficient number of HEPA-filtered vacuum cleaners equipped with pick-up adapters, steel floor wands, crevice tools, and carpet tools.
3. Airless sprayers capable of spraying amended water shall be provided in sufficient number to allow continuous uninterrupted work.
4. Asbestos filtration devices shall utilize high efficiency particulate air (HEPA) filtration systems.
5. Transportation equipment, as required, shall be suitable for loading, temporary storage, and unloading of contaminated waste without exposure to persons or property, and shall be quiet in motion if used within the building.

1.3 EXECUTION

A. Safety Procedures For Power And Lighting
1. The use of wet methods for removal, repair, encapsulation or cleaning procedures increases the potential for electrical shock when working around electrical panels, conduit, light fixtures, alarm systems, junction boxes, transformers, etc. In coordination with the Owner, de-energize as much electrical equipment as possible to prevent electrical shock to employees performing the work. The Contractor shall use the following precautions:
   a. Use non-conductive tools and vacuum attachments.
   b. Utilize "hot line" covers over energized cables and power lines when possible.
   c. Ensure all electrical equipment in use is properly grounded before the job starts. Check outlets, wiring, extension cords and power pickups.
   d. Avoid stringing wiring across floors. Elevate wiring if possible.
   e. Ensure electrical outlets are tightly sealed and taped to avoid water spray.
   f. Determine operating voltages of equipment and lines before working on or near energized parts.
   g. Energized parts must be insulated or guarded from employee contact and other conductive objects. Extension cords must be three-wire type and connected to a Ground Fault Interrupter (GFI) circuit.
   h. Lock or secure de-energized circuits at panel and post warning signs.

i. Seal heating vents with two layers of polyethylene sheeting prior to the start of work. The Contractor shall repair any damage caused by Contractor's operations to duct work, grilles, dampers, louvers or HVAC equipment at the completion of the work at Contractor's expense. Coordinate all lock out and or de-energizing with the Owner.

B. Temporary Facilities

1. Use qualified tradesmen for installation of temporary services and facilities. Locate temporary services and facilities where they will serve the entire project adequately and result in minimum interference with the performance of the work and operations of the building. Coordinate all installations and shut downs with building owner.
2. Relocate, modify and extend services and facilities as required during the course of work so as to accommodate the entire work of the project.
3. Provide new or used materials and equipment that are undamaged and in serviceable condition. Provide only materials and equipment that are recognized as being suitable for the intended use, by compliance with appropriate standards.
4. During the erection and/or moving of scaffolding, care must be exercised so that the polyethylene floor covering is not damaged.
5. Clean, as necessary, debris from non-slip surfaces.
6. At the completion of abatement work, clean all construction aids within the work area, wrap in one layer of 6-mil polyethylene sheet and seal before removal from the work area.
7. Temporary water service connections to the Owner's water system shall include back flow protection. Valves shall be temperature and pressure rated for operation of the temperatures and pressures encountered.
8. Employ heavy-duty abrasion-resistant hoses with a pressure rating 50 percent greater than the maximum pressure of the water distribution system to provide water into each work area and to each Decontamination Unit. Provide fittings as required to allow for connection to existing wall hydrants or spouts, as well as temporary water heating equipment, branch piping, showers, shut-off nozzles and equipment.
9. Electrical Services shall comply with applicable NEMA, NECA and UL standards and governing regulations for materials and layout of temporary electric service.
10. Provide a weatherproof, grounded temporary electric power service and distribution system of sufficient size, capacity, and power characteristics to accommodate performance of work during the construction period. Install temporary lighting adequate to provide sufficient illumination for safe work and traffic conditions in every area of work.
11. Provide receptacle outlets equipped with ground fault circuit interrupters, reset button and pilot light, for plug-in connection of power tools and equipment.
12. Use only grounded extension cords; use "hard-service" cords where exposed to abrasion and traffic. Use single lengths or use waterproof connectors to connect separate lengths of electric cords, if single lengths will not reach areas of work. All cords shall be elevated off the floor inside the containment area.
13. Temporary wiring in the work area shall be type UL non-metallic sheathed cable located overhead and exposed for surveillance. Do not wire temporary lighting with plain, exposed (insulated) electrical conductors. Provide liquid tight enclosures or boxes for wiring devices.
14. Provide Type "A" fire extinguishers for temporary offices and similar spaces where there is minimal danger of electrical or grease-oil-flammable liquid fires. In other locations provide type "ABC" dry chemical extinguishers, or a combination of several extinguishers of NFPA recommended types for the exposures in each case.
15. Use of the Owner's existing toilet facilities, as indicated, will be permitted, so long as these facilities are properly cleaned and maintained in a condition acceptable to the Owner. At Final Completion, restore these facilities to the condition prevalent at the time of initial use. All provisions of these specifications regarding leaving the work area must be met.
16. When mini-enclosures area being used all of the requirements above will be enforced by the Owner's Representative. The construction and set-up of the mini-enclosures may be done by the Abatement Contractor.

C. Pressure Differential System

1. Before start of work Contractor shall submit design of pressure differential system to the Owner's Representative for review. Do not begin work until system has been approved by the Owner's Representative. Include in the submittal the following:
   a. Number of pressure differential machines required and the calculations necessary to determine the number of machines.
   b. Description of projected air-flow within work area and methods required to provide adequate air flow in all portions of the work area.
2. If the enclosure is not a mini-enclosure, the Contractor must supply the required number of asbestos air filtration units to the site in accordance with these specifications. Each unit shall include the following:
   a. Cabinet constructed of steel or other durable materials able to withstand damage from rough handling and transportation. The width of the cabinet should be less than 30 inches to fit through standard-size doorways. Cabinet shall be factory sealed to prevent asbestos-containing dust from being released during use, transport, or maintenance. Access to and replacement of all air filters shall be from intake end. Unit shall be mounted on casters or wheels.
   b. Rate capacity of fan according to useable air-moving capacity under actual operating conditions. Use centrifugal-type fan.
   c. The final filter shall be the HEPA type. The filter media (folded into closely pleated panels) must be completely sealed on all edges with a structurally rigid frame.
   d. A continuous rubber gasket shall be located between the filter and the filter housing to form a tight seal.
   e. Provide HEPA Units that are individually tested and certified on site by an independent testing agency to have an efficiency of not less than 99.97 percent when challenged with 0.3 m dioctylphthlaate (DOP) particles when tested in accordance with Military Standard Number 2182 and Army Instruction Manual 136-300-175A. Provide filters that bear a UL586 label to indicate ability to perform under specified conditions.
   f. Pre-filters, which protect the final filter by removing the larger particles, are required to prolong the operating life of the HEPA filter. Two stages of pre-filtration are required. The first-stage pre-filter shall be a low-efficiency type (e.g., for particles 10 microns and larger). The second-stage (or intermediate) filter shall have a medium efficiency (e.g., effective for particles down to 5 microns). Pre-filters and intermediate filters shall be installed either on or in the intake grid of the unit and held in place with special housings or clamps.
   g. Each unit shall be equipped with a Magnahelic gauge or manometer to measure the pressure drop across filters and indicate when filters have become loaded and need to be changed. A table indicating the useable air-handling capacity for various static pressure readings on the Magnahelic gauge shall be affixed near the gauge for reference, or the Magnahelic reading indicating at what point the filters should be changed, noting Cubic Feet per Minute (CFM) air delivery at that point. Provide units equipped with an elapsed time meter to show the total accumulated hours of operation.
   h. The unit shall have an electrical (or mechanical) lockout to prevent fan from operating without a HEPA filter. Units shall be equipped with automatic shutdown system to stop fan in the event of a major rupture in the HEPA filter or blocked air discharge. Warning lights are required to indicate normal operation, too high a pressure drop across the filters (i.e., filter overloading), and too low of a pressure drop (i.e., major rupture in HEPA filter or obstructed discharge).
   i. Electrical components shall be approved by the National Electrical Manufacturers Association (NEMA) and Underwriters' Laboratories (UL). Each unit shall be equipped with overload protection sized for the equipment. The motor, fan, fan housing, and cabinet shall be grounded.
   j. If a mini-enclosure is used the air filtration unit may be a HEPA filtered vacuum with a flow rate of at least 100 cubic feet per minute (CFM).
3. Provide a fully operational pressure differential system within the work area maintaining continuously a pressure differential across work area enclosures of 0.02 inches of water for glove

bag operations and mini-containments**.** Demonstrate to the Owner's Representative the pressure differential by use of pressure differential meter or a manometer, before disturbance of any asbestos-containing materials. In the case of a mini-enclosure visual evidence of pressure differential through the use of a smoke generation tube shall be sufficient as in paragraph C.13 of this section.

4. Continuously monitor and record the pressure differential between the work area and the building outside of the work area.
5. Provide fully operational negative pressure systems supplying a minimum of one air change every ten minutes (six changes per hour), less in the instance of a mini-enclosure. Determine the volume in cubic feet of the work area by multiplying floor area by ceiling height. Determine total ventilation requirement in cubic feet per minute (cfm) for the work area by dividing this volume by the air change rate.
6. Ventilation Required (CFM) = Volume of work area (cu. ft.)/10 min.
7. Determine number of units needed to achieve ten-minute change rate by dividing the ventilation requirement (CFM) above capacity of exhaust unit(s) used. Capacity of a unit for purposes of this section is the capacity in cubic feet per minute with fully loaded filters (pressure differential which causes loaded filter warning light to come on) in the machines labeled operating characteristics.
8. Add one additional unit as a backup in case of equipment failure or machine shutdown for filter changing.
9. Locate exhaust unit(s) so that makeup air enters work area primarily through decontamination facilities and traverses work area as much as possible. This may be accomplished by positioning the unit(s) at a maximum distance from the worker access opening or other makeup air sources.
10. Vent to outside of building, unless authorized in writing by the Owner's Representative.
11. Each unit shall be serviced by a dedicated minimum 115v-20A circuit with overload device tied into an existing building electrical panel which has sufficient spare capacity to accommodate the load of all pressure differential units connected. Dedication of an existing circuit may be accomplished by shutting down existing loads on the circuit.
12. Test pressure differential system before any asbestos-containing material is wetted or removed. After the work area has been prepared, the decontamination facility set up, and the exhaust unit(s) installed, start the unit(s) (one at a time). Demonstrate operation and testing of pressure differential system to the Owner's Representative.
13. Demonstrate of operations of the pressure differential system to the Owner's Representative will include, but not be limited to, the following:
    a. Plastic barriers and sheeting move lightly in toward work area.
    b. Curtain of decontamination units move lightly in toward work area.
    c. There is a noticeable movement of air through the decontamination unit. Use stroke tube to demonstrate air movement from clean room, and from equipment room to work area.
    d. Use smoke tubes to demonstrate a positive motion of air across all area in which work is to be performed.
    e. Use a differential pressure meter or manometer to demonstrate a pressure difference of at least 0.02 inches (as allowed) of water across every barrier separating the work area from the balance of the building or outside. This is not required in the case of a mini enclosure.
14. Start exhaust units before beginning work (before any asbestos-containing material is disturbed). After abatement work has begun, run units continuously to maintain a constant negative pressure until decontamination of the work area is complete. Do not turn off units at the end of the work shift or when abatement operations temporarily stop.
15. Do not shut down pressure differential system during encapsulating procedures, unless authorized by the Owner's Representative in writing. Start abatement work at a location farthest from the exhaust units and proceed toward them. If an electric power failure occurs, immediately stop all abatement work and do not resume until power is restored and exhaust units are operating again.
16. At completion of abatement work, allow exhaust units to run as specified to remove airborne fibers that may have been generated during abatement work and cleanup and to purge the work area with clean makeup air. The units may be required to run for a longer time after decontamination, if

dry or only partially wetted asbestos material was encountered during any abatement work. In the case of a mini-enclosure the vacuum may be removed and the entrance sealed following encapsulation until the clearance sample is collected.

17. Prior to final air test, remove pre-filter and wipe out inside lip of negative air machine.
18. When a final inspection and the results of final air tests indicate that the area has been decontaminated, exhaust units may be removed from the work area. Before removal from the work area, remove and properly dispose of pre-filter, and seal Intake to the machine with 6-mil polyethylene to prevent environmental contamination from the filters.

D. Work Area Preparation

1. The work area is the location where asbestos-abatement work occurs. It is a variable of the extent of work of the contract. It may be a portion of a room, a single room, or a complex of rooms. A "work area" is considered contaminated during the work, and must be isolated from the balance of the building, and decontaminated at the completion of the asbestos-control work.
2. Pre-clean fixed objects, walls and floor surfaces within the proposed work areas using HEPA filtered vacuum equipment and wet cleaning methods as appropriate.
3. Seal all openings, supply and exhaust vents, and convectors within ten feet of the work area with 6-mil polyethylene sheeting secured and completely sealed with plastic adhesion tape.
4. Contact fire control agencies to review procedures prior to start of work.
5. Provide flame resistant polyethylene sheeting that conforms to requirements set forth by the National Fire Protection Association Standard 701, Small Scale Fire Test for Flame-resistant Textiles and Films. Provide largest size possible to minimize seams, four- or six- mils thick, frosted or black.
6. Provide spray adhesive in aerosol cans which is specifically formulated to stick tenaciously to sheet polyethylene and supporting surface.
7. Completely isolate the work area from other parts of the building so as to prevent asbestos-containing dust or debris from passing beyond the isolated area. Should the area beyond the work area(s) become contaminated with asbestos-containing dust or debris as a consequence of the work, clean those areas in accordance with the procedures indicated in Paragraph "Decontamination Procedures." All such required cleaning or decontamination shall be performed at no additional cost to the Owner.
8. Place all tools (i.e., scaffolding, staging) necessary for the work in the area to be isolated prior to erection of plastic sheeting temporary enclosure.
9. Disable ventilation systems or any other system bringing air into or out of the work area. Disable system by disconnecting wires, removing circuit breakers, by lockable switch or other positive means that will prevent accidental premature restarting of equipment.
10. Remove and dispose of all electrical and mechanical items, such as lighting fixtures, clocks, diffusers, registers, escutcheon plates, etc., which cover any part of the surface on which work is to be performed.
11. All general construction items such as cabinets, casework, doors and window trim, moldings, ceilings, trim, etc., which cover the surface of the work as required to prevent interference with the work. To be performed by the Owner: clean, decontaminate and reinstall all such materials, upon completion of all removal work with materials, finishes, and workmanship to match existing installations before start of work.
12. Permit Access to the work area only through the Decontamination Unit. All other means of access shall be closed off and sealed and warning signs displayed on the clean side of the sealed access.
13. Provide Warning Signs at each visual and physical barriers reading as follows in both English and Spanish:

Legend	Notation
KEEP OUT	3" Sans Serif Gothic or Block
BEYOND THIS POINT	1" Sans Serif Gothic or Block
ASBESTOS ABATEMENT WORK	1" Sans Serif Gothic or Block

IN PROGRESS BREATHING ASBESTOS DUST MAY BE HAZARDOUS TO YOUR HEALTH	1" Sans Serif Gothic or Block 14 Point Gothic

14. Alternate methods of containing the work area may be submitted to the Owner's Representative for approval. Do not proceed with any such method(s) without prior written approval of the Owner's Representative.
15. Individually seal all ventilation openings (supply and exhaust), lighting fixtures, clocks, doorways, windows, convectors and speakers, and other openings into the work area with plastic adhesion tape alone or with polyethylene sheeting at least 4-mil in thickness, taped securely in place with plastic adhesion tape. Maintain seal until all work including Project Decontamination is completed. Take care in sealing off lighting fixtures to avoid melting or burning of sheeting.
16. Provide sheet plastic barriers at least 6-mil in thickness as required to completely seal openings from the work area into adjacent areas. Seal the perimeter of all sheet plastic barriers with plastic adhesion tape or spray cement.
17. Where applicable, construct framing of the containment out of fire treated wood or aluminum studs. Mini-enclosure frames may be constructed of Polyvinyl Chloride (PVC) tubing.
18. Cover all walls in work area extending to the underside of the ceiling grid system with one layer of polyethylene sheeting, at least 6-mil in thickness, mechanically supported and sealed with plastic adhesion tape or spray-glue in the same manner as "Critical Barrier" sheet plastic barriers. Tape all joints with plastic adhesion tape. Contractor shall be responsible for repair of damaged wall finishes.
19. Cover floor with two layers of 6-mil polyethylene sheeting (exclude for floor tile and adhesive).
20. Provide Pressure Differential System per Paragraph “Pressure Differential System.”
21. If the enclosure barrier is breached in any manner that could allow the passage of asbestos debris or airborne fibers, then add the affected area to the work area, enclose it as required by this section of the specification and decontaminate it as described in Paragraph “Decontamination Procedures.”
22. Establishing a Mini-Containment area:
    a. Establish work area so that unauthorized entry is prevented; Construct a two-compartment fire treated wood frame around work area; install one layer 6-mil polyethylene sheeting to structural members and two layers 6 mil polyethylene sheeting to the floor. Exception: no floor required if mini-containment is being constructed to perform a floor tile activity. Seal all edges to wall, ceiling, and floor surfaces with duct tape. Install viewing inspection windows, where feasible.
    b. Seal all penetrations with duct tape such as pipes, electrical conduit, or ducts contained within the mini-containment.
    c. Install triple 6-mil polyethylene flaps at both doorways. Place portable sprayer with clean water, disposable towels, and pre-labeled disposal bag in air lock.
    d. Install appropriate signs on outside of mini-containment area.
    e. Install HEPA vacuum; extend hose into mini-containment area for general vacuuming, negative air, and cleaning of disposal suit.
    f. Accumulate all loose materials for disposal. Place in approved container. Apply appropriate labels. Adequately wet clean all wall, floor, tool and equipment surfaces.
    g. Abatement worker must wear two disposable suits. Remove outer suit in work area and place in a plastic bag. Enter air lock.
    h. In air lock, wet wipe respirator and wash hands with clean water. Remove respirator and place in a clean plastic bag. Proceed to remote shower unit where inner suit may be removed.

E. Worker Protection
    1. This section describes the equipment and procedures required for protecting workers against asbestos contamination and other work place hazards except for respiratory protection.
    2. Respiratory Protection is specified in Paragraph “Respiratory Protection.”

3. Train in accordance with EPA's Model Accreditation Plan, 40 CFR 763 - Asbestos, all workers in the dangers inherent in handling asbestos and breathing asbestos dust and in proper work procedures and personal and area protective measures. Include but do not limit the topics covered in the course to the following:
   a. Methods of recognizing asbestos.
   b. Health effects associated with asbestos.
   c. Relationship between smoking and asbestos in producing lung cancer.
   d. Nature of operations that could result in exposure to asbestos.
4. Importance of and instruction in the use of necessary protective controls, practices and procedures to minimize exposure including:

   Engineering controls
   Work practices
   Respirators
   Housekeeping procedures
   Hygiene facilities
   Protective clothing
   Decontamination procedures
   Emergency procedures
   Waste disposal procedures
   Appropriate work practices for the work
   Requirements of medical surveillance program
   Review of OSHA 29 CFR 1926.1101(k)(9)(viii)(G) - Asbestos
   Pressure differential systems
   Work practices including hands on or on job training
   Personal decontamination procedures
   Air monitoring, personal and area

5. Provide medical examinations for all workers who may encounter an airborne fiber level of 0.1 f/cc or greater for an 8 hour time weighted average. In the absence of specific airborne fiber data, provide medical examination for all workers who will enter the work area for any reason. Examination shall, at minimum, meet OSHA requirements as set forth in 29 CFR 1926.1101(k)(9)(viii)(G) - Asbestos. In addition, provide an evaluation of the individual's ability to work in environments capable of producing heat stress in the worker.
6. Before start of work Contractor shall submit the following to the Owner's Representative for review. Do not start work until receipt of the Owner's Representative.
   a. An original signed copy of the Certificate of Worker's Acknowledgement found at the end of this specification, for each worker who is to be at the job site or enter the work area.
   b. Courses outline or name of institution providing the worker training course.
   c. Report from medical examination conducted within last 12 months as part of compliance with OSHA medical surveillance requirements for each worker who is to enter the work area.
7. Provide disposable full-body coveralls and disposable head covers, and require that they be worn by all workers in the work area. Provide a sufficient number for all required changes, for all workers in the work area.
8. Provide work boots with non-skid soles, and where required by OSHA, foot protectives, for all workers. Provide boots at no cost to workers. Paint uppers of all boots red with water proof enamel. Do not allow boots to be removed from the work area for any reason, after being contaminated with asbestos-containing material. Dispose of boots as asbestos contaminated waste at the end of the work.
9. Provide head protectives (hard hats) as required by OSHA for all workers, and provide four spares for use by the Owner's Representative, and the Owner. Label hats with same warning labels as used on disposal bags. Require hard hats to be worn at all times that work is in progress that may potentially cause head injury. Provide hard hats with plastic strap type suspension. Require hats

to remain in the work area throughout the work. Thoroughly clean, decontaminate and bag hats before removing them from work area at the end of the work.

10. Provide eye protectives (goggles) as required by OSHA for all workers involved in scraping, spraying, or any other activity which may potentially cause eye injury.
11. Provide work gloves to all workers and require that they be worn at all times in the work area. Do not remove gloves from work area. Dispose of gloves as asbestos contaminated waste at the end of the work.
12. Respirators, disposable coveralls, head covers, and footwear covers shall be provided by the contractor for the Owner, the Owner's Representative, and other authorized representatives who may inspect the job site.
13. Provide worker protection as required by the most stringent OSHA and/or EPA standards applicable to the work. The following procedures are minimums to be adhered to regardless of fiber count in the work area.
14. Each time work is entered, remove all street clothes in the changing room of the Personnel Decontamination Unit and put on new disposable coverall, new head cover, and a clean respirator. Proceed through shower room to equipment room and put on work boots.
15. In the event a mini-enclosure is used refer to Paragraph "Work Area Preparation" for personal decontamination procedures.

F. Respiratory Protection

1. Instruct and train each worker involved in asbestos abatement or maintenance and repair of friable asbestos-containing materials in proper respiratory use and require that each worker always wear a respirator, properly fitted on the face in the work area from the start of any operation which may cause airborne asbestos fibers until the work area is completely decontaminated. Use respiratory protection appropriate for the fiber level encountered in the work place or as required for other toxic or oxygen-deficient situations encountered.
2. Except to the extent that more stringent requirements are written directly into the Contract Documents, the following regulations and standards have the same force and effect (and are made a part of the Contract Documents by reference) as if copied directly into the Contract Documents, or as if published copies were bound herewith. Where there is a conflict in requirements set forth in these regulations and standards meet the more stringent requirement.
    a. OSHA - U.S. Department of Labor Occupational Safety and Health Administration, Safety and Health Standards 29 CFR 1910, Section 1001 and Section 1910.134.29 CFR 1926.
    b. ANSI - American National Standard Practices for Respiratory Protection. ANSI Z88.2-1980.
    c. NIOSH - National Institute for Occupational Safety and Health.
    d. MSHA - Mine Safety and Health Administration.

G. Type Of Respiratory Protection Required

1. Provide Respiratory Protection as indicated in paragraph below. Where paragraph below does not apply, determine the proper level of protection by dividing the expected or actual airborne fiber count in the work area by the "protection factors" given below. The level of respiratory protection which supplies an airborne fiber level inside the respirator, at the breathing zone of the wearer, at or below 0.01 fibers/cubic centimeter is the minimum level of protection allowed.
2. Eight-hour Time Weighted Average (TWA) of asbestos fibers to which any worker may be exposed shall not exceed 0.1 fibers/cubic centimeter.
3. For purposes of this section fibers are defined as all fibers regardless of composition as counted in the OSHA Reference Method (ORM), NIOSH P&CAM 239 or 7400 procedure, or asbestos fibers of any size as counted using either a scanning or transmission electron microscope.
4. Require that respiratory protection be used at all times that there is any possibility of disturbance of asbestos-containing materials whether intentional or accidental.
5. Require that a respirator be worn by anyone in a work area at all tunes, regardless of activity, during a period that starts with any operation which could cause airborne fibers until the area has been cleared for re-occupancy.

H. Respiratory Protection Factor

Respirator Type	Protection Factor
Air purifying: Negative pressure respirator High efficiency filter Half facepiece	10
Air purifying: Negative pressure respirator High efficiency filter Full facepiece	50
Powered-air purifying (PAPR): Positive pressure respirator High efficiency filter Half or Full facepiece	100
Type C supplied air: Positive pressure respirator continuous-flow Half or full facepiece	100
Type C supplied air: Positive pressure respirator pressure demand Full facepiece	1000
Type C supplied air: Positive pressure respirator pressure demand Full facepiece Equipped with an auxiliary positive pressure Self-contained breathing apparatus (SCBA)	over 1000
Self-contained breathing apparatus (SCBA): Positive Pressure respirator Pressure demand Full facepiece	over 1000

I. Air Purifying Respirator

1. Provide half face or full face type respirators. Equip full-face respirators with a nose cup or other anti-fogging device as would be appropriate for use in air temperatures less than 32 degrees Fahrenheit.
2. Provide, at a minimum, HEPA type filters labeled with NIOSH and MSHA certification for "Radionuclides, Radon Daughters, Dust, Fumes, Mists including Asbestos-Containing Dusts and Mists" and color coded in accordance with ANSI Z228.2 (1980). In addition, a chemical cartridge section may be added, if required, for solvents, etc., in use. In this case, provide cartridges that have each section of the combination canister labeled with the appropriate color code and NIOSH/MSHA Certification.
3. Supply with a sufficient quantity of respirator filters approved for asbestos, so that workers can change filters during the work day. Require that respirators be wet-rinsed, and filters discarded, each time a worker leaves the work area. Require that new filters be installed each time a worker re-enters the work area. Store respirators and filters at the job site in the changing room and protect totally from exposure to asbestos prior to their use. Do not use single use, disposable or quarterface respirators.

J. Powered Air Purifying Respirator (PAPR)
   1. Provide full-facepiece type respirators. Provide nose-cups for full-facepiece respirators. Provide, at a minimum, HEPA type cartridges approved by NIOSH/MSHA and certified for use in atmospheres containing asbestos dusts.
   2. Provide, at a minimum, one extra battery pack for each respirator so that one can be charging while one is in use.
   3. Provide non-cloth belts capable of being decontaminated in shower.
   4. Supply with a sufficient quantity of high efficiency respirator filters approved for asbestos so that workers can change filters at any time that flow through the face piece decreases to the level at which the manufacturer recommends filter replacement. Require that regardless of flow, filter cartridges be replaced after 40 hours of use. Require that HEPA elements in filter cartridges be protected from wetting during showering. Require entire exterior housing of respirator including blower unit, filter cartridges, hoses, battery pack, face mask, belt, and cords to be washed each time a worker leaves the work area. Caution should be used to avoid shorting battery pack during washing.

K. Required Respiratory Protection
   1. Regardless of airborne fiber levels, require the following minimum level of respiratory protection:
      a. Half-face air purifying respirators may be used during set-up of the containment and removal of the material so long as fiber counts inside the respirator do not exceed .01 f/cc fibers per cubic centimeter.

L. Decontamination Units -Three-Stage
   1. Provide a Personnel Decontamination Unit consisting of a serial arrangement of rooms or spaces, Changing Room, Shower Room, Equipment Room adjacent to each full containment area.
   2. Require all persons without exception to pass through this decontamination unit for entry into and exiting from the work area for any purpose. Do not remove equipment or materials through Personnel Decontamination Unit.
   3. Changing (Clean) Room:
      a. Provide a room that is physically and visually separated from the rest of the building for the purpose of changing into protective clothing.
      b. Locate so that access to work area from changing room is through shower room.
      c. Separate changing room from the building by a double-sheeted polyethylene flapped doorway.
      d. Provide sub-panel at changing room to accommodate all removal equipment. Power sub-panel directly from a building electrical panel. Connect all electrical branch circuits in decontamination unit and particularly any pumps in shower room to a ground-fault circuit protection device.
   4. Shower Room:
      a. Provide a completely water tight operational shower to be used for transit by cleanly dressed workers heading for the work area from the changing room, or for showering by workers headed out of the work area after undressing in the equipment room.
      b. Construct room by providing a shower pan and two shower walls in a configuration that will cause water running down walls to drip into pan. Install a freely draining wood floor in shower pan at elevation of top of pan.
      c. Separate this room from rest of building, drying room and airlock with airtight walls fabricated of 6-mil polyethylene.
      d. Provide splash proof entrances to Drying Room and Airlock.
   5. Equipment Room (contaminated area):
      a. Require work equipment, footwear and additional contaminated work clothing to be left here. This is a change and transit area for workers. Separate this room from the work area by a 6-mil polyethylene flap doorway.
      b. Separate this room from the rest of the building, the shower room and work area with air tight walls fabricated of 6-mil polyethylene.

6. Clean Room: Provide Clean Room to isolate the holding room from the building exterior.
7. Load-out Area:
   a. The load-out area is the transfer area from the building to a truck or dumpster.
   b. Wet wipe bags before they are passed through the equipment decon-chamber.
   c. When cleaning is complete pass items into holding room. Close all doorways except the doorway between the holding room and the Clean Room.
   d. Workers from the area outside the containment area enter holding area and remove decontaminated equipment and/or containers for disposal.
   e. Require these workers to wear full protective clothing and appropriate respiratory protection.
   f. At no time is a worker from an uncontaminated area to enter the enclosure when a removal worker is inside.
   g. Post an approximately 20 inch x 14 inch manufactured caution sign at each entrance to the work area displaying the following legend with letter sizes and styles of a visibility required by OSHA 29 CFR 1926.1101(k)(9)(viii)(J) - Asbestos.

LEGEND
DANGER

ASBESTOS

CANCER AND LUNG DISEASE HAZARD
RESPIRATORS AND PROTECTIVE CLOTHING ARE REQUIRED
IN THIS AREA

   h. Provide spacing between respective lines at least equal to the height of the respective upper line.
   i. Additional Signage: Shall also be posted in accordance with OSHA 29 CFR 1926.1101(k)(9)(viii)(J) - Asbestos

DANGER
ASBESTOS
CANCER AND LUNG DISEASE HAZARD

AUTHORIZED PERSONNEL ONLY
RESPIRATORS AND PROTECTIVE CLOTHING
ARE REQUIRED IN THIS AREA
DANGER
ASBESTOS
CANCER AND LUNG HAZARD
KEEP OUT

   j. Post an approximately 10 inch by 14 inch manufactured sign at each entrance to each work area displaying the following legend with letter sizes and styles of a visibility at least equal to the following:

LEGEND	NOTATION
No Food, Beverages or Tobacco Permitted	3/4 inch Block
All Persons Shall Don Protective Clothing (Coverings) Before Entering the Work Area	3/4 inch Block
All Persons Shall Shower Immediately After Leaving Work Area and Before Entering the Changing Area	3/4 inch Block

M. Decontamination Procedures

1. Contractor shall require all workers and visitors to adhere to the following personal decontamination procedures whenever they leave the work area:

   a. Require that all workers use the following decontamination procedure as a minimum requirement whenever leaving the work area.
   b. When exiting area, remove disposable coveralls, disposable head covers, and disposable footwear covers or boots in the Equipment Room.
   c. Still wearing respirators, proceed to showers. Showering is mandatory. Care must be taken to follow reasonable procedures in removing the respirator to avoid asbestos fibers while showering. The following procedure is required as a minimum:
      1) Thoroughly wet body including hair and face. If using a PAPR, hold blower unit above head to keep canisters dry.
      2) With respirator still in place thoroughly wash body, hair, respirator face piece, and all parts of the respirator except the blower unit and battery pack on a PAPR. Pay particular attention to seal between face and respirator and under straps.
      3) Take a deep breath, hold it and/or exhale slowly, completely wet hair, face, and respirator. While still holding breath, remove respirator and hold it away from face before starting to breathe.
      4) Carefully wash face-piece of respirator inside and out.
   d. If using PAPR, shut down in the following sequence, first cap inlets to filter cartridges, then turn off blower unit (this sequence will help keep debris which has collected on the inlet side of filter from dislodging and contaminating the outside of the unit). Thoroughly wash blower unit and hoses. Carefully wash battery pack with wet rag. Be extremely cautious of getting water in battery pack as this will short out and destroy battery.
      1) Shower completely with soap and water.
      2) Rinse thoroughly.
      3) Rinse shower room walls and floor prior to exit.
      4) Proceed from shower to changing room and change into street clothes or into new disposable work items.
   e. Require that all workers use the following decontamination procedure as a minimum requirement whenever leaving the work area with a half or full face cartridge type respirator:
      1) When exiting area, remove disposable coveralls, disposable headcovers, and disposable footwear covers or boots in the equipment room.
      2) Still wearing respirators, proceed to showers. Showering is mandatory. Care must be taken to follow reasonable procedures in removing the respirator and filters to avoid asbestos fibers while showering. The following procedure is required as a minimum:
      3) Thoroughly wet body from neck down.
      4) Wet hair as thoroughly as possible without wetting the respirator filter if using an air purifying type respirator.
      5) Take a deep breath, hold it and/or exhale slowly, complete wetting of hair, thoroughly wetting face, respirator and filter (air purifying respirator). While still holding breath, remove respirator and hold it away from face before starting to breath.
      6) Dispose of wet filters from air purifying respirator.
      7) Carefully wash facepiece of respirator inside and out.
      8) Shower completely with soap and water.
      9) Rinse thoroughly.
      10) Rinse shower room walls and floor prior to exit.
      11) Proceed from shower to changing room and change into street clothes or into new disposable work items.

N. Project Decontamination

1. If the asbestos abatement work is on damaged or friable materials, then the building space is deemed contaminated before start of the work and in need of decontamination. In this case, the

procedure includes two cleanings of the primary barrier plastic prior to its removal and two cleanings of the room surfaces to remove any new or existing contamination.

2. Work of this section includes the decontamination of air in the work area which has been, or may have been contaminated by the elevated airborne asbestos fiber levels generated during abatement activities, or which may previously have had elevated fiber levels due to friable materials in the space.
3. Work of this section also includes the cleaning, decontamination, and removal of temporary facilities installed prior to abatement work and decontamination of all surfaces (ceiling, walls, floor) of the work area, and all furniture or equipment in the work area.
4. First Cleaning
   a. Carry out a first cleaning of all surfaces of the work area including items of remaining sheeting, tools, scaffolding and/or staging by use of damp-cleaning and mopping, and/or a HEPA filtered vacuum. (Note: A HEPA vacuum will fail if used with wet material). Do not perform dry dusting or dry sweeping. Use each surface of a cleaning cloth one time only and then dispose as contaminated waste. Continue this cleaning until there is no visible debris from removed materials on plastic sheeting or other surfaces. Upon authorization of the Owner's Representative proceed with encapsulation of substrate.
   b. Perform encapsulation of substrate where required at this time. Maintain pressure differential system in operation during encapsulation work. Allow encapsulant to dry before proceeding with removal of Secondary layer of plastic.
5. Second Cleaning
   a. Upon authorization of the Owner's Representative, remove all Primary Barrier sheeting and Material Decontamination Unit, if there is one, leaving only the following:
      1) Critical Barrier which forms the sole barrier between the work area and other portions of the building or outside.
      2) Critical Barrier Sheeting over lighting fixtures and clocks, ventilation openings, doorways, convectors, speakers and other openings.
      3) Personnel Decontamination Unit.
      4) Pressure Differential System in continuous operation.
   b. Remove all filters in Air Handling System(s) and dispose of as asbestos-containing waste.
6. Final Cleaning: Carry out a final cleaning of all surfaces in the work in the same manner as the first cleaning immediately after removal of primary plastic. This cleaning is now being applied to existing room surfaces. Take care to avoid water marks or other damage to surfaces.
7. Visual Inspection: Perform a complete visual inspection with the Owner's Representative of the entire work area including decontamination unit, all plastic sheeting, seals over ventilation openings, doorways, windows, and other openings; look for debris from any sources, residue on surfaces, dust or other matter. If any such debris, residue, dust or other matter is found repeat cleaning and continue decontamination procedure from that point. When the area is visually clean, complete the certification at the end of this section.
8. Final Air Sampling
   a. After the work area is found to be visually clean, air samples will be taken and analyzed in accordance with the procedures set forth in Paragraph “Powered Air Purifying Respirator (PAPR).
   b. If Release Criteria are not met, repeat cleaning and continue decontamination procedure from that point.
   c. If Release Criteria is met, remove the interior of the decontamination unit leaving in place only the Critical Barriers separating the work area from the rest of the building and the operating negative pressure system.
   d. Any small quantities of residual material found upon removal of the plastic sheeting shall be removed with a HEPA filtered vacuum cleaner and local area protection. If significant quantities, as determined by the Owner's Representative, are found then the entire area affected shall be decontaminated as specified herein for the cleaning.

O. Work Area Clearance
   1. Air Monitoring

a. Visual Inspection is required as a prerequisite of air testing.
b. To determine if the elevated airborne asbestos structure concentration during abatement operations have been reduced to the specified level, the Owner's Representative will secure samples and analyze them according to the following procedures.

2. Aggressive Sampling
   a. All air samples will be taken using aggressive sampling techniques as follows. (There are no standards available for flow rate of leaf blowers or large fans. However, this information is not critical to the success of the procedure).
   b. Before sampling pumps are started, the exhaust from forced-air equipment (leaf blower with at least 1 horsepower electric motor) will be swept against all walls, ceilings, floors, ledges and other surfaces in the room. This procedure will be continued for five minutes per 10,000 cubic feet of room volume.
   c. Air samples will be collected in areas subject to normal air circulation away from room corners, obstructed locations, and sites near windows, doors or vents.
3. Schedule of Air Samples
   a. General: The number and volume of air samples taken and analytical methods used by the Owner's Representative will be in accordance with the following schedule. Sample volumes given may vary depending upon the analytical instruments used. In each homogeneous work area after completion of all cleaning work, samples will be taken and analyzed by either PCM of TEM analysis.
   b. Transmission Electron Microscopy (TEM) Samples:
      1) In each homogeneous work area after completion of all cleaning work, samples will be taken and analyzed by either PCM or TEM analysis as follows:
      2) Samples will be collected on 25 mm cassettes with filter media: TEM - 0.45 micrometer mixed cellulose ester or 0.40 micrometer polycarbonate, with 5.0 micron mixed cellulose ester backing filter.

Location **Sampled**	Number of **Samples**	Detection **Limit** (f/cc)	**Minimum** Volume (Liters)	**Rate** LPM
Each Work Area	5	0.005	1,300	2-10

      3) TEM Analysis will be performed using the analysis method set forth in the AHERA Regulation 40 CFR Part 763 Appendix A.
      4) Asbestos Structures referred to in this Section include asbestos fibers, bundles, clusters, or matrices, as defined by method of analysis.
      5) Decontamination of the work site is complete when all the sample results are below 0.01 fibers per cubic centimeters (f/cc) of air or 70 structures per square millimeter.
   c. Phase Contrast Microscopy (PCM) Samples:
      1) In each homogeneous work area after completion of all cleaning work, samples may be taken and analyzed as follows:
      2) Samples will be analyzed by PCM for clearance in areas where ceiling tile and/or pipe insulation are removed
      3) Samples will be collected on 25 mm cassettes with filter media: PCM - 0.8 micrometer mixed cellulose ester.

Location Sampled	**Number of Samples**	**Detection Limit** (s/cc)	**Minimum Volume** (Liters)	**Rate** LPM
Each Work Area	1-5	0.01	2,400	2-10

      4) PCM Analysis: Fibers on each filter will be measured using the NIOSH 7400 Method entitled "Fibers" published in the NIOSH Manual of Analytical Methods, 3rd Edition, Second Supplement, August 1987.

5) Fibers: Referred to in this section include fibers regardless of composition as counted by the phase contrast microscopy method used
6) Decontamination of the work site is complete when all the sample results are below 0.01 fibers per cubic centimeters (f/cc) of air or 70 structures per square millimeter.

4. Failure of Clearance Sampling: Should results from analysis of final clearance air samples not meet the specified criteria, Contractor will be responsible for the payment of all costs, including Consultant's time for subsequent clearance air sampling. The costs associated with subsequent re-sampling for final clearance shall be deducted from the Contractor's final payment of the contract amount.

P. Removal Of Pipe Insulation
1. The work of this section applied to the removal of asbestos-containing Pipe Insulation.
   a. Place one layer of 6-mil fire retardant polyethylene sheeting directly below the work. The sheet shall be of sufficient size to completely wrap the pipe once it has been removed.
   b. Thoroughly wet the ends of the pipe with amended water and scrape off a minimum of 6 inches of asbestos wrap from both ends of the pipe. Immediately place the wetted material into pre-labeled asbestos disposal bag(s).
   c. Detach the pipe at each scraped end and place the pipe onto one sheet of 6-mil fire retardant polyethylene sheeting. Wrap the pipe with the 6-mil fire retardant polyethylene sheeting. Contractor shall wrap the pipe with a second sheet of 6-mil, fire retardant polyethylene sheeting and label as asbestos-containing material. Dispose of the bag(s) and duct in accordance with the Paragraph "Handling and Disposal of Asbestos Contaminated Waste" of this specification.
   d. Upon clearance from the Owner's Representative, Contractor shall remove the 6-trail, fire retardant polyethylene sheeting from the openings.

Q. Glove Bag Removal
1. The work of this section applies to full containment or glovebag removal.
2. Isolate the area in accordance with Paragraph “Temporary Facilities.”
3. Construct a decontamination unit as described in Paragraph “Decontamination Units” and attach to the work area.
4. Set up pressure differential isolation and ventilation of the work area in accordance to Paragraph “Pressure Differential System.”
   a. Upon approval of the enclosure by the Owner's Representative, Contractor may proceed to remove the material using the following method.
   b. Thoroughly wet to satisfaction of the Owner's Representative, asbestos-containing insulation to be removed prior to stripping and/or tooling to reduce fiber dispersal into the air. Accomplish wetting by a fine spray (mist) of amended water or removal encapsulant. Saturate material sufficiently to wet the substrate without causing excess dripping. Allow time for removal encapsulant to penetrate material thoroughly. If amended water is used, spray material repeatedly during the work process to maintain a continuously wet condition. If a removal encapsulant is used, apply in strict accordance with manufacturer's written instructions. If insulation is covered with canvas, Contractor will wet the exterior covering and slice it with utility knife while saturating the material.
   c. Mist work area continuously with amended water whenever necessary to reduce airborne fiber levels using commercially available "foggers."
   d. Remove saturated asbestos-containing material in small sections from all areas. Do not allow material to dry out. As it is removed, simultaneously pack material while still wet into disposal bags. Twist neck of bags, bend over and seal with minimum three wraps of duct tape. Clean outside and move to wash down station adjacent to material decontamination unit.
   e. Evacuate air from disposal bags with a HEPA filtered vacuum cleaner before sealing.
   f. Contractor must always clean area of visible asbestos debris prior to end of shift.
5. These procedures shall be followed to remove pipe insulation elbows:
   a. Install critical barriers to isolate the work site. Install 2 or 3 Stage Decontamination Units.

b. HEPA vacuum the work site.
c. Provide negative air machine in addition to those required, in the vicinity of the work. Arrange so that exhaust is into the work area, oriented in a direction away from the work. Extend a 2-inch diameter flexible non-collapsing duct from the intake end to a point no more than 4'-0" from any scraping or brushing activity.
d. Locate intake of duct so that airflow is horizontally and slightly downward into intake. Replace primary filter on negative air machine at an interval of no greater than 30 minutes. Allow no more than one scraping or brushing activity per negative air machine.
e. Check pipe where the work will be performed. Wrap damaged (broken lagging, hanging, etc.), pipe in 6 mil plastic and "candy-stripe" with duct tape. Place one layer of duct tape around undamaged pipe at each end where the glovebag will be attached.
f. Place necessary tools into pouch located inside glovebag. This will usually include: bone saw, utility knife, rags, scrub brush, wire cutters, tin snips and pre-wetted cloth.
g. Place one strip of plastic adhesion tape along the edge of the open top slit of glove bag for reinforcement.
h. Place the glove bag around section of pipe to be worked on and staple top together through reinforcing tape. Next, tape the ends of glovebag to pipe itself, where previously covered with plastic or tape.
i. Use smoke tube and aspirator bulb to test seal. Place tube into water sleeve (two-inch opening to glovebag) squeezing bulb and filling bag with visible smoke. Remove smoke tube and twist water sleeve closed. While holding the water sleeve tightly, gently squeeze glovebag and by using a flashlight, look for smoke leaking out, (especially at the top and ends of the glovebag). If leaks are found, tape closed using plastic adhesion tape and re-test.
j. Insert wand from garden sprayer through water sleeve. Plastic adhesion tape water sleeve tightly around the wand to prevent leakage.
k. One person places its hands into the long-sleeved gloves while the second person directs garden sprayer at the work.
l. Use bone saw, if required, to cut insulation at each end of the section to be removed. A bone saw is a serrated heavy gauge wire with ring-type handles at each end. Throughout this process, spray amended water or removal encapsulant on the cutting area to keep dust to a minimum.
m. Remove insulation using putty knives or other tools. Place pieces in bottom of bag without dropping.
n. Rinse all tools with water inside the bag and place back into pouch.
o. Using scrub brush, rags and water, scrub and wipe down the exposed pipe. (Inexpensive horse rub-down mittens work well for this).
p. Remove water wand from water sleeve and attach the small nozzle from HEPA-filtered vacuum. Turn on the vacuum only briefly to collapse the bag.
q. Remove the vacuum nozzle, twist water sleeve closed and seal with plastic adhesion tape.

R. Handling And Disposal Of Asbestos-Containing Waste
1. All waste and asbestos contaminated waste shall be double bagged in pre-labeled 6-mil airtight puncture resistant bags. Labeling shall be in accordance with OSHA and EPA requirements.
a. Bags of asbestos-containing waste shall be sealed with tape in the work area. Asbestos waste shall not be allowed to dry out prior to sealing bags. While in the work area, bags shall be decontaminated of any bulk debris by wet wiping. Bags shall be pre-labeled in accordance with OSHA and EPA.
b. The Contractor shall ensure that the sealed bags are transported to the waste disposal site.
2. The Contractor shall establish a manifest system to enable the Owner to report the quantity of asbestos waste being deposited at the landfill. Contractor shall report the quantity of waste in pounds or tons as appropriate. The Contractor must be able to demonstrate custody over all asbestos waste from the time it is removed from the work area until it is deposited at the land fill.

a. Copies of the manifest and any receipts generated during the handling and disposal process shall be provided to the Owner's Representative and the Owner.
b. Final manifest and documents must be provided to the Owner's Representative and the Owner within two weeks of the removal of the asbestos materials from the site by the waste hauler.

S. Encapsulation Of Asbestos-Containing Materials
1. General provisions of Contract, including General and Supplementary Conditions and Division 01, apply to work of this section.
a. The work includes the sealing of all piping or vessels from which asbestos-containing insulation has been removed with one coat of a lock down encapsulant.
b. Where repair work is being performed, the end will be sealed with a minimum of one coat of bridging encapsulant.
2. Submittals
a. Product Data: Submit manufacturer's technical information including label analysis and application instructions for each material proposed for use.
b. Installation Instructions: Submit manufacturer's installation instructions with specific project requirements noted.
c. Performance Warrantee: Submit manufacturer's performance guarantee.
d. Certification: Submit written approval of entity installing the encapsulant from encapsulant manufacturer.
e. Material Safety Data Sheet: Submit the Material Safety Data Sheet, or equivalent, in accordance with the OSHA Hazard Communication Standard (29 CFR 1910.1200) for each surfactant and encapsulating material proposed for use on the work. Include a separate attachment for each sheet indicating the specific worker protective equipment proposed for use with the material indicated.
3. Deliver materials to the job site in original, new and unopened packages and containers bearing manufacturer's name and label, and following information:
a. Name or title of material
b. Manufacturer's stock number and date of manufacture
c. Manufacturer's name
d. Thinning Instructions
e. Application Instructions
4. Deliver materials together with a copy of the OSHA Material Safety Data Sheet for the material.
5. Job Conditions
a. Apply encapsulating materials only when environmental conditions in the work area are as required by the manufacturer's instructions.
6. Quality Assurance
a. Installation of Spray-on Encapsulation Materials: Install spray-on materials by a firm and personnel approved by the manufacturer of the primary materials.
b. Testing: Test material to be encapsulated using methods set forth in ASTM E1494 "Standard Practice for Encapsulants Spray-or-Trowel-Applied for Friable Asbestos-Containing Building Materials."
c. Performance Warranty: Submit written Performance Warranty, executed by the manufacturer and co-signed by the Contractor, agreeing to repair/replace spray-on work which has cracked, fallen from substrate, or otherwise deteriorated to a condition where it would not perform effectively for its intended purposes due substantially to defective materials or workmanship and not due to abuse by occupants, improper maintenance, non-foreseeable ambient exposures or other causes beyond anticipated conditions and manufacturer's/contractor's control.
d. Compatibility: Selection and use of encapsulant shall be compatible with replacement materials. Submit manufacturer's data indicating compatibility with replacement materials.
7. Product Selection
a. Encapsulants: Provide penetrating or bridging type encapsulants specifically designed for application to asbestos-containing material.

b. Standards: Product shall be rated as acceptable for use intended when field tested in accordance with ASTM E1494 "Standard Practice for Encapsulants Spray-or-Trowel-Applied for Friable Asbestos-Containing Building Materials."
c. Fire Safety: Use only materials that have a flame spread index of less than 25, when dry, when tested in accordance with ASTM E84.

8. Manufacturers
   a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products, which may be incorporated in the work, include, but are not limited to the following:
      1) Penetrating Encapsulants: As currently accepted by the EPA. Refer to most recent EPA approval list.
      2) Bridging Encapsulants: As currently accepted by the EPA. Refer to most recent EPA approval list.
9. General
   a. Prior to applying any encapsulating material, ensure that application of the sealer will not cause the base material to fail and allow the sealed material to fall of its own weight or separate from the substrate. Should Contractor doubt the ability of the installation to support the sealant, request direction from the Owner's Representative before proceeding with the encapsulating work.
   b. Do Not Commence Application of encapsulating materials until all removal work within the work area has been completed.
10. Worker Protection
    a. Before beginning work with any material for which a Material Safety Data Sheet has been submitted, provide workers with the required protective equipment. Require that appropriate protective equipment be used at all times.
    b. In addition to protective breathing equipment required by OSHA requirements or by this specification, use painting pre-filters on respirators to protect the dust filters when organic solvent based encapsulants are used.
11. Substrate
    a. Apply lock down encapsulant to all substrate after all asbestos-containing materials have been removed. Apply in strict accordance with the manufacturer's printed instructions for use of the encapsulation as an asbestos coating. Any deviations from such printed instructions shall be approved by the Owner's Representative in writing prior to commencing work.
    b. Apply encapsulant with an airless spray gun with air pressure and nozzle orifice as recommended by the encapsulant manufacturer.

T. Removal Of Floor Tile
1. This section applies to the removal of floor tile.
   a. Prior to start of work, wet wipe all surfaces including floor tile to remove any visible dust.
   b. Isolate the room by sealing hallway or doors and installing critical barriers on all ducting, windows and other penetrations of the room, in the specified area. Install a splash guard a minimum of 4 feet high on the walls of the room with one layer of 6-mil fire retardant poly.
   c. Install a two-stage decontamination configuration contiguous (under certain conditions may be remote) with the work in accordance with Paragraph “Decontamination Units.”
   d. Using water or amended water in a Hudson-type sprayer or garden sprayer, lightly mist the area where the material is to be removed. This may take several passes with the hose of the sprayer. Allow time for the water to soak into the material.
   e. Immediately place individual tiles in proper asbestos disposal bags. Vacuum collapse the bag, twist the neck of the bag, tape with duct tape, fold the twisted portion over onto itself and tape again. Wipe the outside of the bag with clean damp cloths and place the bag into a second prelabeled disposal bag. Tape shut the second bag.

U. Removal Of Fireproofing

1. The work of this section applies to the removal of all asbestos containing fireproofing including all over-spray that may be located on concrete block, columns, metal deck, beams, fixtures conduit and ducting.
    a. Isolate the floor per Paragraph “Temporary Enclosure.”
    b. Construct a decontamination unit as described in Paragraph “Decontamination Units” and attach to the work area.
    c. Set up pressure differential isolation and ventilation of the work area in accordance to Paragraph “Temporary Pressure Differential and Air Circulation System.”
    d. Upon approval of the enclosure by the Owner's Representative, contractor may proceed to remove the material using the following method.
    e. Pre-clean columns, beams, electrical, mechanical and plumbing systems in the work area using wet wipe and HEPA vacuuming methods. Mask off with flame retardant polyethylene sheeting to protect from contamination during bulk abatement.
    f. Thoroughly wet to satisfaction of the Owner's Representative, asbestos-containing fireproofing to be removed prior to stripping and/or tooling to reduce fiber dispersal into the air. Accomplish wetting by a fine spray (mist) of amended water or removal encapsulant. Saturate material sufficiently to wet the substrate without causing excess dripping. Allow time for removal encapsulant to penetrate material thoroughly. If amended water is used, spray material repeatedly during the work process to maintain a continuously wet condition. If a removal encapsulant is used, apply in strict accordance with manufacturer's written instructions.
    g. Mist work area continuously with amended water whenever necessary to reduce airborne fiber levels using commercially available "foggers."
    h. Remove saturated asbestos-containing material in small sections from all areas. Do not allow material to dry out. As it is removed, simultaneously pack material while still wet into disposal bags. Twist neck of bags, bend over and seal with minimum three wraps of duct tape. Clean outside and move to wash down station adjacent to material decontamination unit.
    i. Evacuate air from disposal bags with a HEPA filtered vacuum cleaner before sealing.
    j. Provide Pressure Differential Machine in addition to those required in Paragraph “Pressure Differential System,” in the vicinity of the work. Arrange so that exhaust is into the work area, oriented in a direction away from the work. Extend a 12" diameter flexible non-collapsing duct from the intake end to a point no more than 4'-0" from any scraping or brushing activity.
    k. Locate intake of duct so that air flow is horizontally and slightly down-ward into intake. Replace primary filter on pressure differential machine at an interval of no greater that 30 minutes. Allow no more than one scraping or brushing activity per pressure differential machine.

V. Removal Of Wall Plaster: HEPA vacuum work site.
1. Place two layers of 6-mil flame retardant polyethylene sheeting on the floor adjacent to the wall to be demolished. Pull the wall down in manageable sections onto the polyethylene sheeting. Control dust and fiber release by misting the air and lightly wetting the material with amended water from a Hudson-type sprayer or garden sprayer as it is demolished.
2. Wrap the first layer of polyethylene sheeting around the material and seal with duct tape. Wrap the second layer of polyethylene sheeting around the bundle and seal with duct tape.
3. Label and dispose of the entire bundle.
4. Provide Pressure Differential Machine in addition to those required in Paragraph “Pressure Differential System,” in the vicinity of the work. Arrange so that exhaust is unto the work area, oriented in a direction away from the work. Extend a 12-inch diameter flexible non-collapsing duct from the intake end to a point no more than 4'-0" from any scraping or brushing activity.
5. Locate intake of duct so that air flow is horizontally and slightly down-ward into intake. Replace primary filter on negative air machine at an interval of no greater that 30 minutes.

W. Clean-Up Of Asbestos-Containing Debris On Ceiling Tile Or Solid Ceiling

1. This section applies to the decontamination of the entire plaster ceiling, removal of existing fiberglass on duct work and removal of all batt insulation covering the existing plaster ceiling.
   a. Isolate the floor per Paragraph "Temporary Facilities."
   b. Construct a decontamination unit as described in Paragraph "Decontamination Units" and attach to the work area. General Contractor will give direction regarding exact location of decontamination unit(s).
   c. Set up pressure differential isolation and ventilation of the work area in accordance to Paragraph "Temporary Pressure Differential and Air Circulation System."
   d. Upon approval of the enclosure by the Owner's Representative, contractor may proceed to remove the material using the following method:
2. These procedures shall be followed to for clean up of asbestos-containing debris on existing plaster ceiling:
   a. This work will be performed prior to the removal of fireproofing. The isolation of the work area is considered essential to the pre-cleaning activities for the total area. Isolate the area in accordance with Paragraph “Temporary Facilities.”
   b. Remove asbestos-containing debris and fiberglass batt and duct insulation and decontaminate the area using the following procedures:
      1) Remove all small debris with the HEPA vacuum.
      2) Gently mist all fiberglass insulation, remove from ducts and ceiling and place into pre-labeled hazardous disposal bags and dispose of in accordance with Paragraph “Disposal of Asbestos Containing Waste Material.”
      3) Exposure of ducting will expose all fireproofing overspray, this material may be removed during the removal of fireproofing from decks and beams.
      4) Pick up all large visible debris on the ceiling or any horizontal surfaces and place in the bottom of a 6-mil polyethylene disposal bag conforming to the requirements of Paragraph “Disposal of Asbestos-Containing Waste.” Place pieces in the bag without dropping and avoiding unnecessary disturbance and release of material.
      5) HEPA vacuum the entire plaster ceiling surface.
   c. Upon completion of the decontamination of the area request a visual inspection of the ceiling and other horizontal surfaces. This area will be considered a portion of work area for the duration of the work and will be included in the final encapsulation of the area.

X. Removal Of Adhesive: This section applies to the removal of all asbestos-containing floor tile and adhesive, sheet vinyl flooring, vinyl floor tile, and baseboard adhesive, etc.
1. Ensure that workers are equipped with proper respiratory protection. In addition to the HEPA cartridges, respirators must also be equipped with organic solvent cartridges.
2. Provide HEPA filtered fan units in the vicinity of the work. Arrange so that units exhaust outside the building. Replace primary filters on HEPA filtered fan units at an interval of no greater than 30 minutes.
3. Apply adhesive removal solvent as recommended by manufacturer after removal of floor tile has been completed.
4. Provide tile adhesive (mastic) remover that meets the following criteria:
   a. Flash Point: 122E or greater.
   b. Special Precautions: No heavy smoke generated if ignited.
   c. Health Effects: Limited to mild skin rash or eye irritation.
   d. Respiratory Protection: MSHA - NIOSH approved Organic vapor cartridges in conjunction with standard HEPA filters.
   e. Petroleum Distillates: None.
   f. Odor: Pine, Citrus or none.

Use of diesel fuel in the removal of tile and baseboard adhesive is strictly prohibited.

5. Remove adhesive in small sections from all areas. Do not allow material to dry out. As adhesive is removed, simultaneously pack rags contaminated with adhesive material into disposal bags. Twist

neck of bags, bend over and seal with minimum three wraps of duct tape. Clean outside of bag and move to material decontamination unit.

6. Upon completion of adhesive removal, thoroughly clean bare substrate of all solvent residue.
7. Place adhesive residue in proper asbestos disposal bags. Vacuum collapse the bag, twist the neck of the bag, tape with duct tape, fold the twisted portion over onto itself and tape again. Wipe the outside of the bag with clean damp cloths and place bag into second prelabeled disposal bag. Tape shut the second bag.

CERTIFICATE OF WORKER'S ACKNOWLEDGEMENT

PROJECT NAME: _____

PROJECT ADDRESS: _____

CONTRACTOR: _____

WORKING WITH ASBESTOS CAN BE DANGEROUS. INHALING ASBESTOS FIBERS HAS BEEN LINKED WITH VARIOUS TYPES OF CANCER IF YOU SMOKE AND INHALE ASBESTOS FIBERS, THE CHANCE THAT YOU WILL DEVELOP LUNG CANCER IS GREATER THAN THAT OF THE NON-SMOKING PUBLIC.

Your employer's contract with the Owner for the above project requires that: You be supplied with the proper respirator and be trained in its use. You be trained in safe work practices and in the use of the equipment found on the job. You receive a medical examination. These things are to have been done at no cost to you. By signing this certification you are assuring the Owner that your employer has met these obligations to you.

RESPIRATORY PROTECTION: I have been trained in the proper use of respirators, and informed ofthe type respirator to be used on the above referenced project. I have a copy of the written respiratory protection manual issued by my employers. I have been equipped at no cost with the respirator to be used on the above project.

TRAINING COURSE: I have been trained in the dangers inherent in handling asbestos and breathing asbestos dust and in proper work procedures and personal and area protective measures. The topics covered in the course included the following:

Physical characteristics of asbestos
Health hazards associated with asbestos
Respiratory protection
Use of protective equipment
Pressure differential systems
Work practices including hands-on or on-the-job training
Personal decontamination procedures
Air monitoring, personal and area

MEDICAL EXAMINATION: I have had a medical examination within the last 12 months which was paid for by my employer. This examination included: health history, pulmonary function tests and may have included an evaluation of a chest x-ray.

Signature _____ Witness _____

Printed Name _____ Social Security Number _____

CERTIFICATION OF VISUAL INSPECTION

AREA _____

In accordance with Paragraph "Project Decontamination" the Contractor hereby certifies that it has visually inspected the work area (all surfaces including pipes, beams, ledges, walls, ceiling and floor, Decontamination Unit, sheet plastic, etc.) and has found no dust, debris or residue.

By: _____

Signature _____ Date _____

Print Name _____

Print Title _____

OWNER'S REPRESENTATIVE CERTIFICATION

the Owner's Representative hereby certifies that it has accompanied the Contractor on its visual inspection and verifies that this inspection has been thorough and to the best of its knowledge and belief, the Contractor's certification above is a true and honest one.

Signature _____ Date _____

Print Name _____

Print Title _____

RESPIRATORY PROTECTION PROGRAM

Project Name _____

Location _____

Date _____

Based upon airborne asbestos-fiber counts encountered on previous projects of similar type working on materials similar to those found on the above referenced project. The following level of respiratory protection is proposed for the indicated operations to maintain an Airborne Fiber Count (as measured by the NIOSH 7400 Method) below the specified Permissible Exposure Limit (PEL) inside the respirator face piece.

Operation	Anticipated f/cc	Respiratory Protection	Protection Factor	f/cc in Mask
Installing sheet plastic				
Removing trim in contact with asbestos-containing material				
Removal of architectural finish or fireproofing				
Removal of pipe insulation				
Removal of fitting insulation				
Encapsulation of pipe and boiler insulation				
Gross debris removal				
Cleaning "primary" sheet plastic				
Cleaning "critical" barrier				
Removing Decontamination Unit				
Other				

The Contractor certifies that to the best of its knowledge and belief the above represent a true and accurate representation of Airborne Fiber Counts to be expected for the operations indicated, and are based upon airborne fiber data from past projects with similar materials and operations.

Contractor _____

Signature _____ Date _____

Print Name _____ Title _____

END OF SECTION 02 82 33 00

SECTION 02 82 33 00a - REMOVAL OF NONFRIABLE ASBESTOS-CONTAINING MATERIALS

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for removal of nonfriable asbestos-containing materials. Products shall be as follows or as directed by the 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. ACM: Asbestos Containing material which is any material containing more than one percent asbestos.
2. Amended Water: Water containing a wetting agent or surfactant with a maximum surface tension of 2.9 Pa 29 dynes per centimeter when tested in accordance with ASTM D 1331.
3. Area Sampling: Sampling of asbestos fiber concentrations which approximates the concentrations of asbestos in the theoretical breathing zone but is not actually collected in the breathing zone of an employee.
4. Asbestos: The term asbestos collectively refers to a naturally occurring mineral known by the following specific names: chrysotile, amosite, crocidolite, tremolite, anthophyllite, and actinolite.
5. Asbestos control Area: That area where asbestos removal operations are performed. The area shall be isolated by physical boundaries to assist in the prevention of the uncontrolled access by non-qualified persons.
6. Asbestos Fibers: Those fibers having an aspect ratio of at least 3:1 and longer than-5 micrometers as determined by National Institute for Occupational Safety and Health (NIOSH) Method 7400.
7. Asbestos Permissible Exposure Limit: 0.1 fibers per cubic centimeter of air as an e-hour time weighted average measured in the breathing zone as by defined 29 CFR 1926.1101 or other Federal legislation having legal jurisdiction for the protection of workers health.
8. Background: The ambient airborne asbestos concentration in an uncontaminated area as measured prior to any asbestos hazard abatement efforts. Background concentrations for contaminated areas are measured in similar but asbestos free locations.
9. Contractor: The Contractor is that individual, or entity under contract to the Owner to perform the herein listed work.
10. Contractor/Supervisor (Asbestos abatement): A person who has successfully completed training and is therefore accredited as a Contractor/Supervisor under a State Model Accreditation Plan or EPA Model Accreditation Plan as described in 40 CFR 763.
11. Critical Barrier: The layer of polyethylene sheeting that covers an opening or penetration in a room or area that is to become a negative pressure enclosure.
12. Encapsulation: The abatement of an asbestos hazard through the appropriate use of chemical encapsulants.
13. Encapsulants: Specific materials in various forms used to chemically or physically entrap asbestos fibers in various configurations to prevent these fibers from becoming airborne. There are four types of encapsulants as follows which must comply with performance requirements as specified herein.
    a. Removal Encapsulant (can be used as a wetting agent)
    b. Bridging Encapsulant (used to provide a tough, durable surface coating to asbestos containing material)
    c. Penetrating Encapsulant (used to penetrate the asbestos containing material encapsulating all asbestos fibers and preventing fiber release due to routine mechanical damage)
    d. Lock-Down Encapsulant (used to seal off or "lock-down" minute asbestos fibers left on surfaces from which asbestos containing material has been removed).
14. Friable Asbestos Material: Any material containing more than one percent asbestos that can be crumbled, pulverized, or reduced to powder by hand pressure when dry.

15. Glovebag Technique: Those asbestos removal and control techniques put forth in 29 CFR 1926.1101.
16. HEPA Filter Equipment: High efficiency particulate air (HEPA) filtered vacuum and/or exhaust ventilation equipment with a filter system capable of collecting and retaining asbestos fibers. Filters shall retain 99.97 percent of particles 0.3 microns or larger as indicated in UL 586.
17. the Owner: That qualified person employed directly by the Owner to monitor, sample, inspect the work, and advise the Owner.
18. Negative Pressure Enclosure (NPE): That engineering control technique described as a negative pressure enclosure in 29 CFR 1926.1101.
19. Non-friable Asbestos Material: Material that contains asbestos in which the fibers have been immobilized by a bonding agent, coating, binder, or other material so that the asbestos is well bound and will not normally release asbestos fibers during any appropriate use, handling, storage or transportation. It is understood that asbestos fibers may be released under other conditions such as demolition, renovation, removal, or mishap.
20. Personal Sampling: Air sampling which is performed to determine asbestos fiber concentrations within the breathing zone of a specific employee, as performed in accordance with 29 CFR 1926.1101.
21. Competent Person (CP): A person who has successfully completed training and is therefore accredited under a legitimate State Model Accreditation Plan or EPA Model Accreditation Plan as described in 40 CFR 763 as a Contractor/Supervisor and shall be appropriately licensed according to the Statutes of the State in which the work is to be performed.
22. TEM: Refers to Transmission Electron Microscopy.
23. Time Weighted Average (TWA): The TWA is an 8-hour time weighted average airborne concentration of asbestos fibers.
24. Wetting Agent: A chemical added to water to reduce the water's surface tension thereby increasing the water's ability to soak into the material to which it is applied. An equivalent wetting agent must have a surface tension of at most 2.9 Pa 29 dynes per centimeter when tested in accordance with ASTM D 1331.

C. Requirements

1. Description of Work: The work covered by this section includes the handling and control of asbestos containing materials and describes some of the resultant procedures and equipment required to protect workers, the environment and occupants of the building or area, or both, from contact with airborne asbestos fibers. The work also includes the disposal of any asbestos containing materials generated by the work. More specific operational procedures shall be outlined in the Asbestos Hazard Abatement Plan called for elsewhere in this specification. The asbestos work includes the use of non-friable removal technique(s) which is governed by 40 CFR 763 as indicated. Provide non-friable removal technique(s) as outlined in this specification for the locations indicated.
2. Medical Requirements: Provide medical requirements including but not limited to medical surveillance and medical record keeping as listed in 29 CFR 1926.1101.
    a. Medical Examinations: Before exposure to airborne asbestos fibers, provide workers with a comprehensive medical examination as required by 29 CFR 1926.1101 or other pertinent State or local directives. This requirement must have been satisfied within the 12 months prior to the start of work on this contract. The same medical examination shall be given on an annual basis to employees engaged in an occupation involving asbestos and within 30 calendar days before or after the termination of employment in such occupation. Specifically identify x-ray films of asbestos workers to the consulting radiologist and mark medical record jackets with the word "ASBESTOS."
    b. Medical Records: Maintain complete and accurate records of employees' medical examinations, medical records, and exposure data for a period of 30 years after termination of employment and make records of the required medical examinations and exposure data available for inspection and copying to: The Assistant Secretary of Labor for Occupational

Safety and Health (OSHA), or authorized representatives of them, and an employee's physician upon the request of the employee or former employee.

c. Medical Certification: Submit written certification for each worker and contractor/supervisor, signed by a licensed physician indicating that the worker and contractor/supervisor has met or exceeded all of the medical prerequisites listed herein and in 29 CFR 1926.1101 and 29 CFR 1910.134 as prescribed by law.

3. Training: Train all personnel involved in the asbestos control work in accordance with United States Environmental Protection Agency (USEPA) Asbestos Hazard Emergency Response Act (AHERA) training criteria or State training criteria whichever is more stringent. The Contractor shall document the training by providing a copy of a current training certification to the the Owner for each person assigned to work on this project. Furnish each employee with respirator training and fit testing documentation as required by 29 CFR 1910.134. Provide instruction on the engineering and other hazard control techniques and procedures to be used on this project.

a. Employee Training: Submit copies of training certificates for each employee indicating that the employee has received training at the appropriate level in accordance with 40 CFR 763.

4. Permits, Licenses, and Notifications: Notify the local air pollution control district/agency and the the Owner in writing 10 working days prior to commencement of work in accordance with 40 CFR 61-SUBPART M or applicable state and local regulations. Obtain necessary permits or licenses in conjunction with asbestos removal, encapsulation, hauling, and disposal. Post the permit and/or license at the work site, visible from a non-controlled area. Notify the local fire department 3 days prior to removing fire-proofing material from the building including notice that the material contains asbestos.

5. Environment, Safety and Health Compliance: Comply with the applicable requirements of the current issue of 29 CFR 1926.1101, 40 CFR 61-SUBPART A, and 40 CFR 61-SUBPART M or applicable State or local regulations regarding handling, storing, transporting, and disposing of asbestos waste materials. Submit matters of interpretation of standards to the appropriate administrative agency for resolution before starting the work. Where the requirements of this specification, applicable regulations, or referenced documents vary, the most stringent requirement shall apply.

a. Site Inspection: While performing asbestos engineering control work, the Contractor shall be subject to on-site inspection by the Federal, State, or local regulatory agencies and the Contracting Officer or its designated representative. If the work is found to be in violation of Federal, State, or local regulations or this specification, the Contracting Officer or its representative will issue a stop work order to be in effect immediately and until the violation is resolved. All related costs including standby time required to resolve the. violation shall be at the Contractor's expense.

6. Respiratory Protection Program: Establish and implement a respirator program as required by ANSI 288.2 and 29 CFR 1910.134. Submit a written program manual or operating procedure including methods of compliance with regulatory statutes.

a. Respirator Program Records: Submit records of the respirator program as required by ANSI 288.2 and 29 CFR 1910.134.

7. Contractor/Supervisor (Asbestos Abatement): The Contractor shall be represented on-site by a trained contractor/Supervisor. This person shall be on-site at all times when asbestos work is in progress. The Qualified Person, as defined herein, can be the Contractor/Supervisor.

8. Hazard Communication: Adhere to all parts of 29 CFR 1910.1200 and 29 CFR 1926.59. Provide the Contracting Officer with a copy of the Material Safety Data Sheets (MSDS) for all materials brought to the site. Review the Asbestos Survey Report(s) provided by the the Owner, if any.

9. Asbestos Hazard Abatement Plan: Submit a detailed plan of the safety precautions such as lockout, tag-out, tryout, fall protection, and confined space entry procedures and equipment and work procedures to be used in the removal of materials containing asbestos. The plan shall be prepared by the Contractor (and reviewed and signed by an asbestos consultant (LAC) licensed according to the Statutes of the State in which the work is to be performed) for review and recommendation for approval by the the Owner. The plan shall be forwarded to the the Owner for final approval at least 10 days prior to beginning abatement activities. The plan shall include but not be limited to the detailed description of personal protective equipment and work practices to

be used including, but not limited to, respiratory protection, type of whole-body protection , the location of asbestos control areas including clean and dirty areas, buffer zones, showers, storage areas, change rooms, removal method, interface of trades involved in the construction, sequencing of asbestos related work, disposal plan, type of wetting agent and asbestos encapsulant to be used, locations of local exhaust equipment, planned air sampling strategies, and a detailed description of the method to be employed in order to control environmental pollution. The plan shall also include both fire and medical emergency response plans. The Asbestos Hazard Abatement Plan must be approved in writing prior to starting any asbestos work.

10. Testing Laboratory: Submit the name, address, and telephone number of each testing laboratory selected for the sampling, analysis, and reporting of airborne concentrations of asbestos fibers along with evidence that each laboratory selected holds the appropriate State license and/or permits and certification that each laboratory is American Industrial Hygiene Association (AIHA) accredited and that persons counting the samples have been judged proficient by current inclusion on the AIHA Asbestos Analysis Registry (AAR) and successful participation of the laboratory in the Proficiency Analytical Testing (PAT) Program. Where analysis to determine asbestos content in bulk materials or transmission electron microscopy is required, submit evidence that the laboratory is accredited by the National Institute of Science and Technology (NIST) under National Voluntary Laboratory Accreditation Program (NVLAP) for asbestos analysis.
11. Landfill Approval: Submit written evidence that the landfill for disposal is approved for asbestos disposal by the USEPA and State and local regulatory agency(s).
12. Waste Shipment Records/Asbestos Waste Manifest: Submit waste shipment records and/or asbestos manifest records, prepared in accordance with applicable Federal, State, or local regulations, signed and dated by an agent of the landfill, certifying the amount of asbestos materials delivered to the landfill, within 3 days after delivery.
13. Negative Exposure Assessment: Submit objective data demonstrating that the method(s) used for the specified non-friable ACM removal does not release airborne concentrations of asbestos fibers exceeding the TWA PEL or excursion limit. This data may be from previous work within the last 12 months or from initial exposure assessments on this project. Data from previous work must have been gathered by the firm employed on this contract, using workers trained to the same level, with the ACM and workplace conditions "closely resembling" the conditions for this contract.
14. Contractor Daily Reports: Prepare a written report for each day that asbestos work is being accomplished. The report should be submitted to the the Owner monthly. The report as a minimum shall include the following, where applicable:
    a. Daily Visual Inspection Reports: Prepare a written report documenting compliance with the Asbestos Hazard Abatement Plan and Federal, State, or local regulations.
    b. Air Sampling Reports: Complete fiber counting within 24 hours of the "time off" of the sample pump. Notify the the Owner immediately of any airborne levels of asbestos fibers in excess of the acceptable limits. Sampling results shall be submitted to the the Owner the day following receipt. The affected employees will be provided copies of the results where required by law within 3 working days. These results shall be signed by the air sampler and the testing laboratory employee that analyzed the sample.
    c. Pressure Differential Recordings for Local Exhaust System-Not Used
    d. Asbestos Disposal Quantity Report: The Contractor shall record and report daily the amount of asbestos containing material removed and the amount transported for disposal. Deliver the report for the previous day and cumulative totals with amounts of material removed reported in linear meters or square meters linear feet or square feet as described initially in this specification and the amounts of material transported for disposal reported in cubic meters yards.

D. Submittals
    1. Submit the following in accordance with Section "Submittal Procedures."
        a. Vacuums and tools

b. Respirators
c. Wetting Agent
d. Material Safety Data Sheets (MSDS) for all materials proposed for transport to the project site
e. Local exhaust system
f. Pressure differential automatic recording instrument
g. Daily Reports
h. Asbestos hazard abatement plan
i. Testing laboratory
j. Training Certificates
k. Landfill approval
l. Employee training
m. Medical certification requirements
n. Waste shipment records/Asbestos waste manifest
o. Respiratory Protection Program
p. Negative Exposure Assessment
q. Local Exhaust system
r. Show compliance with ANSI Z9.2 by providing manufacturers' certifications.
s. Permits, licenses, and Notifications
t. Rental equipment
u. Respirator program records
v. Protective clothing decontamination quality control records
w. Protective clothing decontamination facility notification.

E. Quality Assurance
1. Glovebags-Not Used
2. Rental Equipment: Provide a copy of the written notification to the rental company concerning the intended use of the equipment and the possibility of asbestos contamination of the equipment.
3. Protective Clothing Decontamination Quality Control Records: Provide all records that document quality control for the decontamination of reusable outer protective clothing.
4. Protective Clothing Decontamination Facility Notification: Submit written evidence that persons who decontaminate, store, or transport asbestos contaminated clothing used in the performance of this contract were duly notified in accordance with 29 CFR 1926.1101.

1.2 PRODUCTS

A. Encapsulants
1. See Division 21 Section "Facility Fire-suppression Water-service Piping".

1.3 EXECUTION

A. Equipment
1. Respirators: Select respirators from those approved by the National Institute for Occupational Safety and Health (NIOSH). Provide personnel engaged in pre-cleaning, cleanup, handling, and removal of asbestos containing materials with the appropriate respiratory protection as specified in 29 CFR 1910.134.
2. Exterior Whole Body Protection
a. Outer Protective Clothing: Provide personnel exposed to asbestos with disposable "non-breathable," or reusable "non-breathable" whole body outer protective clothing, head coverings, gloves, and foot coverings. Provide disposable plastic or rubber gloves to protect hands. Cloth gloves may be worn inside the plastic or rubber gloves for comfort, but shall not be used alone. Make sleeves secure at the wrists, make foot coverings secure at the ankles, and make clothing secure at the neck by the use of tape. Reusable whole body

outer protective clothing shall be either disposed of as asbestos contaminated waste upon exiting from the asbestos regulated work area or be properly decontaminated.

b. Work Clothing-Not Used

c. Decontamination of Reusable Outer Protective Clothing: When reusable outer protective clothing is used, transport the double bagged clothing to a previously notified commercial/industrial decontamination facility for decontamination. Perform non-destructive testing to determine the effectiveness of asbestos decontamination. If representative sampling is used, ensure the statistical validity of the sampling results. If representative sampling is used, reject any entire batch in which any of the pieces exceed 40 fibers per square millimeter. Inspect reusable protective clothing prior to use to ensure that it will provide adequate protection and is not or is not about to become ripped, torn, deteriorated, or damaged, and that it is not visibly contaminated. Notify, in writing, all personnel involved in the decontamination of reusable outer protective clothing as indicated in 29 CFR 1926.1101.

d. Eye Protection: Provide goggles to personnel engaged in asbestos abatement operations when the use of a full face respirator is not required.

3. Warning Signs and Labels: Provide bilingual warning signs printed in English and Spanish at all approaches to asbestos control areas. Locate signs at such a distance that personnel may read the sign and take the necessary protective steps required before entering the area. Provide labels and affix to all asbestos materials, scrap, waste, debris, and other products contaminated with asbestos.

a. Warning Sign: Provide vertical format conforming to 29 CFR 1926.1101 minimum 20 by 14 inches (500 by 355 mm) displaying the following legend in the lower panel:

DANGER
ASBESTOS
MAY CAUSE CANCER
CAUSES DAMAGE TO LUNGS
AUTHORIZED PERSONNEL ONLY
WEAR RESPIRATORY PROTECTION AND
PROTECTIVE CLOTHING IN THIS AREA

b. Warning Labels: Provide labels conforming to 29 CFR 1926.1101 of sufficient size to be clearly legible, displaying the following legend:

DANGER
CONTAINS ASBESTOS FIBERS
MAY CAUSE CANCER
CAUSES DAMAGE TO LUNGS
DO NOT BREATHE DUST
AVOID CREATING DUST

c. Provide the following asbestos labels, of sufficient size to be clearly legible, for display on waste containers (bags or drums) which will be used to transport asbestos contaminated material in accordance with United States Department of Transportation 49 CFR Parts 171 and 172.

NA2212, (WASTE) ASBESTOS, 9, PGIII

4. Vacuums and Tools: Vacuums shall be leak proof to the filter and equipped with HEPA filters. Filters on vacuums shall conform to ANSI Z9.2 and UL 586. Do not use power tools to remove asbestos containing materials unless the tool is equipped with effective, integral HEPA filtered

exhaust ventilation systems. Remove all residual asbestos from reusable tools prior to storage or reuse.

B. General
   1. Pre-Asbestos Work Conference: The Contractor and the Contractor/Supervisor shall meet with the Contracting officer prior to beginning work, to discuss in detail the Asbestos Hazard Abatement Plan, including work procedures and safety precautions. Once approved by the Owners Engineer, the plan will be enforced as if a part of this specification. Any changes required in the specification as a result of the plan shall be identified specifically in the plan to allow for free discussion and approval by the Owners Engineer prior to starting work.
   2. Asbestos Control Area Requirements: The Contractor shall demarcate the asbestos control area(s) using physical barriers and signs to prevent access by unauthorized personnel. This area is defined by 29 CFR 1926.1101 as the regulated area.
   3. Work Procedure: Perform asbestos related work in accordance with 29 CFR 1926.1101, 40 CFR 61-SUBPART M, applicable State or local regulation, and as specified herein. Use wet removal procedures. Personnel shall wear and utilize protective clothing and equipment as specified herein. Eating, smoking, drinking, chewing gum or tobacco, or applying cosmetics shall not be permitted in the asbestos control area(s). Personnel of other trades not engaged in the removal of asbestos containing material shall not be exposed at any time to airborne concentrations of asbestos. If an asbestos fiber release or spill, stop work immediately, correct the condition to the satisfaction of the Owners Engineer, including clean-up and clearance sampling, if appropriate, prior to resumption of work.
   4. Furnishings: Furniture will be removed from the area of work by the Owner before asbestos work begins.
   5. Pre-cleaning: Wet wipe and HEPA vacuum all surfaces potentially contaminated with asbestos prior to establishment of an enclosure.

C. Removal Procedures: Wet asbestos containing material with a fine spray of amended water during removal, cutting, or other handling so as to reduce the emission of airborne fibers. Remove material and immediately place in 0.15 mm 6 mil plastic disposal bags. Remove asbestos containing material in a gradual manner, with continuous application of the amended water in such a manner that no asbestos material is disturbed prior to being adequately wetted. Where unusual circumstances prohibit the use of 0.15 mm 6 mil plastic bags, submit an alternate proposal for containment of asbestos fibers to the Owner's Engineer for approval. Asbestos containing material shall be containerized while wet. At no time shall asbestos containing material be allowed to accumulate or become dry. Handle asbestos containing material as indicated in 40 CFR 61-SUBPART M, applicable State or local regulation, and 29 CFR 1926.1101.
   1. Exposed Pipe Insulation Edges-Not Used
   2. Negative Pressure Enclosure: Block and seal openings in areas where the release of airborne asbestos fibers can be expected. Establish an asbestos negative pressure enclosure with the use of curtains, portable partitions, or other enclosures in order to prevent the escape of asbestos fibers from the contaminated asbestos work area.
      a. Personnel/Equipment Decontamination Unit: Provide a temporary facility with a separate equipment/dirty change room and clean change room. Provide a shower that complies with 29 CFR 1926.51 in between the dirty room and clean room for personnel required to wear whole body protective clothing. Provide two separate lockers for each asbestos worker, one in each locker room. Keep street clothing and street shoes in the clean locker. HEPA vacuum and remove asbestos contaminated disposable protective clothing while still wearing respirators at the boundary of the asbestos work area and seal in impermeable bags or containers for disposal. Do not wear work clothing between home and work. All employees shall shower before changing into street clothes. Collect used shower water and filter with approved water filtration equipment to remove asbestos contamination. Dispose of filters and residue as asbestos waste. Discharge clean water to the sanitary system. Dispose of asbestos contaminated work clothing as asbestos contaminated waste or properly decontaminate as specified in the Asbestos Hazard Abatement Plan.

b. Waste Load-Out Unit: Provide a separate temporary area expressly for short-term storage of bagged asbestos containing material that is ready for disposal. The unit shall be the only port used to transfer waste to a truck, dumpster, or other approved on-site storage facility. It shall not be used for personnel egress. A waste load-out unit shall be integral to each negative pressure enclosure.

3. Non-friable Removal Procedures:
   a. Under normal conditions EPA Category II, non-friable asbestos containing materials may not be considered hazardous; however, this material may release airborne asbestos fibers during demolition and removal; therefore it must be handled in a manner to prevent the release of asbestos fibers. At no time will this material be mechanically chipped, sawed, sanded, or ground.
   b. Prior to beginning removal, establish an Asbestos Control Area and install Critical Barriers as specified elsewhere in this section. Submit a Negative Exposure Assessment which is less than 12 months old to the the Owner for approval or conduct air sampling as specified elsewhere in this section to establish the exposure levels for the exact removal method being used. The Contractor will establish the correct level of Personal Protective Equipment required.
   c. Acceptable methods of removal include, but are not limited to, the use of dry ice, a heat gun or lamp, citrus-based solvents, and hand tools with amended water. Removal shall be accomplished to keep the ACM substantially intact. Breakage into small pieces is an unacceptable work practice. The method shall-be detailed in the Asbestos Abatement Plan and shall not be changed during the removal without Contracting Officer approval.
   d. Upon completion of the removal and clean-up, but prior to removal of critical barriers, the Contractor Testing company shall conduct a visual inspection of all areas affected by the removal. Re-clean as required.

D. Field Quality Control Requirements
   1. Visual Inspections: The the Owner will conduct periodic inspections of all areas where asbestos removal and activities are in progress to ensure compliance with the approved Asbestos Hazard Abatement Plan and Federal/State regulatory requirements. This inspection shall include confirmation of proper control/containment/enclosure, worker protection, housekeeping, exhaust equipment operation, decontamination procedures, proper wetting and disposal, and inspection of work progress and work practices. Each activity will be documented as acceptable or noted as unacceptable with justification for the non-compliance.
   2. Air Sampling: Sampling of airborne concentrations of asbestos fibers shall be performed in accordance with 29 CFR 1926.1101 and as specified herein. Unless otherwise specified, use NIOSH Method 7400 for sampling and analysis. Air Sampling may be duplicated by the Government at the discretion of the Contracting Officer. If the air sampling results obtained by the Government differ from those results obtained by the Contractor, the Government will determine which results predominate.
      a. Sampling Prior to Asbestos Work (Not Used)
      b. Sampling During Asbestos Work
         1) The Contractor's testing company shall perform area sampling as indicated in 29 CFR 1926.1101 and governing environmental regulations. Perform area sampling at least once every week close to the work inside the enclosure, outside the personnel/equipment decontamination unit entrance to the enclosure.
         2) If sampling outside the enclosure shows airborne levels have exceeded background or 0.01 fibers per cubic centimeter, whichever is greater, stop all work, correct the condition(s) causing the fiber release, and notify the the Owner immediately. Determine by testing if adjacent areas are contaminated. If so the Contractor shall clean the contaminated areas, visually inspect, and sample the areas as specified herein.
         3) The Contractor shall conduct personal sampling of at least 25% of the workers engaged in asbestos handling (removal, disposal, transport and other associated

work) throughout the duration of the project. If the quantity of airborne asbestos fibers monitored at the breathing zone of the workers at any time exceeds 0.1 fibers per cubic centimeter, notify the PQP immediately, evaluate work practices, and take corrective action to reduce airborne asbestos fibers.

E. Clean-Up And Disposal

1. Housekeeping
   a. Essential parts of asbestos dust control are housekeeping and clean-up procedures. Maintain surfaces of the asbestos control area free of accumulations of asbestos fibers. Give meticulous attention to restricting the spread of dust and debris; keep waste from being distributed over the general area. Use HEPA filtered vacuum cleaners. DO NOT BLOW DOWN THE SPACE WITH COMPRESSED AIR. All asbestos waste shall be placed in an approved on-site storage facility or transported for disposal daily. When asbestos removal is complete, all asbestos waste is removed from the work-site, and final clean-up is completed, the PQP shall visually inspect the asbestos control area for cleanliness. After final clean-up and acceptable pre-clearance airborne concentrations are attained but before the local exhaust system is turned off and the negative pressure enclosure removed), remove all pre-filters on the building HVAC system and provide new pre-filters.
   b. Dispose of filters as asbestos contaminated materials. Reestablish HVAC,. mechanical, and electrical systems in proper working order.
2. Title to Materials: All waste materials, except as specified otherwise, shall become the property of the Contractor and shall be disposed of as specified in applicable Federal, State, and local regulations and herein.
3. Disposal of Asbestos
   a. Collect all removed asbestos containing material, contaminated materials, contaminated water, scrap, debris, bags, containers, expendable equipment, and asbestos contaminated clothing which may produce airborne asbestos fibers and place in sealed fiber-proof, waterproof, non-returnable containers (e.g. double plastic bags 0.15 mm 6 mils thick, cartons, drums or cans). Wastes within the containers must be adequately wet in accordance with 40 CFR 61-SUBPART M. Affix a warning and Department of Transportation (DOT) label to each container including the bags or use at least 0.15 mm 6 mils thick bags with the approved warnings and DOT labeling preprinted on the bag.
   b. Each container or bag shall clearly indicate that the waste generator is the Owner and the development at which the waste is generated, and the Job Order number of the project.
   c. Prevent contamination of the transport vehicle (especially if the transport vehicle is a rented truck likely to be used in the future for non-asbestos purposes). These precautions include lining the vehicle cargo area with plastic sheeting (similar to work area enclosure) and thorough cleaning of the cargo area after transport and unloading of asbestos debris is complete. Dispose of waste asbestos material at an Environmental Protection Agency (EPA) or State-approved asbestos landfill off the Owner's property. For temporary storage, store sealed impermeable bags in asbestos waste drums or skids. An area for interim storage of asbestos waste-containing drums or skids will be coordinated with the the Owner. Procedure for hauling and disposal shall comply with 40 CFR 61-SUBPART M, State, regional, and local standards. Sealed plastic bags may be dumped from drums into the burial site unless the bags have been broken or damaged. Damaged bags shall remain in the drum and the entire contaminated drum shall be buried. Uncontaminated drums may be recycled. Workers unloading the sealed drums shall wear appropriate respirators and personal protective equipment when handling asbestos materials at the disposal site.

END OF SECTION 02 82 33 00a

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Task	Specification	Specification Description
02 82 33 00	01 22 16 00	No Specification Required
02 82 33 00	02 81 00 00	Disposal Of Hazardous Materials
02 82 33 00	02 82 16 00	Encapsulation (Lock-Down) Of Asbestos-Containing Materials

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SECTION 02 83 19 13 - REMOVAL AND DISPOSAL OF LEAD-CONTAINING PAINT

1.1 GENERAL

A. Description Of Work

1. This specification covers the removal and disposal of lead-based or lead-containing paint. 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. Definitions

1. Action Level: Employee exposure, without regard to use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter of air averaged over an 8 hour period in an occupational/industrial environment.
2. Area Sampling: Sampling of lead concentrations within the lead control area and inside the physical boundaries which is representative of the airborne lead concentrations but is not collected in the breathing zone of personnel.
3. Competent Person (CP): As used in this section, refers to a person employed by the Contractor who is trained in the recognition and control of lead hazards in accordance with current federal, State, and local regulations. An industrial hygienist or safety professional certified for comprehensive practice by the American Board of Industrial Hygiene or by the Board of Certified Safety Professionals is the best choice.
4. Contaminated Room: Room for removal of contaminated personal protective equipment (PPE).
5. Decontamination Shower Facility: That facility that encompasses a clean clothing storage room, and a contaminated clothing storage and disposal rooms, with a shower facility in between.
6. Eight-Hour Time Weighted Average (TWA): Airborne concentration of lead to which an employee is exposed, averaged over an 8 hour workday as indicated in 29 CFR 1926.62.
7. High Efficiency Particulate Air (HEPA) Filter Equipment: HEPA filtered vacuuming equipment with a UL 586 filter system capable of collecting and retaining lead-contaminated paint dust. A high efficiency particulate filter means 99.97 percent efficient against 0.3 micron or larger size particles.
8. Lead: Metallic lead, inorganic lead compounds, and organic lead soaps.
9. Lead-Based Paint (LBP): Paint or other surface coating that contains lead in excess of 1.0 milligrams per centimeter squared or 0.5 percent by weight.
10. Lead-Based Paint Hazard (LBP Hazard): Any condition that causes exposure to lead from lead-contaminated dust, lead-contaminated soil, lead-based paint that is deteriorated or present in accessible surfaces, friction surfaces, or impact surfaces that would result in adverse human health effects.
11. Lead-Containing Paint (LCP): Lead-based paint or other similar surface coating containing lead or lead compound in excess of 0.06 percent by weight of the total nonvolatile content of the paint.
12. Lead Control Area: An enclosed area or structure, constructed as a temporary containment equipped with HEPA filtered local exhaust, which prevents the spread of lead dust, paint chips, or debris existing as a condition of lead-based paint removal operations. The lead control area is also isolated by physical boundaries to prevent unauthorized entry of personnel.
13. Lead Permissible Exposure Limit (PEL): Fifty micrograms per cubic meter of air as an 8 hour time weighted average as determined by 29 CFR 1926.62. If an employee is exposed for more than eight hours in a work day, the PEL shall be determined by the following formula:

    PEL (micrograms/cubic meter of air) = 400/No. hrs. worked per day.
14. Personal Sampling: Sampling of airborne lead concentrations within the breathing zone of an employee to determine the 8 hour time weighted average concentration in accordance with 29 CFR 1926.62. Samples shall be representative of the employees' work tasks. Breathing zone shall be considered an area within a hemisphere, forward of the shoulders, with a radius of 6 to 9 inches (150 to 225 mm) and centered at the nose or mouth of an employee.

15. Physical Boundary: Area physically roped or partitioned off around an enclosed lead control area to limit unauthorized entry of personnel. As used in this section, "inside boundary" shall mean the same as "outside lead control area but inside boundary."

C. Submittals: Submit the following:
   1. Product Data:
      a. Vacuum filters
      b. Respirators
   2. Test Reports
      a. Sampling results
      b. Assessment data report
   3. Certificates
      a. Qualifications of CP
      b. Testing laboratory</SUB> qualifications
      c. Third party consultant qualifications
      d. Lead-Based Paint/Lead-Containing Paint Removal Plan including CP approval (signature, date, and certification number)
      e. Rental equipment notification
      f. Respiratory protection program
      g. Hazard communication program
      h. EPA approved hazardous waste treatment or disposal facility for lead disposal
      i. Hazardous waste management plan
      j. Vacuum filters
   4. Manufacturer's Instructions
      a. Chemicals and equipment
      b. Materials
      c. Material safety data sheets for all chemicals
   5. Closeout Submittals
      a. Completed and signed hazardous waste manifest from treatment or disposal facility
      b. Certification of medical examinations
      c. Employee training certification

D. Qualifications Of CP
   1. Submit name, address, and telephone number of the CP selected to perform responsibilities specified in paragraph entitled "Competent Person (CP) Responsibilities." Provide previous experience of the CP. Submit proper documentation that the CP is trained and licensed and certified in accordance with Federal, State, and local laws.

E. Third Party Consultant Qualifications
   1. Submit the name, address, and telephone number of the third party consultant selected to perform the wipe sampling for determining concentrations of lead in dust or soil sampling. Submit proper documentation that the consultant is trained and certified as an inspector technician or inspector/risk assessor by the USEPA authorized State (or local) certification and accreditation program.

F. Testing Laboratory
   1. Submit the name, address, and telephone number of the testing laboratory selected to perform the air and wipe and soil sampling, testing, and reporting of airborne concentrations of lead. Use a laboratory accredited under the EPA National Lead Laboratory Accreditation Program (NLLAP) by either the American Association for Laboratory Accreditation (A2LA) or the American Industrial Hygiene Association (AIHA) and that is successfully participating in the Environmental Lead Proficiency Analytical Testing (ELPAT) program to perform sample analysis.

G. Lead-Based Paint/Lead-Containing Paint Removal Plan (LBP/LCPRP)

1. Submit a detailed job-specific plan of the work procedures to be used in the removal of LBP/LCP. The plan shall include a sketch showing the location, size, and details of lead control areas, location and details of decontamination facilities, viewing ports, and mechanical ventilation system. Include in the plan, eating, drinking, smoking and sanitary procedures, interface of trades, sequencing of lead related work, collected waste water and paint debris disposal plan, air sampling plan, respirators, personal protective equipment, and a detailed description of the method of containment of the operation to ensure that airborne lead concentrations of 30 micrograms per cubic meter of air and baseline lead dust/soil concentrations are not reached or exceeded outside of the lead control area. Include site preparation and cleanup procedures. Include occupational and environmental sampling, training and strategy, sampling methodology, frequency, duration of sampling, and qualifications of sampling personnel in the air sampling portion of the plan.

H. Occupational And Environmental Sampling Results
   1. Submit occupational and environmental sampling results to the the Owner within three working days of collection, signed by the testing laboratory responsible official, the employee that performed the sampling, and the CP.
      a. The sampling results shall represent each job classification, or if working conditions are similar to previous jobs by the same employer, provide previously collected exposure data that can be used to estimate worker exposures in accordance with 29 CFR 1926.62. The data shall represent the worker's regular daily exposure to lead.
      b. Submit worker exposure data conducted during the task based trigger operations of 29 CFR 1926.62.
      c. The initial monitoring shall determine the requirements for further monitoring and the need to fully implement the control and protective requirements including the compliance program (LBP/LCP) in accordance with 29 CFR 1926.62.

I. Occupational And Environmental Assessment Data Report:
   1. Some LBP/LCP removal work may not require full implementation of the requirements of 29 CFR 1926.62. Based on the experience of the Contractor and/or the use of a specific process or method for performing the work, the Contractor may be able to provide historic data (previous 12 months) to demonstrate that airborne exposures are controlled below the action level. Such methods or controls shall be fully presented in the LBP/LCPRP. To reduce the full implementation of 29 CFR 1926.62, the Contractor shall provide documentation in an Assessment Data Report.
   2. Submit occupational and environmental assessment report to the the Owner prior to start of work, signed by the testing laboratory responsible official, and the CP.
      a. Submit a report that supports the determination regarding the reduction of the need to fully implement the requirements of 29 CFR 1926.62 and supporting the LBP/LCP. The exposure assessment shall represent each job classification, or if working conditions are similar to previous jobs by the same employer, provide previously collected exposure data that can be used to estimate worker exposures in accordance with 29 CFR 1926.62. The data shall represent the worker's regular daily exposure to lead for stated work.
      b. Submit worker exposure data conducted during the task based trigger operations of 29 CFR 1926.62 with a complete process description in supporting a negative assessment.
      c. The initial assessment shall determine the requirement for further monitoring and the need to fully implement the control and protective requirements including the compliance program (LBP/LCPRP) in accordance with 29 CFR 1926.62.

J. Quality Assurance
   1. Medical Examinations: Initial medical surveillance as required by 29 CFR 1926.62 shall be made available to all employees exposed to lead at any time (1 day) above the action level. Full medical surveillance shall be made available to all employees on an annual basis who are or may be exposed to lead in excess of the action level for more than 30 days a year or as required by 29 CFR 1926.62. Adequate records shall show that employees meet the medical surveillance requirements of 29 CFR 1926.33, 29 CFR 1926.62, and 29 CFR 1926.103.

a. Medical Records: Maintain complete and accurate medical records of employees for a period of at least 30 years or for the duration of employment plus 30 years, whichever is longer.
b. Medical Surveillance: Provide medical surveillance to all personnel exposed to lead as indicated in 29 CFR 1926.62.

2. Competent Person (CP) Responsibilities
   a. Certify training as meeting all federal, State, and local requirements.
   b. Review and approve lead-based paint/lead-containing paint removal plan for conformance to the applicable referenced standards.
   c. Continuously inspect lead-based paint removal work for conformance with the approved plan.
   d. Perform air and wipe sampling.
   e. Ensure work is performed in strict accordance with specifications at all times.
   f. Control work to prevent hazardous exposure to human beings and to the environment at all times.
   g. Certify the conditions of the work as called for elsewhere in this specification.
3. Training: Train each employee performing paint removal, disposal, and air sampling operations prior to the time of initial job assignment and annually thereafter, in accordance with 29 CFR 1926.21, 29 CFR 1926.62, and State and local regulations.
   a. Training Certification: Submit a certificate for each employee, signed and dated by the approved training source, stating that the employee has received the required lead training.
4. Respiratory Protection Program
   a. Furnish each employee required to wear a negative pressure respirator or other appropriate type with a respirator fit test at the time of initial fitting and at least annually thereafter as required by 29 CFR 1926.62.
   b. Establish and implement a respiratory protection program as required by ANSI Z88.2, 29 CFR 1926.103, 29 CFR 1926.62, and 29 CFR 1926.55.
5. Hazard Communication Program: Establish and implement a Hazard Communication Program as required by 29 CFR 1926.59.
6. Hazardous Waste Management: The Hazardous Waste Management Plan shall comply with applicable requirements of federal, State, and local hazardous waste regulations and address:
   a. Identification and classification of hazardous wastes associated with the work.
   b. Estimated quantities of wastes to be generated and disposed of.
   c. Names and qualifications of each contractor that will be transporting, storing, treating, and disposing of the wastes. Include the facility location and operator and a 24-hour point of contact. Furnish two copies of EPA, or State and local hazardous waste permit applications or permits or manifests, as required, and EPA Identification numbers.
   d. Names and qualifications (experience and training) of personnel who will be working on-site with hazardous wastes.
   e. List of waste handling equipment to be used in performing the work, to include cleaning, volume reduction, and transport equipment.
   f. Spill prevention, containment, and cleanup contingency measures including a health and safety plan to be implemented in accordance with 29 CFR 1926.65.
   g. Work plan and schedule for waste containment, removal and disposal. Wastes shall be cleaned up and containerized daily.
   h. Unit cost for hazardous waste disposal according to this plan.
7. Environmental, Safety and Health Compliance: In addition to the detailed requirements of this specification, comply with laws, ordinances, rules, and regulations of Federal, State, and local authorities regarding removing, handling, storing, transporting, and disposing of lead waste materials. Comply with the applicable requirements of the current issue of 29 CFR 1926.62. Submit matters regarding interpretation of standards to the the Owner for resolution before starting work. Where specification requirements and the referenced documents vary, the most stringent requirement shall apply.

8. Pre-Construction Conference: Along with the CP, meet with the the Owner to discuss in detail the hazardous waste management plan and the lead-based paint/lead-containing paint removal plan, including work procedures and precautions for the removal plan.

K. Equipment
1. Respirators: Furnish appropriate respirators approved by the National Institute for Occupational Safety and Health (NIOSH), Department of Health and Human Services, for use in atmospheres containing lead dust. Respirators shall comply with the requirements of 29 CFR 1926.62.
2. Special Protective Clothing: Furnish personnel who will be exposed to lead-contaminated dust with proper disposable uncontaminated, reusable protective whole body clothing, head covering, gloves, and foot coverings as required by 29 CFR 1926.62. Furnish proper disposable plastic or rubber gloves to protect hands. Reduce the level of protection only after obtaining approval from the CP.
3. Rental Equipment Notification: If rental equipment is to be used during lead-based paint handling and disposal, notify the rental agency in writing concerning the intended use of the equipment. Furnish a copy of the written notification to the the Owner.
4. Vacuum Filters: UL 586 labeled HEPA filters.
5. Equipment for Owner's Personnel: Furnish the the Owner with two complete sets of personal protective equipment (PPE) daily, as required herein, for entry into and inspection of the paint removal work within the lead controlled area. Personal protective equipment shall include disposable whole body covering, including appropriate foot, head, and hand protection. PPE shall remain the property of the Contractor. Respiratory protection for the the Owner will be provided by the Owner.

L. Removal
1. Title to Materials: Materials resulting from demolition work, except as specified otherwise, shall become the property of the Contractor and shall be disposed of in accordance with Division 02 Section(s) "Selective Structure Demolition" OR "Structure Demolition", except as specified herein.

1.2 PRODUCT

A. Chemicals
1. Submit applicable Material Safety Data Sheets for all chemicals used in paint removal work. Use the least toxic product approved by the the Owner.

B. Materials
1. The soluble metal content and the total metal content shall not exceed values which would cause a material to be classified as a hazardous waste.

1.3 EXECUTION

A. Protection
1. Notification: Notify the the Owner 20 days prior to the start of any paint removal work.
2. Lead Control Area Requirements
a. If LBP will be removed by means which will not likely create airborne, lead-containing dust (such as careful wet scraping or chemical stripping), establish a lead control area by situating critical barriers and physical boundaries around the area or structure where LBP/LCP removal operations will be performed.
b. If removal practice will create airborne, lead-containing dust (such as sanding, abrasive blasting, thermal cutting, demolition, or needle gun use), utilize full containment procedures - Contain removal operations by the use of critical barriers and HEPA filtered exhaust **OR** a negative pressure enclosure system with decontamination facilities and with HEPA filtered exhaust if required by the CP, **as directed**. For containment areas larger than 1,000 square feet (100 square meters) install a minimum of two 18 inch (450 mm) square viewing

ports. Locate ports to provide a view of the required work from the exterior of the enclosed contaminated area. Glaze ports with laminated safety glass.

3. Protection of Existing Work to Remain: Perform paint removal work without damage or contamination of adjacent areas. Where existing work is damaged or contaminated, restore work to its original condition or better.
4. Boundary Requirements: Provide physical boundaries around the lead control area by roping off the area designated in the work plan or providing curtains, portable partitions or other enclosures to ensure that airborne concentrations of lead will not reach 30 micrograms per cubic meter of air outside of the lead control area.
   a. Physical Boundary: Provide physical boundaries around the lead control area by roping off the area designated in the work plan or providing curtains, portable partitions or other enclosures to ensure that airborne concentrations of lead will not reach 30 micrograms per cubic meter of air outside of the lead control area.
   b. Warning Signs: Provide warning signs at approaches to lead control areas. Locate signs at such a distance that personnel may read the sign and take the necessary precautions before entering the area. Signs shall comply with the requirements of 29 CFR 1926.62.
5. Furnishings:
   a. The Owner will remove furniture and equipment from the building before lead-based paint removal work begins.

      OR

      Furniture and equipment will remain in the building. Protect and cover furnishings or remove furnishings from the work area and store in a location approved by the the Owner.

      OR

      Existing furniture and equipment is lead contaminated, decontaminate, dispose of as lead contaminated waste.
6. Heating, Ventilating and Air Conditioning (HVAC) Systems: Shut down, lock out, and isolate HVAC systems that supply, exhaust, or pass through the lead control areas. Seal intake and exhaust vents in the lead control area with 6 mil (0.15 mm) plastic sheet and tape. Seal seams in HVAC components that pass through the lead control area. Provide temporary HVAC system for areas in which HVAC has been shut down outside the lead control area.
7. Decontamination Shower Facility: Provide clean and contaminated change rooms and shower facilities in accordance with this specification and 29 CFR 1926.62.
8. Eye Wash Station: Where eyes may be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of the eyes shall be provided within the work area.
9. Mechanical Ventilation System
   a. Use adequate ventilation to control personnel exposure to lead in accordance with 29 CFR 1926.62.
   b. To the extent feasible, use fixed local exhaust ventilation connected to HEPA filters or other collection systems, approved by the CP. Local exhaust ventilation systems shall be designed, constructed, installed, and maintained in accordance with ANSI Z9.2.
   c. Vent local exhaust outside the building only and away from building ventilation intakes.
   d. Use locally exhausted, power actuated, paint removal tools.
10. Personnel Protection: Personnel shall wear and use protective clothing and equipment as specified herein. Eating, smoking, or drinking or application of cosmetics is not permitted in the lead control area. No one will be permitted in the lead control area unless they have been appropriately trained and provided with protective equipment.

B. Work Procedures: Perform removal of lead-based paint in accordance with approved lead-based paint/lead-containing paint removal plan. Use procedures and equipment required to limit occupational and environmental exposure to lead when lead-based paint is removed in accordance with 29 CFR 1926.62, except as specified herein. Dispose of removed paint chips and associated waste in compliance with Environmental Protection Agency (EPA), federal, State, and local requirements.
   1. Personnel Exiting Procedures: Whenever personnel exit the lead-controlled area, they shall perform the following procedures and shall not leave the work place wearing any clothing or equipment worn during the work day:

a. Vacuum themselves off.
b. Remove protective clothing in the contaminated change room, and place them in an approved impermeable disposal bag.
c. Shower **OR** Wash hands and face at the site, **as directed**, don appropriate disposable or uncontaminated reusable clothing; move to an appropriate facility; shower.
d. Change to clean clothes prior to leaving the physical boundary designated around the lead control area.

2. Air and Wipe Sampling
   a. Air sample for lead in accordance with 29 CFR 1926.62 and as specified herein. Air and wipe sampling shall be directed or performed by the CP.
      1) The CP shall be on the job site directing the air and non-clearance wipe sampling and inspecting the lead-based paint removal work to ensure that the requirements of the contract have been satisfied during the entire lead-based paint removal operation.
      2) Collect personal air samples on employees who are anticipated to have the greatest risk of exposure as determined by the CP. In addition, collect air samples on at least 25 percent of the work crew or a minimum of two employees, whichever is greater, during each work shift.
      3) Submit results of air samples, signed by the CP, within 72 hours after the air samples are taken. Notify the the Owner immediately of exposure to lead at or in excess of the action level of 30 micrograms per cubic meter of air outside of the lead control area.
      4) For high profile, sensitive work such as present in family housing, child care facilities, administrative buildings, kitchens, barracks, etc., surface dust sampling to determine clearance (i.e., that the work has not contaminated surfaces within and adjacent to the control area) should be performed by a third party to reduce a conflict of interest. Samples must be conducted by an individual not paid or employed or otherwise compensated by the LBP/LCP removal Contractor. State or local regulations may require third party testing if the LBP/LCP removal operation is considered a lead hazard reduction activity.
      5) Before any work begins, collect and analyze baseline or soil wipe samples in accordance with methods defined in federal, State, and local standards inside and outside of the physical boundary to assess the degree of dust contamination in the facility prior to lead-based paint removal.
   b. Air Sampling During Paint Removal Work: Conduct area air sampling daily, on each shift in which lead-based paint removal operations are performed, in areas immediately adjacent to the lead control area. Sufficient area monitoring shall be conducted to ensure unprotected personnel are not exposed at or above 30 micrograms per cubic meter of air. If 30 micrograms per cubic meter of air is reached or exceeded, stop work, correct the conditions(s) causing the increased levels. Notify the the Owner immediately. Determine if condition(s) require any further change in work methods. Removal work shall resume only after approval is given by the CP and the the Owner. For outdoor operations, at least one sample on each shift shall be taken on the downwind side of the lead control area.

3. Lead-Based Paint Removal
   a. Manual or power sanding of interior and exterior surfaces is not permitted. Provide methodology for removing LBP in work plan. Remove paint within the areas designated on the drawings in order to completely expose the substrate. Take whatever precautions necessary to minimize damage to the underlying substrate.
   b. Avoid flash rusting or deterioration of the substrate. Provide surface preparations for painting in accord with Division 07.
   c. Provide methodology for removing LBP/LCP removal processes to minimize contamination of work areas outside the control area with lead-contaminated dust or other lead-contaminated debris/waste and to ensure that unprotected personnel are not exposed to hazardous concentrations of lead. Describe this LBP/LCP removal process in the LBP/LCPRP.

d. Indoor Lead Paint Removal: Perform manual **OR** mechanical **OR** thermal **OR** chemical, **as directed**, paint removal in lead control areas using enclosures, barriers, or containments and powered locally exhausted paint removal tools. Collect residue and/or debris for disposal in accordance with federal, State, and local requirements.

e. Outdoor Lead Paint Removal: Perform outdoor removal as indicated in federal, State, and local regulations and in the LBP/CPRP. The worksite preparation (barriers or containments) shall be job dependent and presented in the LBP/LCPRP.

f. Sampling After Paint Removal: After the visual inspection, conduct soil sampling if bare soil is present during external removal operations and collect air samples inside and outside the lead control area to determine the airborne levels of lead inside and outside the work area. Collect wipe samples according to the HUD protocol contained in HUD Guidelines to determine the lead content of settled dust and dirt in micrograms per square foot (square meter) of surface area and parts per million (ppm) or micrograms per gram (µg/g) for soil.

4. Cleanup and Disposal

a. Cleanup: Maintain surfaces of the lead control area free of accumulations of paint chips and dust. Restrict the spread of dust and debris; keep waste from being distributed over the work area. Do not dry sweep or use compressed air to clean up the area. At the end of each shift and when the paint removal operation has been completed, clean the area of visible lead paint contamination by vacuuming with a HEPA filtered vacuum cleaner, wet mopping the area and wet wiping the area as indicated by the CP. Reclean areas showing dust or residual paint chips or debris. After visible dust, chips and debris is removed, wet wipe and HEPA vacuum all surfaces in the work area. If adjacent areas become contaminated at any time during the work, clean, visually inspect, and then wipe sample all contaminated areas. The CP shall then certify in writing that the area has been cleaned of lead contamination before restarting work.

b. Clearance Certification

1) The CP shall certify in writing that the final air samples collected inside and outside the lead control area are less than 30 micrograms per cubic meter of air; the respiratory protection used for the employees was adequate; the work procedures were performed in accordance with 29 CFR 1926.62 and 40 CFR 745; and that there were no visible accumulations of material and dust containing lead left in the work site. Do not remove the lead control area or roped off boundary and warning signs prior to the the Owner's acknowledgement of receipt of the CP certification.

2) A third party consultant shall certify surface wipe sample results collected inside and outside the work area are less than 100 micrograms per square foot (0.1 square meter) on uncarpeted floors, less than 500 micrograms per square foot (0.1 square meter) on interior window sills and less than 800 micrograms per square foot (0.1 square meter) on window troughs **OR** not significantly greater than the initial surface loading determined prior to work, **as directed**.

3) For exterior paint removal work, soil samples taken at the exterior of the work site shall be sued to determine if soil lead levels had increased at a statistically significant level (significant at the 95 percent confidence limit) from the soil lead levels prior to the work. If soil lead levels do show a statistically significant increase above any applicable Federal or State standard for lead in soil, the soil shall be remediated back to the pre-work level.

c. Testing of Lead-Based Paint Residue and Used Abrasive: Test paint residue and used abrasive in accordance with 40 CFR 261 for hazardous waste.

d. Disposal

1) Collect lead-contaminated waste, scrap, debris, bags, containers, equipment, and lead-contaminated clothing which may produce airborne concentrations of lead particles. Label the containers in accordance with 29 CFR 1926.62 and 40 CFR 261. Dispose of lead-contaminated waste material at an EPA or State approved hazardous waste treatment, storage, or disposal facility off Owner’s property.

2) Store waste materials in U.S. Department of Transportation (49 CFR 178) approved 55 gallon (208 liter) drums. Properly label each drum to identify the type of waste (49 CFR 172) and the date the drum was filled. The the Owner or an authorized representative will assign an area for interim storage of waste-containing drums. Do not store hazardous waste drums in interim storage longer than 90 calendar days from the date affixed to each drum.
3) Handle, store, transport, and dispose lead or lead-contaminated waste in accordance with 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, and 40 CFR 265. Comply with land disposal restriction notification requirements as required by 40 CFR 268.
4) All material, whether hazardous or non-hazardous shall be disposed in accordance with laws and provisions and Federal, State, or local regulations. Ensure waste is properly characterized. The result of each waste characterization (TCLP for RCRA materials) will dictate disposal requirements.

5. Disposal Documentation: Submit written evidence that the hazardous waste treatment, storage, or disposal facility (TSD) is approved for lead disposal by the EPA and State or local regulatory agencies. Submit one copy of the completed manifest, signed and dated by the initial transporter in accordance with 40 CFR 262.
6. Payment for Hazardous Waste: Payment for disposal of hazardous waste will not be made until a signed copy of the manifest from the treatment or disposal facility certifying the amount of lead-containing materials delivered is returned and a copy is furnished to the Owner.

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SECTION 02 83 19 13a - LEAD PAINT RELATED ABATEMENT PROCEDURES

1.1 GENERAL

A. Description Of Work

1. This specification covers the furnishing and installation of materials for lead paint related abatement procedures. 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 Provisions

1. The site of this work will be occupied while work is being done. Perform the abatement work with the least inconvenience to the residents.
2. Take all necessary precautions to protect the property of the the Owner and its residents. Damaged property shall be repaired and restored to its original condition. If the damage is beyond repair, the Contractor shall replace it with new materials to match existing, at the Contractor's expense.
3. Hazardous waste generated during the abatement process (including lead-base paint) when carted away from the developments shall not be transferred from one vehicle to another except at a licensed transfer station.
4. Develop a work plan to be performed as requested by the the Owner. The detailed plan shall include sequencing of abatement work in a manner that will be least disruptive to the normal use of the non-work areas in the building. The plan should also include emergency procedures in case of fire.
5. The Contractor shall include all supplementary miscellaneous items not specified but implied or required in order to complete the work.
6. Workmanship required in the execution of the work herein specified shall be of good quality and subject to the approval of the the Owner.
7. Make in a timely fashion all applicable and necessary notifications to relevant Federal, State and Local authorities. The Contractor shall indemnify the the Owner and the the Owner's representative from, and pay all claims resulting from failure to adhere to these provisions.
8. the Owner may retain an independent Monitoring Contractor to monitor the abatement contract and conduct all wipe sampling and clearance tests.
9. Contractor performing lead-based paint abatement or renovation activities involving lead-based paint shall be a Certified Lead Abatement Contractor and shall ensure that supervisors and workers are trained and certified by U.S. EPA approved state program or equivalent, to perform lead paint removal operations.
10. Establish and implement a Chemical Hazard Communication Program as required by OSHA regulations 29 CFR 1926.59.
11. Provide workers with a comprehensive medical examination as required by OSHA regulations 29 CFR 1926.62 before exposure to lead contaminated dust. The medical examination shall be conducted to approve use of appropriate respirators and shall include biological monitoring NIOSH/MSHA approved respirators shall be utilized.
12. For employees required to wear a negative pressure respirators: conduct a respirator fit test at the time of initial fitting and at least once every six (6) months thereafter as required by OSHA regulations 29 CFR 1926.62.
13. Determine if any worker will be exposed to lead at or above the action level in accordance with OSHA regulation 29 CFR 1926.62 and 29 CFR 1910.1025. Conduct an exposure assessment to identify the level of exposure a worker would be subjected to without respiratory protection. Assess the exposure level by obtaining personal monitoring samples representative of a full shift of at least an 8-hour TWA.
14. Furnish appropriate respirators approved by NIOSH/MSHA for use in atmospheres containing lead aerosols. Instruct workers in all aspects of respiratory protection. Maintain an adequate supply of HEPA filter elements and spare parts on site for all types of respirators in use.

15. For manual demolition, scraping, sanding, use of heat gun or power tool paint removal with HEPA collection systems, workers shall minimally use the half-mask negative pressure respirator with high efficiency filters (for airborne concentrations not in excess of 500µg/m³).
16. Ensure that work area preparation, work practices, and clean-up procedures comply with these specifications and applicable Federal, State and Local regulations.
17. Notify all applicable agencies five days prior to the date the abatement will begin and provide evidence of notifications to the the Owner at the pre-start meeting.

C. Submissions

1. Within ten (10) consecutive calendar days calculated from the date of the the Owner's Job Order, the Contractor shall tender all required submissions. Six (6) sets of each submission are required. Where physical samples are required two (2) physical samples shall be submitted for each item. In general, items shall include but not be restricted to the following:
   a. Paint remover - corner cutter/Vac-Pac System by Pentek Inc; Decontamination Products Division 1026 Fourth Avenue, Corapolis, PA. 15108. Telephone No. (412) 262-0725 or approved equal.
   b. Description of removal method to be used on each substrate condition including manufacturer's operating instructions and recommendation for equipment usage.
   c. Copies of current training certificates of Staff to be assigned to the contract.
   d. List of three previous lead abatement jobs performed successfully by Contractor and name, address, and telephone number of contact person for verification.
2. In the event that all or any portion of the submitted material is rejected by the the Owner, the Contractor shall tender new submissions. All submissions returned for corrections shall be resubmitted with the required corrections within ten(10) consecutive calendar days calculated from the date of rejection, until final submissions are obtained that require no further correction. In no event shall the Contractor be permitted to tender submissions hereunder beyond twenty (20) days from the the Owner's Job Order, unless duly extended in writing by the the Owner.
3. No work shall begin, nor shall the materials be ordered or delivered to the site until final approval of all submissions.

D. Applicable Regulations

1. 24 CFR Part 35
2. HUD ”Guidelines For the Evaluation and Control of Lead-Based Paint Hazards in Housing”
3. Abatement work shall also be in accordance with applicable regulations of the Environmental Protection Agency (EPA), Occupational Safety & Health Agency (OSHA) and any State or Local LBP standards. Where there is a conflict between Federal, State or Local regulations, the more stringent requirement shall prevail.
4. OSHA Standards
   a. 29 CFR 1926.20 General safety and health provisions;
   b. 29 CFR 1926.21 Safety training and education;
   c. 29 CFR 1925.25 Housekeeping;
   d. 29 CFR 1926-28 Personal protective equipment;
   e. 29 CFR 1926.51(f) Washing facilities;
   f. 29 CFR 1926.55 Gases, vapors, fumes, dusts, and mists;
   g. 29 CFR 1926.57 Ventilation
   h. 29 CFR 1926.59 Hazardous Communication Standards;
   i. 29 CFR 1926.103 Respiratory protection, and
   j. 29 CFR 1926.62 Lead in Construction
5. The Contractor must comply with all applicable requirements of the Resource Conservation & Recovery Act (RCRA) of 1976 as amended in 1980 and 1984 by the Hazardous & Solid Waste Amendments (HSWA).
6. These Specifications refer to many requirements found in the preceding references but in no way is it intended to cite or reiterate all provisions therein or elsewhere. It is the Contractor's responsibility to obtain a copy, and know, understand and abide by all such regulations, guidelines and common practices.

1.2 PRODUCTS – (not used)

1.3 EXECUTION

A. Abatement

1. Have risk assessment or paint inspection performed by certified risk assessor or a certified inspector technician who is independent of the abatement contractor.
2. Develop a site specific lead hazard control plan, reviewed and signed by an asbestos consultant (LAC) who is licensed in the State in which the work is to be performed, and submit for review and approval to the the Owner.
3. Obtain any necessary building or waste permits, notify local authorities as required by applicable codes and laws.
4. Select specific building component replacement items, enclosure materials, paint removal equipment and/or chemicals, tools, and cleaning supplies. Consider waste management and historical preservation implications of selected treatment.
5. Develop project specific specifications.
6. Schedule other work so that leaded surfaces are not inadvertently disturbed and unprotected workers are not place at risk. Include time for clearance examinations and laboratory dust sample analysis in the scheduling process.
7. Select a certified abatement subcontractor.
8. Conduct a pre-construction conference to ensure that the subcontractor fully understands the work involved.
9. Notify residents of the dwelling and adjacent dwellings of the work and date it will begin. Coordinate this with the the Owner.
10. Correct any existing conditions that could impede the abatement work (i.e. trash removal, structural deficiencies).
11. Post warning signs and restrict entry to work area to authorized personnel. Implement worksite preparation procedures.
    a. Place proper warning signs required by OSHA regulations at all entrances to the work area. Signage shall be minimum of 12" x 20" and shall state the following:

WARNING
LEAD WORK AREA
POISON
NO SMOKING OR EATING

12. Coordinate test, pilot or sample portion approach to the project with the Owner.
13. Shut-down forced air heating, ventilation and air conditioning systems and cover all vents, diffusers, windows etc., with a single layer six-mil polyethylene sheet secured with duct tape. Exceptions shall be for minor disturbances of area less than 2 square feet and where if vents, diffusers, and windows are more than 5 feet away from surface being disturbed, they need not be covered.
14. Collect preabatement soil samples, which may not have to be analyzed until post abatement soil samples have been collected, analyzed, and compared to clearance standards. If postabatement soil levels are below applicable limits, the preabatement samples need not be analyzed.
15. Cover entrances to the work area with a single layer of 6 mil polyethylene sheets taped to the top and weighted at bottom.
16. Rig a containment non-flammable polyethylene sheet underneath the work area. This containment method should catch all stripped paint for proper disposal.
17. Execute abatement work.
18. Avoid spreading dust and debris outside the work area.
19. Store all waste in a secure area and make sure it is properly labeled with an accumulation start date.
20. Conduct daily and final cleanup.
21. Execute waste disposal procedures.

22. Maintain appropriate records.

B. Paint Removal
1. Do not use the following prohibited paint removal methods:
   a. Dry scraping or sanding (except for limited areas)
   b. Use of heat gun over 1,100°F
   c. Open flame burning or torching
   d. Machine sanding or grinding without HEPA vacuum exhaust tool
   e. Abrasive blasting or sandblasting without HEPA vacuum exhaust tool
   f. Uncontained hydro blasting or high-pressure wash
   g. Use of chemical strippers containing Methylene chloride.
2. Select the appropriate worksite preparation level.
3. For heat gun work, provide fire extinguishers in the work area and ensure that adequate electrical power is available. Use for limited areas only. Train workers to avoid gouging or abrading the substrate.
4. For mechanical removal methods, use tools equipped with HEPA exhaust capability. Be sure workers keep the shroud against the surface being treated. Vacuum blasting and needle guns should not be used on wood, plaster, drywall, or other soft substrates. Observe all manufacturers directions for the amount of vacuum airflow required.
5. For wet scraping, use a spray bottle or wet sponge attached to the scraper to keep the surface wet while scraping. Apply enough water to moisten the surface completely, but not so much that large amounts of water run onto the ground or floor. Do not moisten areas near electrical circuits.
6. For chemical paint removers, determine if the building component can be removed and stripped offsite. Offsite stripping is generally preferred to onsite paint removal. Observe all manufacturers' directions for use of paint removers.
7. For offsite stripping, determine how to remove the component. Score the edges with a knife or razor blade to minimize the damage to adjacent surfaces. Punch or tag the building component, if similar building components are also being stripped offsite (i.e. doors). This will ensure that the individual component is reinstalled in the same location. Inform the offsite paint remover that the lead-based paint component is present for shipping. Wrap the component in plastic and send to the offsite stripping location. Clean all surfaces before reinstallation and remove any lead residue by HEPA vacuuming all surfaces, cleaning with other lead-specific cleaners, or phosphate detergents, and HEPA vacuuming again.
8. For onsite paint removal, first test the product on a small area to determine its effectiveness. Chemical paint removers may not be effective or desirable on exterior, deteriorated wood surfaces, aluminum, and glass. Provide neoprene, nitrile, rubber, or polyvinyl chloride (PVC) gloves (or other type of glove recommended by the manufacture); face shields; respirators with combination filter cartridges for lead dust and organic vapors(if appropriate); and chemically resistant clothing. Be sure to select the right type of organic vapor filter cartridge, gloves, and clothing for the specific chemical being used. Portable eyewash stations capable of providing a 15-minute flow must be on-site. Apply the chemical and wait the required period of time. Securely store chemical s overnight. For caustic chemical paint removers, neutralize the surface before repainting using glacial acetic acid (not vinegar). Repaint.
9. Make sure all debris is caught in the containment sheet for proper disposal.
10. Mark and legally dispose of waste in accordance with all applicable Federal, State and Local regulations. Most wastes from paint removal projects, such as paint chips and paint remover sludge, will need to be managed as hazardous waste.
11. Conduct clean-up
12. Have a certified risk assessor or inspector technician conduct a clearance examination and provide documentation and a Statement of Lead-Based Paint Compliance.

C. Building Component Replacement
1. Prepare work area by selecting proper worksite preparation level.
2. Prepare the hazardous material building component for removal. Turn off and disconnect any electrical circuits inside or near the building component to be removed.

3. Lightly mist the component to be removed (unless electrical circuits are located nearby).
4. Score all painted seams with a sharp knife.
5. Remove any screw, nails, or other fasteners.
6. Use flat pry instrument and hammer to pry component from the substrate.
7. Remove or bend back all nails.
8. Wrap and seal all bulk components in plastic and take them to a covered truck or secured waste storage area along a pathway covered in plastic. Shovel any debris. Dispose of properly.
9. HEPA vacuum any dust or chips in the area where the component was located.
10. Conduct cleaning and clearance activities.

D. Soil and Exterior Dust Abatement
1. Determine if soil lead hazard exists. For hazard to exist, a total of at least 9 square feet of soil in a single yard or area must be bare and soil concentrations must exceed 2,000µg/gram lead for the yard or building perimeter or 400µg/gram of lead for small, high-contact play areas (pending the development of an EPA soil standard). Bare soil above these levels shall be treated by either interim controls or abatement. Soil abatement is most appropriate when levels of lead are extraordinarily high (greater than 5,000µg/gram lead) and when use patterns indicate contact frequency and exposure will be high.
2. Collect Preabatement soil samples to determine baseline levels. These samples need not be analyzed if post abatement samples are below applicable clearance levels.
3. Determine the method of soil abatement (soil removal and replacement, soil cleaning, or paving). Soil cultivation (rototilling or turning over the soil) is not permitted.
4. If paving, use a high quality concrete or asphalt. Observe normal precautions associate with traffic load weight and thermal expansion and contraction. Obtain necessary permits. Keep soil cultivation to a minimum.
5. If removing and replacing soil.
    a. Determine if waste soil will be placed in an offsite burial pit. Prepare vehicle operation and soil movement plan. Test new replacement soil (should not contain more than 200 µg/gram lead).
    b. Contact local utilities to determine location of underground utilities including water, gas, cable TV, electric, telephone, and sewer. Mark all locations to be avoided
    c. Remove fencing, if necessary to allow equipment access and define set limits with temporary fencing, signs, or yellow caution tape.
    d. Tie and protect existing trees, shrubs, and bushes.
    e. Have enough tools to avoid handling clean soil with contaminated tools.
    f. Remove soil.
    g. Clean all walkways, driveways, and street areas near abatement area.
    h. Replace soil at proper grade to allow drainage. Replacement soil should be at least 2 inches above existing grade to allow for settling.
    i. Install new soil covering (grass or sod) and maintain it through the growing season.
    j. Determine if soil waste is hazardous and manage it accordingly
    k. Conduct clean-up and clearance.
    l. Provide walk-off doormats.
    m. Maintain proper documentation.

E. Encapsulation
1. Determine if the applicable regulations aloe encapsulates to be used. Do not encapsulate the following surfaces:
    a. Friction surfaces, such as window jambs and door jambs.
    b. Surfaces that fail patch tests.
    c. Surfaces with substrates or existing coatings that have a high level of deterioration.
    d. Surfaces I which there is a known incompatibility between two existing paint layers.
    e. Surfaces that cannot support the additional weight stress of encapsulation due to existing paint thickness.
    f. Metal surfaces that are prone to rust or corrosion.
2. Conduct field tests of surfaces to be encapsulated for paint film integrity.

3. Consider special use and environmental requirements (i.e. abrasion resistance and ability to span base substrate cracks).
4. Provide to the the Owner encapsulant test data provided by the manufacturer.
5. Conduct at least one test patch on each type of building component where the encapsulant will be used. Report the results to the the Owner.
6. For both nonreinforced and reinforced coatings, use a 6" x 6" test patch area. Prepare the surface in the manner selected to complete the job. Prepared surfaces for patch testing should be at least 2" larger in each direction than the patch area.
7. For fiber-reinforced wall coverings, use 3" x 3" patch. For rigid coatings that cannot be cut with a knife, use soundness test. For all encapsulants, carry out the appropriate adhesion tests.
8. For liquid coating encapsulants, allow coating to cure, then visually examine it for wrinkling, blistering, cracking, bubbling, or other chemical reaction with the underlying paint.
9. Record results of all patch tests and provide to the the Owner.
10. Implement proper work site preparation level.
11. Repair all building components and substrates as needed (i.e. caulk cracks and repair sources of water leaks).
12. Prepare surfaces. Remove all dirt, grease, chalking paint, mildew and other surface contaminants, remnants of cleaning solutions, and loose paint. All surfaces should be deglossed, as needed.
13. Ventilate the contaminated area whenever solvents or chemicals are used.
14. During encapsulant application or installation, monitor temperature and humidity. For liquid coatings monitor coating thickness to ensure that the encapsulant manufacturer's installation/application specifications are followed.
15. Conduct clean up and clearance.
16. Provide the the Owner information on how to care for the encapsulation system properly.
17. Maintain records on the exact detailed locations of encapsulant applications, patch test specifications and results, product name, subcontractor, date of application, a copy of the product label and material Data Safety sheet (MSDS) for the product and provide to the the Owner.

F. Enclosure
1. Stamp, label or stencil all lead-based painted surfaces that will be enclosed with a warning approximately every 2 feet both horizontally and vertically on all components. The Warning shall read "**Danger Lead-Based Paint**". Deteriorated paint should not be removed from the surface to be enclosed.
2. Select the proper worksite preparation level.
3. Attach a durable drawing to the utility room closet showing where lead-based paint has been enclosed in the dwelling.
4. An independent inspector or technician or risk assessor should evaluate the integrity of the enclosure.
5. Repair any unsound substrates and structural members that will support the enclosure, if necessary.
6. Utilize appropriate enclosure material (drywall or fiberboard, wood paneling, laminated products, ridged tile and brick veneers, vinyl, aluminum m, or plywood).
7. Install extension rings for all electrical switches and outlets that will penetrate the enclosure.
8. If enclosing floors, remove all dirt with a HEPA vacuum to avoid small lumps in the new flooring.
9. Seal and back-caulk all seams and joints. Back-caulk means applying caulk to the underside of the enclosure.
10. When installing enclosure directly to painted surfaces, use adhesive and then anchor with mechanical fasteners (screws or nails).
11. Conduct clean up and clearance activities.
12. Maintain proper records and submit a Statement of Lead-Based Paint Compliance.

G. Final Cleaning Procedures
1. Use the following step-by-step procedures

a. Assign responsibilities to specific workers for cleaning and for maintaining the cleaning equipment.
b. Have sufficient cleaning equipment and supplies before beginning work.
c. If contamination is extensive, conduct precleaning of the dwelling unit.
d. Conduct ongoing cleaning during the job, including regular removal of large and small debris and dust. Decontamination of all tools, equipment and worker protection gear is required before it leaves contaminated areas. Electrical equipment should be wiped and high-efficiency particulate air (HEPA) vacuumed, not wetted down, to minimize electrocution hazards.
e. Schedule sufficient time (usually 30 minutes to an hour) for complete daily cleaning, starting at the same time near the end of every workday after lead hazard control activity has stopped.
f. For final cleaning, wait at least 1 hour after active lead hazard control activity has ceased to let dust particles settle.
g. Use a vacuum cleaner equipped with a HEPA exhaust filter. HEPA vacuum all surfaces in the room (ceilings, walls, trim, and floors). Start with the ceiling and work down, moving toward the entry door. Completely clean each room before moving on.
h. Wash all surfaces with lead-specific detergent, high-phosphate detergent, or other suitable cleaning agent to dislodge any ground-in contamination, then rinse. Change the cleaning solution after every room is cleaned.
i. Repeat step g above. To meet clearance standards consistently, a HEPA vacuum, wet wash, and HEPA vacuum cycle is recommended. For interim control projects involving dust removal only, the final HEPA vacuuming step is usually not needed. Other cleaning methods are acceptable, as long as clearance criteria are met and workers are not over exposed.
j. After final cleaning perform visual examination to ensure that all surfaces requiring lead hazard control have been addressed and all visible dust and debris have been removed. Record findings and correct any incomplete work.
k. If other construction work will disturb the lead-based paint surfaces, it should be completed at this point. If those surfaces are disturbed, repeat the final cleaning step after construction work has been completed.
l. Paint and otherwise seal treated surfaces and interior floors.
m. Conduct clearance examination.
n. If clearance is not achieved, repeat final cleaning.
o. Continue clearance testing and repeated cleanings until dwelling unit achieves compliance with all clearance standards. The cost of repeated cleaning, after failure to achieve clearance is to be borne by the contractor.
p. Do not allow residents to enter work area until final cleaning is completed and clearance is established.
q. Cleaning equipment list is as follows:
    1) HEPA Vacuums
    2) Detergent
    3) Waterproof gloves
    4) Rags
    5) Sponges
    6) Mops
    7) Buckets
    8) HEPA vacuum attachments (crevice tools, beater bar for cleaning rugs)
    9) 6-mil plastic bags
    10) Debris containers
    11) Waste water containers
    12) Shovels
    13) Rakes
    14) Water-misting sprayers
    15) 6-mil polyethylene sheeting (or equivalent)

2. Order of execution for final cleaning steps should be as follows:

a. As the first stage in final cleaning, floor plastic shall be misted and swept.
b. Upper level plastic, such as on cabinets and counters should be removed first, after it has been misted and cleaned. All plastic should be carefully folded from the corners/ends to the middle to trap any remaining dust. Next remove both layers of plastic from the floor.
c. Plastic sheets used to isolate contaminated rooms from noncontaminated rooms should remain in place until after cleaning and removal of other plastic sheeting, these sheets may then be misted, cleaned and removed last.
d. Removed plastic should be placed into double 4-mil or single 6-mil plastic bags, or plastic bags with equivalent (or better) performance characteristics, which are sealed and removed from the premises. As with daily cleanings, this plastic removal process usually requires workers to use protective clothing and respirators.
e. After plastic has been removed from the contaminated area, the entire area should be cleaned using the HEPA/wet wash/HEPA cycle.

H. Waste Testing And Disposal

1. General: All materials, whether hazardous or non-hazardous shall be properly disposed of. the Owner may hire an independent Monitoring Consultant to perform TCLP test to determine which of the wastes are hazardous. Contractor shall cooperate in this test. If less than 100kg (200 lbs) or 1/2 of a 55 gallon drum of hazardous waste per month will be generated, it is considered "conditionally exempt" abatement waste, and may be managed as solid non-hazardous waste. The RCRA hazardous waste manifest is not required when shipping this waste to an offsite disposal facility.
2. Separate Abatement Waste into The Following Four Categories:
   a. Category I. Low lead waste (typically non-hazardous) e.g. Filtered personal and commercial wash water.
   b. Category II. Architectural components - (painted finish carpentry items) e.g. Doors, windows, window trim and sills, baseboards, railings, moldings. (May do a TCLP to determine if they are hazardous).
   c. Category III. Concentrated lead waste e.g. sludge from stripping, lead-base paint chip and dust, HEPA vacuum debris and filter, unfiltered wash waste, any waste included in EPA's list of hazardous waste.
   d. Category IV. Material that cannot be determined to be either hazardous or non-hazardous must be tested by TCLP.

   If the hazardous waste generated is greater than 100kg per month, dispose according to the referenced guidelines and RCRA hazardous waste management requirements including those listed below.
3. Disposal Requirements: Contact the regional EPA, state, local and all other pertinent authorities to determine lead-based paint debris disposal requirements. Comply with requirements of the Resource Conservation and Recovery Act (RCRA) and with applicable federal, state, county, or local waste requirements.
4. EPA ID Numbers: Obtain a Generator RCRA Hazardous Material ID number and coordinate this action through the State and secure any additional number as required.
5. Storage Requirements: Keep all hazardous items in a secure area or lockable container that is inaccessible to all persons other than the Contractor's personnel. Label all hazardous waste "Hazardous Waste" with the date that the Contractor began to collect the waste in that container. Keep hazardous and non-hazardous waste in separate containers. Until TCLP testing is completed, considered all items hazardous and store in a secured area or lockable container.
6. Waste Transportation: Transport hazardous waste using a RCRA/DOT/EPA certified Hazardous Waste Transporter. Submit names and qualifications of certified transporter/hauler for the Owner approval. The Contractor shall be responsible for all actions of the waste hauler as pertaining to waste removal and disposal under these procedures and all EPA, DOT and other applicable regulations.
7. Disposal Facility: Supply documents that detail the site(s) to be used for ultimate disposal. Submit documents from these sites proving that they are licensed/permitted to accept such waste and shall accept the waste proposed by the Contractor for treatment or ultimate disposal.

8. Waste Containers: Comply with EPA and DOT regulations for waste containers. Contact the state and local authorities to determine their criteria for containers. In the case of any conflict in regulations, the more stringent shall apply.
9. Emergencies: Contact local fire, police, hospitals or local emergency response teams and inform them of the type of hazardous waste activity and ask for assistance in the event of any accident. Additionally, the container shall provide the following:
    a. Keep and properly maintain a suitable fire extinguisher(s) on site.
    b. Have a immediate means of communication with the regulatory agency in the event of an emergency.
    c. Keep a list of phone numbers of regulatory agencies on site.
    d. Appoint an emergency coordinator and ensure the coordinator is on site to supervise emergency procedures to be carried out in the event of an emergency.
    e. Keep and maintain a "right to know" manual that is in an easily accessible location and in an area that is known to all employees.
10. Transporting Waste: Provide certifications that the transporter is registered with the U.S. Department of Transportation is required by 49 CFR Part 107(a) transport hazardous waste.
    a. Provide certifications that each vehicle dedicated to haul hazardous waste has been assigned a "U.S. DOT Hazardous Material Registration Number" as required by 49 CFR Part 107.
    b. Be responsible for all other applicable permits pertaining to hauling, transport, reduction, and disposal of hazardous waste as they may apply to this project.
    c. Vehicle: Ensure that all non-hazardous waste is transported in covered vehicles to a landfill, or lined landfill, if required.
    d. Container Handling: Carefully place the containers into the truck or dumpster used for disposal. At no time shall debris or containers be thrown or dropped.
    e. Liquid Wastes: Contain and properly dispose of all liquid wastes, including lead-contaminated wash water.
    f. Containers: HEPA vacuum the exterior of all waste containers prior to removing the waste containers from the work area. Wet wipe the containers to ensure that there is no residual contamination. Then move containers out of the work area into the designated storage area.

I. Clearance
1. Clearance on all abatement projects must be done by an independent certified risk assessor or inspector technician. Follow all jurisdictional law with regard to licensure requirements for personnel conducting clearance activities.
2. Clearance step-by-step procedures are as follows:
    a. Finish the lead hazard control clean-up effort. Seal floors before clearance (if necessary).
    b. Wait 1 hour to allow any airborne dust to settle. Do not enter work area during that hour.
    c. Conduct visual examination
        1) Determine if all required work has been completed and all lead-based paint hazards have been controlled.
        2) Determine if there is visible settled dust, paint chips, or debris in the interior or around the exterior.
    d. Complete the Visual Clearance Form required by the the Owner; if all work is not completed inform the the Owner and order completion of the work and repeat cleanup, if necessary.
    e. Conduct clearance dust sampling of the floors, interior window sills, and window troughs using approved protocol.
    f. Conduct soil sampling if bare soil is present that was not sampled previously, or if exterior paint work was completed as part of the lead hazard control effort. Whenever exterior work has been don, it may be necessary to take samples from the soil that is not bare to determine if contamination has occurred. If results are above 1,000 µg/g (or 400 µg/g in high contact play area), compare the results to baseline soil sampling results to determine what additional measures are needed.
    g. Complete the Dust and Soil Sampling Clearance Form required by the the Owner.

h. Submit samples to a U.S. Environmental Protection Agency (EPA) recognized laboratory participating in the National Lead Laboratory Accreditation program (NLLAP) for analysis.

i. Interpret results by comparing them to Interim Clearance Standards as listed below:

1)	Floors	400 µg/ft2
2)	Window sills	250 µg/ft2
3)	Window Troughs	800 µg/ft2
4)	Soils (Play area with children under 6 years of age)	400 µg/gram

j. If clearance is achieved go to step N.

k. Order repeated cleanings or soil treatments if results are above applicable standards. Clean all surfaces the sample represents.

l. Continue sampling and repeated cleanings until the dwelling achieves compliance with all applicable clearance standards.

m. Complete any related construction work that does not disturb a surface with lead-based paint (all work that does disturb painted surfaces or that could generate lead dust should be completed as part of the lead hazard control effort).

n. Issue any necessary statements of lead-based paint compliance or releases and maintain appropriate records.

J. Labels

1. Use the following labels on drums used for disposal.

WORKPLACE ACCUMULATION CONTAINER

Proper D.O.T. Shipping Name: _____

UN or NA# _____

Generator Information:
Name _____
Facility _____
Address _____
Phone _____
City _____
State _____ Zip _____
EPA ID No. / Manifest Document No. _____
State Manifest Document No. _____
EPA Waste No.

HAZARDOUS WASTE

FEDERAL LAW PROHIBITS IMPROPER DISPOSAL.

IF FOUND, CONTACT THE NEAREST POLICE OR PUBLIC SAFETY AUTHORITY OR THE U.S. ENVIRONMENTAL PROTECTION AGENCY.

HANDLE WITH CARE!

Workplace Accumulation Start Date: _____

Waste Accumulation Area: _____

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K. Disposal of lead-based paint waste.

1. Follow the RCRA and HUD recommended practices as defined in the table below:

Waste Management Practices	Category I: Low Lead Waste	Category II: Architectural Components	Category III: Concentrated Lead Waste	Category IV: Other waste
RCRA Requirements	Manage as nonhazardous Waste	Depending upon knowledge or TCLP testing results, manage as solid hazardous or nonhazardous waste	If more than 100 kg/ month, manage as hazardous waste. If less than 100 kg/month manage as solid waste.	Use TCP to determine if waste is hazardous.
HUD Recommended Practices	Applicable	Applicable, if knowledge or TCLP testing indicates that it is nonhazardous.	Applicable if less than 100 kg/month otherwise subject to full RCRA regulations	Only applicable if TCLP testing shows waste is nonhazardous
Wrapped in plastic; seal all seams with tape (if acceptable to the disposal facility).	X	X	X	X
Stored in designated, secure area.	X	X	X	X
Covered During Transport	X	X	X	X
Prohibit cutting/breaking outside work area.	X	X	X	X
Cover ground with 6-mil plastic if handling outside.	X	X	X	X
Prohibit disposal in solid waste incinerators and reuse recycling for mulch	X	X	X	X
Recommended disposal in State licensed/permitted	X	X	If appropriate.	X

solid waste landfill.				

L. Safety Requirements

1. To protect the health and safety of all persons involved, it is of the utmost importance that deleading is safely and correctly done in a timely manner. The following specific safety requirements are the responsibility of the Deleading Contractor.

K. General Safety:

1. General
   a. NO ONE is to be allowed in the work area without an approved respirator except for methods that have been documented not requiring a respirator.
   b. Each work area must be sealed from the remainder of the dwelling by taping plastic sheets (6 mil thick). Work areas must remain sealed off until both work and clean-up are completed.
   c. Cover all floors, carpets, furniture and appliances with 6 mil plastic within the work area. Use automotive masking tape (2 inches wide) to seal all edges and seams.
   d. Make certain all electrical connections are properly grounded.
   e. At least three days prior to the start of any deleading work, post appropriate warning signs at all entrances and exits of work areas and leave in place until all clearance testing indicates that these areas are safe for re-occupancy. The signs must include the following phrase: "CAUTION LEAD HAZARD-KEEP OUT". Post bilingual signs when necessary.
2. Worker Safety: The Deleading Contractor shall take the following minimum precautions to protect the health of all individuals involved in the deleading process.
   a. Pre-Abatement Medical Exam: Each employee shall undergo a medical examination to determine both respiratory fitness capability and also pre-existing/current blood lead level. Said results shall be provided to the employee and also to the Owner within 3 days of receipt of same, and in all cases, prior to employee's commencement to active abatement. Records of same are required to be kept by the Contractor for 40 years.
   b. Medical Surveillance is the monitoring of worker blood levels. It is required that the Contractor have blood level monitoring of all active abatement and clean-up workmen and on-site supervisors performed and said results provided to the Owner.
      1) Before assignment to active abatement activity for each worker.
      2) 30 days after active abatement has begun.
      3) At least every two months during the first six months and every six months throughout the deleading job.
      4) At least every two months for each employee whose blood lead analysis indicated a blood lead level at or above 25 micrograms per deciliter. (20 micrograms per deciliter for women of child bearing age).
      5) At termination of employment.
      6) Contractor shall reassign any employee whose blood lead has reached 25 µg/dl (20 µg/dl for women of child bearing age) to a job function deemed safe from lead exposure. Said employee shall remain away from active abatement until such time as 2 consecutive months' blood tests indicate µg/dl below 20 µg/dl.
   c. Respiratory Protection Programs must be established by the Contractor in accordance with OSHA regulations and qualitative respirator fit testing must be conducted daily by the on-site supervisor. Medical examinations must be performed by a physician prior to fit testing and at anytime when a worker demonstrates any difficulty breathing during the use of or the fit testing of respirators. The following are minimal acceptable respiratory protection program requirements as set up and administered by the Contractor:
      1) Written standard operating procedures which oversees the selection and use of respirators.
      2) Selection of respirators on the basis of hazards to which the worker is exposed.
      3) Worker training on the limitations and use of respirators (includes fit testing).
      4) Individual workers assigned respirators for their exclusive use only.

5) Daily cleaning and disinfecting of respirators.
6) Proper storage of all respirators.
7) Proper inspection of all respirators for wear and tear.
8) Continual surveillance of work area conditions and level of worker exposure or stress.
9) Use of approved respirators only, modified as needed by the weekly exposure monitoring results.
10) Supply weekly report covering items 1-9 to the Owner or its Lead Consultant.

d. Exposure Monitoring is the measured concentration of lead in the workers breathing zones. The Contractor shall perform personnel monitoring during active abatement using the NIOSH 7072 method and-shall be responsible for:
1) Monitoring the level of worker protection needed during the abatement process;
2) Evaluating, modifying and improving any engineering and work practice control(s) as needed;
3) Evaluating each employee's personal quality of work and any need for additional worker training or safety instruction;
4) Providing the Owner results of all personnel monitoring tests within 10 days of testing; and
5) Providing half-face APR respirators with HEPA filters unless said monitoring test results dictate differently. OSHA guidelines shall be used to determine respirator PEL protection factors.

e. Protective Clothing Equipment must be provided to all workers to help assure that lead dust is contained to the work areas. The following must be supplied/enforced by the Deleading Contractor:
1) Full body protective clothing and shoe covers of appropriate sizes on a daily basis or as needed.
2) Clean changing areas separated from the dirty/contaminated clothes storage area.
3) Water and wash facilities for washing of hands and face and shower facilities if deemed necessary by the Owner's Lead Advisor.
4) Instructing worker on proper maintenance of clothing and equipment.
5) Proper disposal of disposable clothing and proper permanent work clothes.
6) Enforcing the removal of protective clothing at the end of each work day and before eating, drinking and smoking.
7) Enforcement of the removal of protective shoe covers before leaving work area.

3. Contractor/Worker Daily Safe-Work Procedures
a. Daily Start-Up:
1) Workers to put on protective gear prior to entering work areas.
2) All garment seams to be sealed with duct tape.
3) All non-working garments must be stored in designated changing area.
4) Respirators, as required, must be properly fitted before entering work area. Perform qualitative fit test.

b. Temporary depart:
1) All protective clothing to be HEPA vacuumed while still being worn.
2) All shoe covers to be removed and left in the work area (immediate departure upon removing).
3) Remove all protective gear in designated "contaminated" changing area before eating, drinking, and smoking or before leaving work site.
4) Wash hands and face.
5) Clean respirators.

c. Daily Shut-Down:
1) Dispose of protective clothing with abatement waste by sealing in a 6 mil poly bag.
2) Laundered clothes must be placed in closed container.
3) Wash hands and face.
4) Shower if facilities allow and circumstances dictate.
5) Clean all protective gear (respirators included).

4. Tenant's Safety: Temporary relocation of the tenants is necessary if the lead paint surface is broken. Temporary relocation of the tenants and their belongings is the responsibility of the Owner. However, the Contractor has the joint responsibility to administer and enforce the following safety practices on behalf of the occupants:
   a. Adults
      1) NO OCCUPANT is allowed to enter the work area during paint removal and initial clean-up. A three day clean-up and settlement period may be imposed depending upon the abatement procedures used, at the discretion of the Owner or their Lead Consultant.
      2) the Owner shall notify all occupants in writing when they are allowed to return to their post-abated residence. Contractor shall abide by these notices.
      3) Every resident who has received prior notice of abatement is responsible for placing all personal items (clothing, dishes, linens, etc.) in closed, easy to handle containers; and move such items to the center of each room as requested.
      4) As long as visible dust remains, occupants may not occupy dwelling, and all surfaces within the dwelling must be re-washed with trisodium phosphate and HEPA vacuumed by deleading contractor.
      5) Persons reoccupying dwellings following abatement are required to report any visible dust or debris to the Owner immediately for additional Contractor clean-up.
   b. Pregnant Women and Children
      1) Absolutely no pregnant women nor children under the age of twelve years of age may be allowed in the building while any part of the abatement process is going on.

END OF SECTION 02 83 19 13a

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SECTION 02 83 19 13b - XRF TESTING FOR LEAD-BASED PAINT

1.1 DESCRIPTION OF WORK

A. This specification covers the furnishing and installation of materials for XRF testing for lead-based paint. 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 SUMMARY

A. The Contractor shall perform work in accordance with the latest HUD Guidelines, in accordance with all applicable regulations of the Environmental Protection Agency (EPA), Occupational Safety & Health Agency (OSHA) and any applicable State or Local standards that may be more stringent than the Federal Standards except, as such guidelines are modified by the Owner in writing in this contract or any contract pursuant to this contract.

B. Workmanship required in the execution of the work herein specified shall be of good quality and subject to the approval of the the Owner.

1.3 SUBMITTALS

A. Notification Before Start of Work
   1. The Contractor shall send notices to the Project Superintendent, Residents, and the Department of Planning and Development 48 hours before the scheduled start of work. The Contractor shall make three (3) attempts to gain entry to each apartment, with proper 48 hour notification to the resident each time.
   2. The Contractor shall begin work no later than 48 hours after receiving a work proceed order.

B. Copies of the submissions listed below must be tendered with the bid:
   1. Ability to perform XRF testing and paint chip sampling by submitting evidence of the successful completion of lead inspector training by all staff to be assigned to the job including inspector technicians. Training must be provided through a State approved EPA-Model program. All staff assigned to the Contract must also demonstrate training in the use of the XRF testing machines to be dedicated to this contract. The serial number of such XRF machine shall be provided to the the Owner.
      a. Contractor or Subcontractor performing the work must have at least 3 years of satisfactory experience (documented) in performing XRF testing for a City, State or Federal Agency.
   2. Laboratory certification by the State Department of Health (or other responsible agency) and by the USEPA through the EPA's National Lead Laboratory Accreditation Program ("NLLAP"), or as an alternative having accreditation application pending before NLLAP, and having acceptable performance on five consecutive rounds of the EPA, Environmental Laboratory Proficiency Analytical Testing (ELPAT) program, including the most recent round; evidence of such accreditation must be provided. Indicate if the laboratory is an independent entity from the Contractor.
   3. If a subcontractor will be used for any of the laboratory work of this contract, evidence of certification stated above must also be provided for the subcontractor.

C. XRF Testing Report Format

a. All XRF report must be made after a formal submittal and approval by the Owner.
b. A faxed summary report must be provided to the the Owner within 48 hours after completion of testing for a work Authorization. For XRF testing requiring confirmation by laboratory analysis of paint chip samples, the faxed summary report must be provided within 48 hours after the the Owner gives approval for testing of the collected paint chip samples.
c. A detailed report must be provided to the the Owner within 5 business days after completion of the testing.

1.4 QUALITY ASSURANCE

A. The work shall consist of furnishing all labor, material, insurance and all other incidental items required to do the following:
1. XRF Testing
a. Random or comprehensive testing of various components in single family housing units, multi-family housing units, common areas and exterior sites, using any of the approved X-ray Fluorescence ("XRF") machines, to determine if the lead-based paint concentration is within permissible limits.
Note: Testing may be for entire apartments or selected rooms or components within the apartment.
b. The permissible limit shall be defined as a final reading showing a lead concentration of less than 1.0 mg/cm^2.
c. Refer to the Manufacturer's manual, as well as the "XRF Performance Characteristic Sheet" when determining calibration check tolerance, and other instrument specific information. Use the adjusted "XRF Performance Characteristic Sheets" in this contract when determining the inconclusive range.
d. In addition to the manufacturer's recommended warm up and quality control procedures, a set of three nominal XRF calibration check readings must be taken before the inspection begins and after the inspection has been completed in a particular unit, or every 4 hours, whichever occurs first. All reference material values and calibration check readings must be included in the report provided to the Owner.
e. Do not use the XRF to test highly curved or ornate surfaces, or surfaces inaccessible to the XRF, due to poor reliability of results. For such surfaces, laboratory analysis of paint chips must be done.
f. Only one XRF reading is required per testing combination. A unique testing combination is characterized by the room equivalent, the component, the substrate and the visible color of the paint. However, testing combinations with different colors on the same component and substrate may be combined into a single component type.
g. All inconclusive results must be treated according to the inspection rules using multi-family inspection or single family inspection rules as appropriate.
h. XRF field data sheets shall be filled out as they appear on completed Form 7.1(“Single-Family Housing LBP Testing Data Sheet”) and 7.5 (“"Multifamily Housing LBP Testing Data Sheet”) in HUD Guidelines.
i. Room equivalents or sections thereof that are not accessible for testing (i.e. locked bedrooms) shall be noted in the final report to the Owner.
2. Laboratory testing of paint chips.
a. Collection of paint chips from various painted components for laboratory analysis due to XRF substrate corrected inconclusive and/or positive readings as directed by the the Owner.

b. Laboratory preparation and testing by Flame Atomic Absorption Spectrometry (FAAS) or Graphite Furnace Atomic Absorption Spectrometry (GFAAS) to determine if the lead paint concentration is within permissible limits.
c. The permissible limit shall be defined as a lead concentration less than 0.5% by weight.
d. Collect paint chips in accordance with ASTM ES28-94.
e. Prepare paint chips in the laboratory for testing in accordance with ASTM ES37-94.
f. Repair and repaint areas from which paint chips have been collected, to match adjacent areas, unless notified by the the Owner in writing to utilize a temporary covering for the tested surfaces. The Contractor shall provide water based latex paint for this purpose. Colors shall be limited to white and off-white; and other colors if provided by the tenant.
g. Only one paint chip is required per testing combination. A unique testing combination is characterized by the room equivalent, the component, the substrate, and the visible color of the paint. However, testing combinations with different colors on the same component and substrate may be combined into a single component type.
h. Field data sheets and signed chain of custodies must be attached to the final report to the Owner.

B. Occupied Residences
1. Some of the work of this contract will be in occupied apartments. The Contractor shall perform all of the work of this contract with the least inconvenience to the tenants.
2. The Contractor shall take all necessary precautions to protect the property of the the Owner, its residents and the public. The contractor must repair any damaged property, whether of the the Owner, its residents, or the public, and restore such property to its original condition. If the damage is beyond repair, the Contractor shall replace it with new, that in the judgement of the the Owner, match the existing materials and are of equal quality and workmanship. All such repairs shall be at the Contractor's expense.

C. Applicable Regulations
1. ASTME Standards
a. ASTM E 1583 on evaluating laboratories used to determine lead levels;
b. ASTM E 1605 on terminology;
c. ASTM E 1613 on determining lead by atomic emission or atomic absorption spectroscopy;
d. ASTM E 1645 on laboratory preparation of paint-chip samples;
e. ASTM E 1775 on-site extraction and field portable stripping voltammetry analysis for lead;
f. ASTM PS 53 on identifying and managing lead in facilities;
g. ASTM PS 87 on ultrasonic extraction for later analysis for lead;
h. ASTM PS 88 on determining lead by portable electro analysis
2. OSHA Standards (without limitation), include:
a. 29 CFR 1926.20 - General safety and health provisions;
b. 29 CFR 1926.21 - Safety training and education;
c. 29 CFR 1925.25 - Housekeeping;
d. 29 CFR 1926.28 - Personal protective equipment;
e. 29 CFR 1926.51(f) - Washing facilities;
f. 29 CFR 1926.55 - Gases, vapors, fumes, dusts, and mists;
g. 29 CFR 1926.57 - Ventilations;
h. 29 CFR 1926.59 - Hazardous Communication Standards;
i. 29 CFR 1926.10 - Respiratory protection; and
j. 29 CFR 1926.62 - Lead in Construction
3. The Contractor must comply with all applicable requirements of the Resource Conservation & Recovery Act (RCRA) of 1976 as amended in 1980 and 1984 by the Hazardous & Solid Waste Amendments (HSWA).

4. The Contractor must follow the XRF Performance Characteristic Sheet (PCS) for all inspection activities. XRF PCSs are available from the National Lead Information Center Clearinghouse or through the HUD website at http://www.hud.gov/offices/lead/lbp/hudguidelines/allpcs.pdf.

1.5 PRODUCTS

A. XRF Instruments and Testing Protocols
1. The Contractor shall use XRF instruments that are approved by the Owner.
2. XRFs must be used in accordance with the manufacturer's instructions and the XRF Performance Characteristic Sheet. If discrepancies exist between the XRF Performance Characteristic Sheet, the HUD Guidelines and the manufacturer's instructions, the most stringent guidelines should be followed.

1.6 EXECUTION

A. Inspection and Testing
1. Single Family Testing Rules
a. If the housing development has less
1) than 10 units built between 1960-1970 or
2) 20 units built before 1960 or
3) the random testing rules in a multi-family development are not being used then single family testing rules must be followed.
b. List all testing combinations (see HUD Guidelines Table for an example) in all interior rooms, on all exterior building surfaces, and on surfaces in other exterior areas, such as fences, playground equipment, and garages. The “SingleFamily Housing LBP Testing Data Sheet” (see HUD Guidelines) or a comparable data collection instrument may be used for this purpose.
1) Test all room equivalents inside and outside the dwelling unit. The final report must include a final determination of the presence or absence of lead-based paint on each testing combination in each room equivalent.
2) Inspect each testing combination in each room equivalent, unless similar building component types with identical substrates (such as windows) are all found to contain lead-based paint in the first five interior room equivalents. In that case, testing of that component type in the remaining room equivalents may be discontinued, if and only if the Owner agrees beforehand to such a discontinuation. The inspector should then conclude that similar building component types in the rest of the dwelling unit also contain lead-based paint.
3) Painted furniture that is physically attached to the unit (for example, a desk or dresser that is built-in) should be included in the inspection as a testing combination.
4) Results of an inspection may be summarized by classifying component types across room equivalents if patterns or trends are supported by the data.
5) All substrates across all room equivalents should be grouped into one of the six substrate categories (brick, concrete, drywall, metal, plaster, or wood).
c. Number and Location of XRF Readings
1) XRF testing is required for at least one location per layers of paint should be included and the XRF probe testing combination, except for interior and exterior faceplate should be able to lie flat against the surface walls, where four readings should be taken, one on of the test location each wall.
2) For interior and exterior walls: take at least four readings (one of ea. wall). If there are more than four walls test the four largest walls, calculate the average of the

readings, round the result to same number of decimal places as the XRF instrument displays, and classify the remaining walls with the same painting history as the tested walls, based on this rounded average. When the remaining walls in a room equivalent clearly do not have the same painting history as that of the tested walls, test and classify the remaining walls individually.

3) Select areas of paint which are most likely to have old paint or coatings, where areas of paint appear thickest. Avoid testing where paint has worn away, chipped; or over pipes, electrical surfaces, nails, and any other possible interferences.

4) A numbering system, floor plan, sketch or other system may be used to document which testing combinations were tested and sufficiently detailed enough for another individual to find them.

a) Side identification Identify perimeter wall sides with letters A, B, C, and D (or numbers or Roman numerals). Side A for single-family housing is the street side for the address. Side A in multi-family housing is the apartment entry door side. Side B, C, and D are identified clockwise from Side A as one faces the dwelling; thus Wall B is to the left, Wall C is across from Side A, and Side D is to the right of Side A. Each room equivalent's side identification follows the scheme for the whole housing unit. Because a room can have two or more entries, sides should not be allocated based on the entry point. For example, giving a closet a side allocation based on how the room is entered would make it difficult for another person to make an easy identification, especially if the room had two closets and two entryways.

b) Room Equivalent Identification Room equivalents should be identified by both a number and a use pattern (for example, Room 5-Kitchen). Room 1 can always be the first room, at the A-D junction at the entryway, or it can be the exterior. Rooms are consecutively numbered clockwise. If multiple closets exist, they are given the side allocation: for example, Room 3, Side C Closet. The exterior is always assigned a separate room equivalent identifier.

c) Sides in a Room Sides in an interior room equivalent follow the overall housing unit side allocation. Therefore, when standing in any four-sided room facing Side C, the room's Side A will always be to the rear, Side B will be to the left, and Side D will be to the right.

d) Building Component Identification Individual building components are first identified by their room number and side allocation (for example, the radiator in Room 1, Side B is easily identified). If multiple similar component types are in a room (for example, three windows), they are differentiated from each other by side allocation. If multiple components are on the same wall side, they are differentiated by being numbered left to right when facing the components. For example, three windows on Wall D are identified as windows D1, D2, and D3, left to right. If window D3 has the only old original sash, it is considered a separate testing combination from the other two windows. Codes or abbreviations for building components and/or locations may be used in order to shorten the time needed for data entry. If codes or abbreviations are used, the inspection records and the inspection report must include a table showing their meaning.

d. XRF Instrument Reading Time

1) The recommended time to open an XRF instrument's shutter to obtain a single XRF result for a testing location depends on the specific XRF instrument model and the mode in which the instrument is operating. Follow manufacturer's instructions per HUD Guidelines.

e. XRF Calibration Check Readings

1) Follow manufacturer's instructions per HUD Guidelines.

f. Substrate Correction

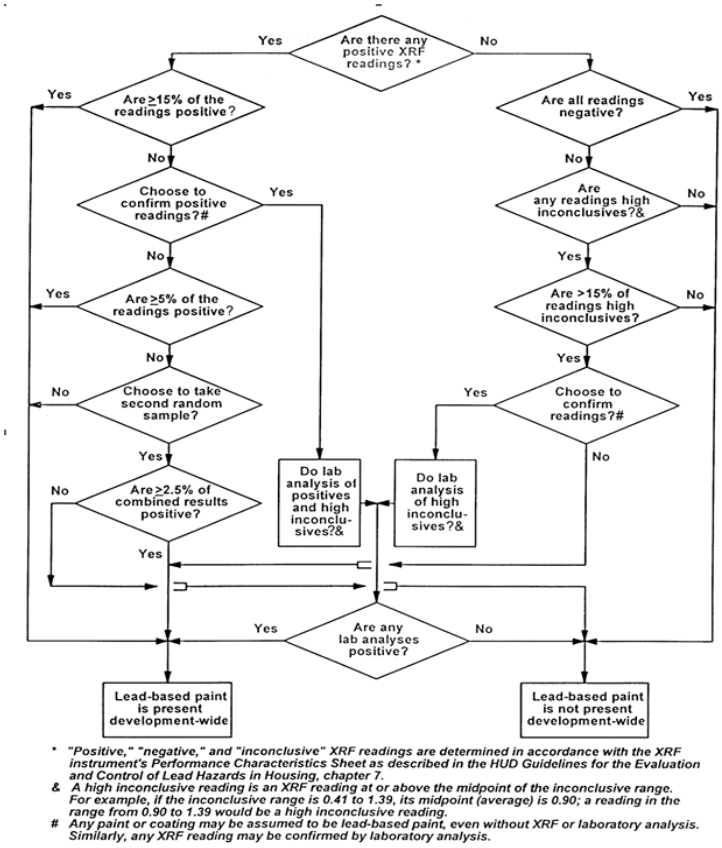
1) The XRF measurements, corrected for substrate contribution, if required by the Performance Characteristic Sheet ("PCS") for the particular type of instrument being used, should be sorted by the inspector by component type into the following categories:

a) Positive- A positive XRF reading in accordance with the XRF's Performance Characteristic Sheet.

b) Negative- A negative XRF reading in accordance with the XRF's Performance Characteristic Sheet.

c) High Inconclusive- An inconclusive XRF reading equal to or greater than the midpoint of the XRF's inconclusive range, in accordance with the XRF's Performance Characteristic Sheet.

g. The following Decision analyses will be used to determine which components are positive, negative or inconclusive:



1)

2) All inconclusive results must be confirmed with laboratory analysis, or as an alternative must be classified as positive. the Owner may also wish to confirm positive XRF results with laboratory analysis. Therefore the Contractor must make a field determination of which XRF readings falls in the inconclusive or positive ranges and take paint chip samples during the XRF testing for possible laboratory analysis. If the majority of XRF readings are positive in the first few units, the inspector must consult with the Owner on whether to continue taking paint chip samples. Only the Owner may determine whether to submit collected paint chip samples for laboratory analysis or to classify the element as positive.

2. Multi-family Housing Testing Rules (Random Sampling)

a. In order to use the Multi-family housing testing rules, there must multi-family housing is defined as any group of more than four units that are similar in construction from unit to unit

b. Determine the number of randomly selected units to be tested in accordance with Table 7.3, below. Chapter 7 of the HUD Guidelines also describes how to select the units randomly. If a unit or units which were selected as part of the original random sample cannot be entered for a particular reason, a replacement unit(s) must be randomly selected in accordance with the HUD Guidelines.

Table 7.3 Number of Units to be Tested in Multi-family Building or Developments*

Number of Similar Units, Similar Common Areas, or Similar Exterior Sites	Pre-1960 or Unknown-Age Building or Development: Number of Units to Test *	1960-1977 Building or Development: Number of Units to Test *
1-10	All	All
11-13	All	10
14	All	11
15	All	12
16-17	All	13
18	All	14
19	All	15
20	All	16
21-26	20	16
27	21	17
28	22	18
29	23	18
30	23	19
31	24	19
32	25	19
33-34	26	19
35	27	19
36	28	19
37	29	19
38-39	30	20
40-48	31	21
49-50	31	22
51	32	22
52-53	33	22
54	34	22
55-56	35	22
57-58	36	22
59	37	23
60-69	38	23
70-73	38	24
74-75	39	24
76-77	40	24

Number of Similar Units, Similar Common Areas, or Similar Exterior Sites	Pre-1960 or Unknown-Age Building or Development: Number of Units to Test *	1960-1977 Building or Development: Number of Units to Test *
78-79	41	24
80-88	42	24
89-95	42	25
96-97	43	25
98-99	44	25
100-109	45	25
110-117	45	26
118-119	46	26
120-138	47	26
139-157	48	26
158-159	49	26
160-177	49	27
178-197	50	27
198-218	51	27
219-258	52	27
259-279	53	27
280-299	53	28
300-379	54	28
380-499	55	28
500-776	56	28
777-939	57	28
940-1004	57	29
1005-1022	58	29
1023-1032	59	29
1033-1039	59	30
1500	87	44
2000	116	58
2500	145	73
3000	174	87
3500	203	102
4000	232	116

* For brevity, "Number of Units" and "Number of Units to Test" are used, but the number to test is the same for similar units, similar common areas, and similar exterior sites.

c. An assessment on each tested component must note four attributes, also called a testing combination.
   1) The room equivalent (where the testing took place i.e. bedroom, bathroom, etc.)
   2) The component type (door, wall #1 - upper left, etc.)
   3) The substrate (brick, wood, concrete, drywall, plaster or metal).
   4) The color of the paint.

d. These attributes must be included as part of the report.

e. For each testing combination, the condition of the painted surfaces should be noted as either intact, fair or poor.

f. One reading with the X-ray fluorescence (XRF) instrument on each testing combination is all that is required.

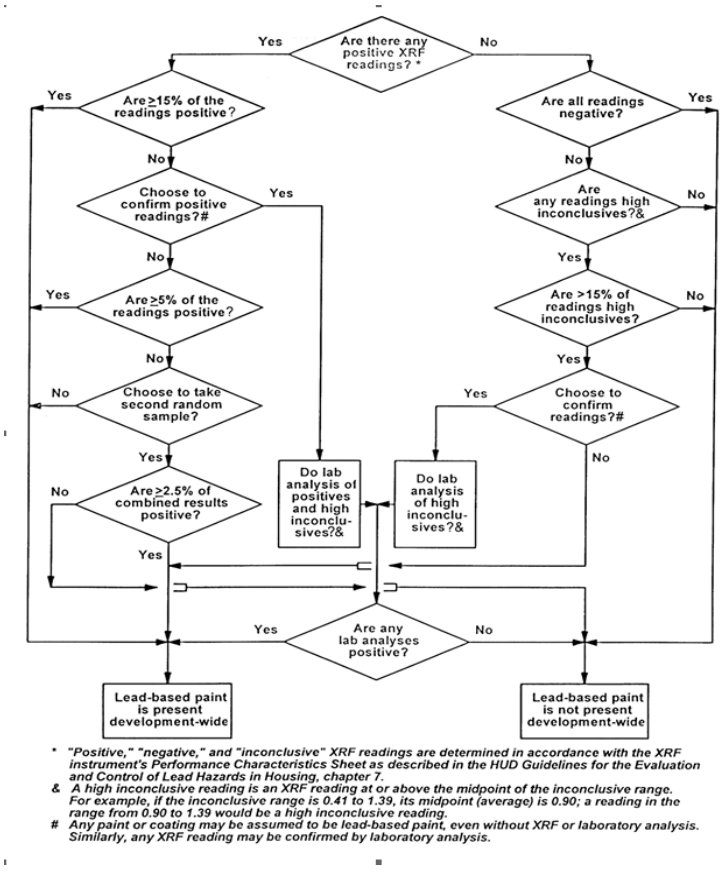
g. At least 40 components of a given type must be tested to obtain the desired level of confidence in the results throughout the multi-family development. If less than 40 components of a given type exist in the buildings to be tested i.e. they are unique components, then the measurement should be taken using single family testing rules (described below). If less than 40 components of a given type exist in the units to be tested, additional components of this type can be identified in other units in the complex and tested to bring the total up to 40 so that multi-family testing rules can be used. The decision of which option the Contractor should use will be made by the the Owner.

h. To increase the number of tested components of a given type, testing combinations with different colors on the same component and substrate may be combined into a single component type. For example, if "wood doors" is the component type, all wood doors tested for lead-based paint could belong to the same component type, regardless of color.

i. A component type may be differentiated by color as long as there are 40 tested and there is a good reason for differentiation.

j. The XRF measurements, corrected for substrate contribution, if required by the Performance Characteristic Sheet ("PCS") for the particular type of instrument being used, should be sorted by the inspector by component type into the following categories:
   1) Positive- A positive XRF reading in accordance with the XRF's Performance Characteristic Sheet.
   2) Negative- A negative XRF reading in accordance with the XRF's Performance Characteristic Sheet.
   3) High Inconclusive- An inconclusive XRF reading equal to or greater than the midpoint of the XRF's inconclusive range, in accordance with the XRF's Performance Characteristic Sheet.

k. The following Decision analyses will be used to determine which components are positive, negative or inconclusive:



l. If there are readings on a component type(s) equal to or greater than 1.0 mg/cm² and paint chip samples are submitted to the laboratory, there are two possible results:

1) If all lab samples on a component type are below 0.5% lead by weight, the component type can be classified as negative throughout the development.
2) If one or more lab results are positive, (equal to or greater than 0.5% lead by weight for a component) the the Owner will take one of three options:
   a) Treat the component type as positive throughout the development, or
   b) Test the component type throughout the development, or
   c) If 5% or less of the component type are positive, take a second random sample, just testing that component type.
3) If option 2)c) above is selected by the Owner and the combined results of the first and second random sample are less than 2½% positive, the following additional options are available depending on the results.
   a) If no positives are found in the second sample, no further testing is necessary. Those positives in the first random sample will be monitored/abated (not by this Agreement), but the rest of the component type can be classified as negative.

b) If positives are found on a component type in the second sample, the the Owner has the option to classify the component type as positive throughout the development or comprehensively test it.

c) If the combined results of the two random samples are equal to or greater than 2½%, the the Owner also has the option to comprehensively test the remaining components of that type or classify them as positive.

m. Paint Chip Sample Size: The Paint chip samples should be taken from a 4 square inch (25 square centimeter) area that is representative of the paint on the testing combination, as close as possible to any XRF reading locations and, if possible, unobtrusive. This area may be a 2" x 2" (5 x 5 centimeters) square, or a 1" x 4" (2.5 x 10 centimeters) rectangle, or have any other dimensions that equal at least 4 square inches (25 square centimeters). Regardless of shape, the dimensions of the surface area must be accurately measured (to the nearest millimeter or 1/16th of an inch) so that the laboratory results can be reported in mg/cm$^{2.}$ Results should be reported as percent by weight if the surface area cannot be measured accurately or if all paint within the sampled area cannot be removed. In these cases, lead should be reported in ppm or percent weight, not in mg/cm^2. Smaller surface area can be used if acceptable to the laboratory. (See ASTME 1729). In all cases those who take the samples should consult with the NLAAP recognized laboratory selected regarding the requirements for the submission samples for lead-based paint analysis.

n. If the the Owner decides to test in search of these hard-to-find components coated with lead based paint, the inspector must use the single family testing rules described in the previous section.

3. Common Areas and Exterior Sites Testing Rules

a. Similar common areas and similar exterior sites must always be tested, but in some cases they can be sampled in much the same way that dwelling units are. Common areas and building exteriors typically have a similar painting history from one building to the next. In multifamily housing, each common area (such as building lobby, laundry room, or hallway) can be treated as a dwelling unit. If there are multiple similar common areas, they may be grouped for sampling purposes I exactly the same way as regular dwelling units. However, dwelling units, common areas and exterior sites cannot be all mixed together in a single group. All testing combinations within each common area or building exteriors selected for testing must be inspected. This includes playground equipment, benches and miscellaneous testing combinations located throughout the development. The specific common areas and building exteriors to test should be randomly selected, in much the same way as specific units are selected using random numbers. The number of common areas to be tested should be taken from table 7.3 (HUD Guidelines). In this instance, common areas and building exteriors can be treated in the same way as housing units (although they are not to be confused with true housing units).

4. Unit and Common Area Drawings

a. Mark-ups of as built drawings depicting room equivalents that are tested must be provided as part of the report.

b. The Contractor should test in a clockwise path starting from the door through the space and room equivalents so that the approximate location of each component tested can be easily established by referencing the room equivalent and sides.

c. Each space must have a reference point (side A, B, C, D or wall 1, 2, 3 or 4). The wall with the door should always be referenced as wall 1 or side A. If there is more than one door, wall 1 or side A should be used to refer to the wall with the door through which the room is first entered when moving in a clockwise fashion through the unit.

B. Evaluation of the Inspection by the the Owner

1. The Contractor will be required to carry out retesting at no additional cost to the the Owner, after completion of the Inspection at each the Owner's development as described in the HUD Guidelines, for single family housing, multi-family housing and common areas. The the Owner shall randomly select the testing combinations to be retested and the Contractor shall perform the retesting using the same XRF instrument(s) which was/were used to take the original readings. An the Owner's inspector shall be present to observe all retesting. The retesting shall be limited to ten (10) testing combinations, and if necessary to repeat the retest, the testing combinations randomly selected for repeating the retest shall also be limited to ten.
2. If the retest tolerance limit computed from the information provided in the "XRF Performance Characteristics Sheet" (see HUD Guidelines) is exceeded, the retest will be repeated as described in the HUD Guidelines for single family, multi-family housing and common areas. If the retest tolerance limit is exceeded again, the the Owner may require the Contractor to retest the entire development at no additional cost to the the Owner, or the the Owner may withhold all payments and terminate its agreement with the Contractor.

C. Option to do Laboratory Testing only
1. The the Owner may, for a specific testing assignment, request in writing that the Contractor, when utilizing the multi-family housing testing rules for random sampling, or the single family housing testing rules, do all testing through laboratory analysis of paint chips rather than through XRF Spectrum Analyzer testing with laboratory confirmation as needed. Please note that under the single family housing testing rules, only one paint chip must be taken and analyzed for each component type.

D. Waste Disposal
1. All waste generated must be legally disposed in accordance with Federal, State and Local regulations.

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SECTION 02 83 19 13c - LEAD DUST WIPE, AIR AND TCLP SAMPLING AND ANALYSIS

1.1 DESCRIPTION OF WORK

A. This specification covers the furnishing and installation of materials for lead dust wipe, air and TCLP sampling and analysis. 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 GENERAL

A. Definitions: Unless otherwise specified the following definitions shall apply:
1. **"Approved"**: shall mean approved by all public agencies having jurisdiction, and the Owner.
2. **"The Owner"**: shall mean the Owner and its designated authorized representatives.
3. **"Contractor"**: shall mean the firm that is awarded this contract and is responsible to ensure compliance with Federal, State and City regulations as well as these Contract documents.
4. **"Development or Project"**: a group of buildings in one or more designated geographical locations, owned or operated by the Owner and referred to by a common name by the Owner.
5. **"Dust Cleaning Firm"**: shall mean the contractor under a separate contract or the Owner responsible for cleaning of lead dust, as directed by the Owner, until the clearance levels are achieved, as defined in the "Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing, June 1995" or latest edition published by the United States Department of Housing and Urban Development (HUD).
6. **"Equal or Approved Equal"**: shall mean equal in the opinion of the Owner.
7. **"HUD"**: the United States Department of Housing and Urban Development.
8. **"HUD Guidelines"**: shall mean Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing issued by HUD'S Office of Lead-Based Paint Abatement and Poisoning Prevention in June 1995 except as such guidelines are later modified by HUD and/or modified by the Owner in writing pursuant to this contract.
9. **"Inspector"**: an individual who has completed training from an accredited program and been licensed or certified by the appropriate State or local agency to (1) perform inspections to determine and report the presence of lead-based paint on a surface-by-surface basis through on-site testing, (2) report the findings of such an inspection, (3) collect environmental samples for laboratory analysis, (4) perform clearance testing, and (5) document successful compliance with lead-based paint hazard control requirements or standards.
10. **"Lead-Based Paint"**: any paint, varnish, shellac, or other coating that contains lead equal to or greater than 1.0 mg/cm² as measured by XRF or laboratory analysis, or 0.5 percent by weight (5,000 µg/g, 5,000 PPM, or 5,000 mg/kg) as measured by laboratory analysis.
11. **"Lead-Based Paint Hazard"**: a condition in which exposure to lead from lead-contaminated dust, lead-contaminated soil or deteriorated lead-based paint would have an adverse effect on human health (as established by the EPA Administrator under Title IV of the Toxic Substance Control Act). Lead-based paint hazards include for example, deteriorated lead-based paint, leaded dust levels above applicable standards and bare leaded soil above applicable standards.
12. **"Lead-Based Paint Hazard Control"**: activities to control or eliminate lead-based paint hazards, including interim controls and complete abatement.
13. **"Lead-Contaminated Dust"**: surface dust in residences that contain an area or mass concentration of lead in excess of the standard established by the EPA Administrator, pursuant to Title IV of the Toxic Substance Control Act. Until the EPA standards are set, the HUD recommended clearance and risk assessment standards for leaded dust are 40 µg/ft² on floors, 250 µg/ft² on interior window sills, and 800 µg/ft² on window troughs.

14. **"Monitoring"**: shall refer to inspection to ensure compliance with all Federal, State and City Standards or guidelines, and contractual specifications.
15. **"Provide"**: shall mean furnish and install.
16. **"Risk Assessor"**: a certified individual who has completed training with an accredited training program and who has been certified to (1) perform risk assessments, (2) identify acceptable abatement and interim control strategies for reducing identified lead-based paint hazards, (3) perform clearance testing and reevaluations, and (4) document the successful completion of lead-based paint hazard control activities.

B. Applicable Regulations/References

1. The work conducted shall comply with all applicable Federal, State and City regulations. Applicable guidelines and standards listed in the scope of work include, but are not limited to:

24 CFR Parts 35,36,37	HUD Lead-Based Paint Regulations
Guidelines for the Evaluation and Control of Lead-Based Paint in Housing (HUD Guidelines June 1995) & 1997 Revisions	
29 CFR 1910	General Industry Standard
29 CFR 1910.1025	Lead Standard for General Industry
29 CFR 1910.134	Respiratory Protection
29 CFR 1910.1200	Hazard Communication
29 CFR 1910.245	Specification for Accident Prevention
29 CFR 1926	Construction Industry Standards
29 CFR 1926.20	General Safety & Health Provisions
29 CFR 1926.21	Safety Training & Education
29 CFR 1926.25	Housekeeping
29 CFR 1926.28	Personal Protective Equipment
29 CFR 1926.51	Washing Facilities
29 CFR 1926.55	Gases, Vapors, Fumes, Dusts & Mists
29 CFR 1926.59	Hazard Communication Standard
29 CFR 1926.62	Construction Industry Lead Standard
29 CFR 1926.103	Respiratory Protection
40 CFR 61 Subpart A	General Provisions
40 CFR 241	Guidelines for the Land Disposal of Solid Waste
40 CFR 257	Criteria for the Land Disposal of Solid Waste
40 CFR 261/262	Waste Disposal Facilities & Practices
American National Standards Institute (ANSI) Z87.1	Eye Protection
ANSI Z88.2-80	Practices for Respiratory Protection
American Society For Testing Materials (ASTM)	All Applicable Standards

2. The contractor shall ensure that any programs, certifications, licenses or other documentation in accordance with the above and/or any other applicable Federal, State, and Local Regulations/Guidelines are provided.

C. Scope Of Work

1. The work shall consist of furnishing labor, materials, insurance and all other incidental items required to perform the following:
   a. Dust wipe sampling and analysis
      1) Collect dust wipe samples from various horizontal surfaces, such as floors, window sills, window troughs, etc., as directed by the Owner.
      2) Dust wipe samples shall be collected in accordance with ASTM ES30-94.

3) Analyze dust wipe sample in the laboratory using Flame Atomic Absorption Spectrometry ("FAAS") or Graphite Furnace Atomic Absorption Spectrometry("GFAAS").
4) Provide result of analysis in micrograms per square foot.
5) A faxed summary of results must be provided to the Owner within 24 hours after the Owner authorizes the Contractor to perform the laboratory analysis of the collected dust wipe sample. Contractor shall also have the ability to provide results in 4 hours for clearance, following lead-based paint abatement work, if requested by the Owner. The sampling result must be provided in a form approved by the Owner and must include for each dust wipe sample, the Project, the building address, the sample number, the room or room equivalent, the surface type, dimensions of sample areas, total micrograms, micrograms per square feet, and an indication of pass or fail.
6) Turn-around time for results shall be counted from the time the Contractor performs collection of dust wipe samples to the time the results are actually presented to the Owner. This includes travel time from the site to the laboratory of the Contractor and back to the site.
7) A detailed final report covering the results of all dust wipe samples taken and analyzed must be submitted within 5 days from the time the Owner authorizes the performance of the laboratory analysis. The sampling report must include for each dust wipe sample, the Project, the building address, the sample number, the room or room equivalent, the surface type, dimensions of sample areas, total micrograms, micrograms per square feet, and indicate pass or fail in a form approved by the Owner. Also include in the report the method of analysis, i.e. "FAAS" or "GFAAS", and the detection limits. The laboratory test results in the final report must be signed by the Laboratory Director.
8) The sampling data report must contain all required data fields as specified by the Owner. The sampling data report shall be provided to the Owner on 3.5 inch high density diskettes in ASCII file form. The required data fields will be provided by the Owner to the Contractor.
9) The laboratory used for the analysis of the dust wipe samples must be certified by the State Department of Health (or other responsible agency) and by the USEPA through the EPA's National Lead Laboratory Accreditation Program ("NLLAP"), or as an alternative having accreditation application pending before NLLAP, and having acceptable performance on five consecutive rounds of the EPA, Environmental Laboratory Proficiency Analytical Testing (ELPAT) program, including the most recent round; evidence of such accreditation must be provided. Indicate if the laboratory is an independent entity from the Contractor.

b. Dust Spiked Samples
1) Provide dust spiked samples to the Owner. Dust spiked samples shall be prepared in accordance with the HUD Guidelines.

NOTE: These samples are separate from the ones required by the Contractor for its own QA/QC

2) Prepare dust spiked samples in a manner such that they are indistinguishable from the field samples.
3) Prepare dust spiked samples using the same lot as that to be used in the field.
4) Dust spiked samples shall be inserted into the sample stream, randomly, by the Owner Inspector.
5) Blind analysis of dust spiked samples must fall within 80%-120% of the true value. If the laboratory fails to obtain readings within these limits, two more spiked samples shall be sent immediately to the lab for analysis.
6) If the two additional spiked samples fail, the sample batch shall be considered invalid, and the Owner may, at its sole discretion, terminate this contract as well as withhold payment for services already rendered.

c. Air Sampling and Analysis

1) Collect area air samples at various locations and various projects for personal exposure assessment as directed by the Owner.
2) Air samples shall be collected in accordance with ASTM E1553-93.
3) Prepare air samples for analysis in accordance with ASTM E33-94
4) Analyze air samples using FAAS or GFAAS.
5) All equipment required for personal air sampling, including pumps shall be provided by the Contractor at no extra cost to the Owner.
6) Provide results of air samples in micrograms per cubic meter.
7) A faxed summary of result must be provided to the Owner within 24 hours after the Owner authorizes the Contractor to perform the laboratory analysis of the collected air sample. The sampling result must include for each air sample taken the Project, the building address, the sample number, the room or room equivalent, and the reading.
8) Turn-around time shall start after collection of the air samples, and includes travel time to and from the laboratory.
9) A detailed final report covering the results of all air samples taken and analyzed must be submitted within 5 days from the time the Owner authorizes the performance of the laboratory analysis. The sampling report must include for each air sample, the Project, the building address, the sample number, the room or room equivalent, and the reading. The laboratory report contained in the final report must be signed by the Laboratory Director.
10) The sampling data report must contain all required data fields as specified by the Owner. The sampling data report shall be provided to the Owner on 3.5 inch high density diskettes in ASCII file form. The required data fields will be provided by the Owner to the Contractor.
11) The laboratory used for the analysis of the dust wipe samples must be certified by the State Department of Health (or other responsible agency) and by the USEPA through the EPA's National Lead Laboratory Accreditation Program ("NLLAP"),or as an alternative having accreditation application pending before NLLAP, and having acceptable performance on five consecutive rounds of the EPA, Environmental Laboratory Proficiency Analytical Testing (ELPAT) program, including the most recent round; evidence of such accreditation must be provided. Indicate if the laboratory is an independent entity from the Contractor.
12) Air sampling technician shall be present during the entire shift of the air sampling.

d. TCLP Sampling and Analysis
1) Take core samples of construction waste as directed by the Owner and analyze by TCLP testing to determine if waste is hazardous.
2) Waste shall be classified as hazardous if the concentration of lead is greater than 5 parts per million by TCLP testing.
3) The laboratory used for the analysis of the TCLP samples must be certified by the State Department of Health (or other responsible agency) and by the USEPA through the EPA's National Lead Laboratory Accreditation Program ("NLLAP"), or as an alternative having accreditation application pending before NLLAP, and having acceptable performance on five consecutive rounds of the EPA, Environmental Laboratory Proficiency Analytical Testing (ELPAT) program, including the most recent round; evidence of such accreditation must be provided. Indicate if the laboratory is an independent entity from the Contractor.
4) A faxed summary of result must be provided to the Owner within 48 hours after the Owner authorizes the Contractor to perform the TCLP analysis of the waste. Provide results in parts per million (ppm).
5) Final results provided to the Owner by the Contractor must include written sample preparation procedure and laboratory specific written procedures for performing TCLP, including quality control procedures used for performing the TCLP, and a table listing the sample numbers, description of the construction waste, and the

result of the TCLP. The laboratory report contained in the final report must be signed by the Laboratory Director.

6) Final report must also specify detection limits.
7) Final report must be provided within 5 days from the time the authorization to perform the TCLP is given by the Owner.

D. General Provisions
1. Some of the work of this contract may be in occupied apartments. The Contractor shall perform all of the work of this contract with the least inconvenience to the tenants.
2. The Contractor shall take all necessary precautions to protect the property of the Owner, its residents, and the public. The Contractor must repair any damaged property, whether of the Owner, its residents, or the public, and restore such property to its original condition. If the damage is beyond repair, the Contractor shall replace it with new, that in the judgment of the Owner, match the existing materials and/or of equal quality and workmanship. All such repairs shall be at the Contractor's expense.
3. The Contractor shall develop a work plan to be performed as requested by the Department of Planning and Development. The detailed plan shall include coordination of the monitoring and sampling work with the Contractor in a manner that will be least disruptive to the normal use of the non-work areas in the building. The plan should also include emergency procedures in case of fire.
4. The Contractor shall perform work in accordance with the latest HUD Guidelines, except as such Guidelines are modified by the Owner in writing in this Contract, or any Contract pursuant to this Contract, and in accordance with all applicable Federal, State and Local regulations.
5. The Contractor shall include in the bid price all supplementary miscellaneous items not specified but implied or required in order to complete the work.

E. Submissions
1. Six (6) copies of the submissions listed below must be submitted to the Owner by the Contractor or Subcontractor performing the Work:
   a. Ability to perform lead dust wipe sampling by submitting evidence of the successful completion of lead inspector and/or risk assessor training by all staff to be assigned to the job including inspector technicians. As stated previously, training must be provided through an approved program.
   b. Laboratory certification by the State Department of Health (or other responsible agency) through its ELAP program and by the USEPA through the EPA's National Lead Laboratory Accreditation Program ("NLLAP"), or as an alternative having accreditation application pending before NLLAP and having acceptable performance on five consecutive rounds of the EPA, Environmental Laboratory Proficiency Analytical Testing (ELPAT) program, including the most recent round; evidence of such accreditation must be provided.
   c. If a subcontractor will be used for any of the laboratory work of this contract, evidence of certification stated in (2) above must also be provided for the subcontractor.

F. Waste Disposal
1. All waste generated must be legally disposed in accordance with the Federal, State and Local Regulations.

END OF SECTION 02 83 19 13c

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Task	Specification	Specification Description
02 83 33 13	02 83 19 13	Removal And Disposal Of Lead-Containing Paint
02 83 33 13	02 83 19 13a	Lead Paint Related Abatement Procedures
02 83 33 13	02 83 19 13b	XRF Testing For Lead-Based Paint
02 83 33 13	02 83 19 13c	Lead Dust Wipe, Air And Tclp Sampling And Analysis

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SECTION 02 84 16 00 - REMOVAL OF FLUORESCENT LIGHT BALLASTS/CAPACITORS AND FLUORESCENT LIGHT TUBES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for removal of fluorescent light ballasts/capacitors and fluorescent light tubes. Products shall be as follows or as directed by the 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. Before Start of Work: Submit the following to the Owner's Representative for review. Do not start work until these submittals are returned with Owner's Representative's approval.
   a. Copy of State or local license for hazardous waste hauler;
   b. Certification of at least one on-site supervisor which has satisfactorily completed the OSHA 40 Hour Health and Safety Course for Handling Hazardous Materials;
   c. Certificates of workers which have successfully completed at least the OSHA 40-Hour Health and Safety Course for Hazardous Materials;
   d. List of employees scheduled to perform this work;
   e. Schedule of start and finish times and dates for this work;
   f. Name and address of landfill where these waste materials are to be deposited (include contact person and telephone numbers);
   g. Material Safety Data Sheets for all materials requiring removal;
   h. If contractor introduces any chemical into the work environmental, a MSDS for that chemical is required before use;
   i. Transporter must have notified the EPA and/or the appropriate local government agency in advance of its intentions to transport PCB's, mercury and cadmium, and receive an identification number pursuant to the Toxic Substance Control Act (TSCA); and
   j. Contingency Plan for handling emergency spills or leaks.

1.2 PRODUCTS

A. Materials
1. Polyethylene Sheet: A single polyethylene film in the largest sheet size possible to minimize seams, 4.0 and 6.0 mil thick, clear, frosted, or black.
2. Duct Tape: Provide duct tape in 3" widths, witty an adhesive which is formulated to stick aggressively to sheet polyethylene.
3. Spray Cement: Provide spray adhesive in aerosol cans which is specifically formulated to stick tenaciously to sheet polyethylene.
4. Disposal Bays: Provide 6 mil thick leak-tight polyethylene bags.
5. Labels: As required by the EPA and OSHA for handling, transportation, and disposal of hazardous waste.
6. **Drums:** Recovery or salvage drums acceptable for disposal of hazardous waste. Prior approval of drums is required. Drums or containers must meet the required OSHA EPA (40 CFR Parts 264-265 and 300), and DOT regulations (49 CFR Parts 171-178). Use of damaged drums will not be allowed.

1.3 EXECUTION

A. General

1. Where necessary, scaffolding shall be erected to fully access all applicable fluorescent light ballasts/capacitors and tubes. At no time will the ballasts/capacitors and tubes be allowed to drop onto the floor. Contractor must take care to protect from dropping the ballasts/capacitors and fluorescent tubes.
2. Prior to removing ballasts/capacitors and fluorescent tubes, contractor shall ensure that all electrical service to lights has been shut off, and locked out. Temporary lighting shall be erected to adequately illuminate work areas.
3. Depending on height of light fixtures, contractor shall utilize at least a 2-person per team system. The fluorescent light tubes shall be removed and passed to the appropriate number of workers required to lower the tubes to the floor without breaking them.
4. The worker on the floor shall lay the tubes in cardboard boxes large enough to hold a small quantity of tubes. Worker shall take care to not damage the tubes while they are lowered into the box. Once the box is full, it shall be wrapped with two layers of 6 mil thick polyethylene sheeting and sealed with duct tape.
5. Contractor may choose to either remove the fluorescent light ballasts/capacitors in-place or lower the lighting fixtures for easy access. The ballasts/capacitors shall be removed from the fixtures. Electrical wiring leading from the ballasts/capacitors shall be cut away. Ballasts/capacitors shall be placed in 55-gallon drums lined with at least two 6 mil thick polyethylene bags. Be careful not to overfill the drums so that they remain manageable. Once the drums have been filled to the acceptable level, seal the lid onto the top of the drum, and affix appropriate labels. Transport drums via hand dollies.

B. Worker Protection
1. As a minimum, while working with the ballasts/capacitors and light tubes, workers shall utilize impervious gloves adequate for the use with hazardous materials. If light ballasts/capacitors and/or light tubes are damaged, and/or exposure to these materials may reach the OSHA PEL or AGGIH threshold limit value (TLV), the contractor shall be required to provide impervious full body protection and respiratory protection. However, contractor is required to verify the type of protection required prior to working with these materials, and have written approval by Owner's Representative prior to beginning.
2. In addition, workers shall not smoke, drink or eat in these areas during work activities.

C. Storage Of Fluorescent Light Ballasts/Capacitors And Light Tubes
1. Once the containers holding the ballasts/capacitors and light tubes have been filled and sealed, they shall be stored in designated areas as agreed upon by the Owners Representative and Contractor. They shall not be allowed to be stored on-site in transportation vehicles until the time for them to be transported to the hazardous waste incinerators or landfill facility.

END OF SECTION 02 84 16 00

SECTION 02 84 16 00a - EXTERIOR LIGHTING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for exterior lighting. 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 luminaires with lamps and ballasts.
b. Luminaire-mounted photoelectric relays.
c. Poles and accessories.
d. Luminaire lowering devices.

C. Definitions
1. CCT: Correlated color temperature.
2. CRI: Color-rendering index.
3. HID: High-intensity discharge.
4. LER: Luminaire efficacy rating.
5. Luminaire: Complete lighting fixture, including ballast housing if provided.
6. Pole: Luminaire support structure, including tower used for large area illumination.
7. Standard: Same definition as "Pole" above.

D. Structural Analysis Criteria For Pole Selection
1. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.
2. Live Load: Single load of 500 lbf (2224 N), distributed as stated in AASHTO LTS-4-M.
3. Ice Load: Load of 3 lbf/sq. ft. (145 Pa), applied as stated in AASHTO LTS-4-M Ice Load Map.
4. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.
a. Basic wind speed for calculating wind load for poles exceeding 49.2 feet (15 m) in height is 100 mph (45 m/s) **OR** 90 mph (40 m/s), **as directed**.
1) Wind Importance Factor: 1.0.
2) Minimum Design Life: 50 years.
3) Velocity Conversion Factors: 1.0.
b. Basic wind speed for calculating wind load for poles 50 feet (15 m) high or less is 100 mph (45 m/s) **OR** 90 mph (40 m/s).
1) Wind Importance Factor: 1.0.
2) Minimum Design Life: 25 years.
3) Velocity Conversion Factors: 1.0.

E. Submittals
1. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
a. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
b. Details of attaching luminaires and accessories.
c. Details of installation and construction.
d. Luminaire materials.
e. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.

1) Testing Agency Certified Data: For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
OR
Manufacturer Certified Data: Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

f. Photoelectric relays.
g. Ballasts, including energy-efficiency data.
h. Lamps, including life, output, CCT, CRI, lumens, and energy-efficiency data.
i. Materials, dimensions, and finishes of poles.
j. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
k. Anchor bolts for poles.
l. Manufactured pole foundations.

2. Shop Drawings: 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. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
   c. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
   d. Wiring Diagrams: For power, signal, and control wiring.
3. Samples: For products designated for sample submission in the Exterior Lighting Device Schedule. Each Sample shall include lamps and ballasts.
4. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a professional engineer.
5. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.
6. Field quality-control reports.
7. Operation and Maintenance Data: For luminaires and poles **OR** luminaire lowering devices, **as directed**, to include in emergency, operation, and maintenance manuals.
8. Warranty: Sample of special warranty.

F. Quality Assurance
1. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
OR
Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.
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. Comply with IEEE C2, "National Electrical Safety Code."
4. Comply with NFPA 70.

G. Delivery, Storage, And Handling
1. Package aluminum poles for shipping according to ASTM B 660.
2. Store poles on decay-resistant-treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
3. Handle wood poles so they will not be damaged. Do not use pointed tools that can indent pole surface more than 1/4 inch (6 mm) deep. Do not apply tools to section of pole to be installed below ground line.

4. Retain factory-applied pole wrappings on fiberglass and laminated wood poles until right before pole installation. Handle poles with web fabric straps.
5. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

H. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
   a. Warranty Period for Luminaires: Five years from date of Final Completion.
   b. Warranty Period for Metal Corrosion: Five years from date of Final Completion.
   c. Warranty Period for Color Retention: Five years from date of Final Completion.
   d. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Final Completion.

1.2 PRODUCTS

A. General Requirements For Luminaires
1. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
   a. LER Tests Incandescent Fixtures: Where LER is specified, test according to NEMA LE 5A.
   b. LER Tests Fluorescent Fixtures: Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
   c. LER Tests HID Fixtures: Where LER is specified, test according to NEMA LE 5B.
2. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
3. Metal Parts: Free of burrs and sharp corners and edges.
4. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.
5. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
6. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
7. Exposed Hardware Material: Stainless steel.
8. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
9. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
10. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
    a. White Surfaces: 85 percent.
    b. Specular Surfaces: 83 percent.
    c. Diffusing Specular Surfaces: 75 percent.
11. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
12. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
13. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

a. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. 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. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
1) Color: As selected from manufacturer's standard catalog of colors **OR** As selected from manufacturer's full range, **as directed**.

14. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
a. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
b. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
c. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
d. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; 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: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black, **as directed**.

15. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
a. Label shall include the following lamp and ballast characteristics:
1) "USES ONLY" and include specific lamp type.
2) Lamp diameter code (T-4, T-5, T-8, T-12), tube configuration (twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
3) Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
4) Start type (preheat, rapid start, instant start) for fluorescent and compact fluorescent luminaires.
5) ANSI ballast type (M98, M57, etc.) for HID luminaires.
6) CCT and CRI for all luminaires.

B. Luminaire-Mounted Photoelectric Relays
1. Comply with UL 773 or UL 773A.
2. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc (16 to 32 lx) and off at 4.5 to 10 fc (48 to 108 lx) with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff, **as directed**.
a. Relay with locking-type receptacle shall comply with ANSI C136.10.
b. Adjustable window slide for adjusting on-off set points.

C. Fluorescent Ballasts And Lamps
1. Ballasts for Low-Temperature Environments:
a. Temperatures 0 Deg F (Minus 17 Deg C) and Higher: Electronic or electromagnetic type rated for 0 deg F (minus 17 deg C) starting and operating temperature with indicated lamp types.
b. Temperatures Minus 20 Deg F (Minus 29 Deg C) and Higher: Electromagnetic type designed for use with indicated lamp types.
2. Ballast Characteristics:
a. Power Factor: 90 percent, minimum.

b. Sound Rating: Class A **OR** Class A except Class B for T8/HO ballasts, **as directed**.
c. Total Harmonic Distortion Rating: Less than 10 **OR** 20, **as directed**, percent.
d. Electromagnetic Ballasts: Comply with ANSI C82.1, energy-saving, high power factor, Class P, automatic-reset thermal protection.
e. Case Temperature for Compact Lamp Ballasts: 65 deg C, maximum.
f. Transient-Voltage Protection: Comply with IEEE C62.41.1 and IEEE C62.41.2, Category A or better.

3. Low-Temperature Lamp Capability: Rated for reliable starting and operation with ballast provided at temperatures 0 deg F (minus 18 deg C) **OR** minus 20 deg F (minus 29 deg C), **as directed**, and higher.

D. Ballasts For HID Lamps
1. Comply with ANSI C82.4 and UL 1029 and capable of open-circuit operation without reduction of average lamp life. Include the following features unless otherwise indicated:
a. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
b. Minimum Starting Temperature: Minus 22 deg F (Minus 30 deg C).
c. Normal Ambient Operating Temperature: 104 deg F (40 deg C).
d. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.
2. Auxiliary, Instant-On, Quartz System: Factory-installed feature automatically switches quartz lamp on when fixture is initially energized and when momentary power outages occur. System automatically turns quartz lamp off when HID lamp reaches approximately 60 percent of light output.
3. High-Pressure Sodium Ballasts: Electromagnetic type with solid-state igniter/starter and capable of open-circuit operation without reduction of average lamp life. Igniter/starter shall have an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg C.
a. Instant-Restrike Device: Integral with ballast, or solid-state potted module, factory installed within fixture and compatible with lamps, ballasts, and mogul sockets up to 150 W.
1) Restrike Range: 105- to 130-V ac.
2) Maximum Voltage: 250-V peak or 150-V ac rms.
b. Minimum Starting Temperature: Minus 40 deg F (Minus 40 deg C).

E. HID Lamps
1. High-Pressure Sodium Lamps: ANSI C78.42, CRI 21 (minimum), CCT color temperature 1900 K, and average rated life of 24,000 hours, minimum.
a. Dual-Arc Tube Lamp: Arranged so only one of two arc tubes is lighted at one time and, when power is restored after an outage, the cooler arc tube, with lower internal pressure, lights instantly, providing an immediate 8 to 15 percent of normal light output.
2. Low-Pressure Sodium Lamps: ANSI C78.43.
3. Metal-Halide Lamps: ANSI C78.43, with minimum CRI 65, and CCT color temperature 4000 K.
4. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and CCT color temperature 4000 K.
5. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and CCT color temperature 4000 K.

F. General Requirements For Poles And Support Components
1. Structural Characteristics: Comply with AASHTO LTS-4-M.
a. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
b. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
2. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.
3. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

a. Materials: Shall not cause galvanic action at contact points.
b. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
c. Anchor-Bolt Template: Plywood or steel.

4. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches (65 by 130 mm), with cover secured by stainless-steel captive screws. Provide on all, except wood poles.
5. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete."
6. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.
7. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4-M.

G. Steel Poles
1. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig (317 MPa); one-piece construction up to 40 feet (12 m) in height with access handhole in pole wall.
   a. Shape: Round, tapered **OR** Round, straight **OR** Square, tapered **OR** Square, straight, **as directed**.
   b. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
2. Steel Mast Arms: Single-arm **OR** Truss **OR** Davit, **as directed**, type, continuously welded to pole attachment plate. Material and finish same as pole.
3. Brackets for Luminaires: Detachable, cantilever, without underbrace.
   a. Adapter fitting welded to pole, allowing the bracket to be bolted to the pole mounted adapter, then bolted together with stainless **OR** galvanized, **as directed**,-steel bolts.
   b. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
   c. Match pole material and finish.
4. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
5. Steps: Fixed steel, with nonslip treads, positioned for 15-inch (381-mm) vertical spacing, alternating on opposite sides of pole; first step at elevation 10 feet (3 m) above finished grade.
6. Intermediate Handhole and Cable Support: Weathertight, 3-by-5-inch (76-by-127-mm) handhole located at midpoint of pole with cover for access to internal welded attachment lug for electric cable support grip.
7. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Division 26 Section "Grounding And Bonding For Electrical Systems", listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
8. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.
9. Platform for Lamp and Ballast Servicing: Factory fabricated of steel with finish matching that of pole.
10. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.
11. Galvanized Finish: After fabrication, hot-dip galvanize complying with ASTM A 123/A 123M.
12. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
    a. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. 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."

b. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
c. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
1) Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

H. Aluminum Poles
1. Poles: Seamless, extruded structural tube complying with ASTM B 429/B 429M, Alloy 6063-T6 with access handhole in pole wall.
2. Poles: ASTM B 209 (ASTM B 209M), 5052-H34 marine sheet alloy with access handhole in pole wall.
a. Shape: Round, tapered **OR** Round, straight **OR** Square, tapered **OR** Square, straight, **as directed**.
b. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
3. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
4. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Division 26 Section "Grounding And Bonding For Electrical Systems", listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
5. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
a. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
b. Finish: Same as pole **OR** luminaire, **as directed**.
6. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.
7. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
a. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
b. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
c. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
d. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; 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: Light bronze **OR** Medium bronze **OR** Dark bronze **OR** Black **OR** As selected from manufacturer's full range, **as directed**.

I. Fiberglass Poles
1. Poles: Designed specifically for supporting luminaires, with factory-formed cable entrance and handhole. Not less than 65 percent fiberglass, with resin and pigment making up the remainder.
a. Resin Color: Dark bronze; provide uniform coloration throughout entire wall thickness.
b. Surface Finish: Pigmented polyurethane, with a minimum dry film thickness of 1.5 mils (0.04 mm). Polyurethane may be omitted if the surface layer of pole is inherently UV inhibited.

J. Decorative Poles
1. Pole Material:
a. Cast ductile iron.
b. Cast gray iron, according to ASTM A 48/A 48M, Class 30.
c. Cast aluminum.
d. Cast concrete.

e. Spun concrete.
f. Steel tube, covered with closed-cell polyurethane foam, with a polyethylene exterior.

2. Mounting Provisions:
   a. Bolted to concrete foundation.
   b. Embedded.
3. Fixture Brackets:
   a. Cast ductile iron.
   b. Cast gray iron.
   c. Cast aluminum.
4. Pole Finish: <**Insert finish**>.

K. Laminated Wood Poles
1. Species and Grades for Structural Glulam Timber: Engineer and fabricate structural laminated wood poles, complying with ANSI A190.1. Use southern pine **OR** Douglas fir **OR** Alaska cedar **OR** any species listed in AITC 117, **as directed**, to withstand indicated structural loads without exceeding allowable design working stresses according to AITC 117.
2. Features: Include wood bracket **OR** wood crossarm **OR** pole-top adapter, **as directed**, for mounting luminaire(s), metal pole cap, **as directed**, and concealed raceway path connected to access handhole.
3. Mounting Provisions: Embedded.
4. Appearance Grade: Architectural appearance grade complying with AITC 110.
5. Preservative Treatment: Pressure treat lumber before gluing according to AWPA C28 for waterborne preservatives. After dressing and end-cutting each member to final size and shape, apply a field-treatment preservative to comply with AWPA M4 to surfaces cut to a depth of more than 1/16 inch (1.6 mm).
6. Adhesive: Wet-use type complying with ASTM D 2559.
7. 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.
8. Penetrating Sealer: Manufacturer's standard, transparent, penetrating wood sealer that is compatible with indicated finish.
9. Finish: Natural, unstained wood **OR** Semitransparent stain applied after erection **OR** Semitransparent stain applied at factory, **as directed**, color as selected.

L. Wood Poles
1. Poles: Douglas fir **OR** Southern yellow pine, **as directed**, machine trimmed by turning, **as directed**, complying with ANSI O5.1 and with AWPA C4 for wood species used; and bored, roofed, and gained before treatment.
   a. Mounting Provisions: Embedded.
2. Preservative Treatment: Pressure treat poles with creosote **OR** pentachlorophenol **OR** ammoniacal copper arsenate, **as directed**, according to AWPA C1 and AWPA C4.
3. Luminaire Brackets: Comply with ANSI C136.13.

M. Prestressed Concrete Poles
1. Poles: Manufactured by centrifugal spin-casting process **OR** of cast concrete, **as directed**.
   a. Shape: Round, tapered **OR** Round, straight **OR** Square, tapered **OR** Square, straight, **as directed**.
   b. Mounting Provisions: Steel butt flange for bolted mounting to foundation or breakaway support **OR** Embedded, **as directed**.
   c. Finishing: Capped at top and plugged at bottom. Seat each steel reinforcing strand with epoxy adhesive.
   d. Grounding: Continuous copper ground wire cast into pole. Terminate at top of pole and attach to 24-inch (610-mm) lightning rod, **as directed**.
2. Cure with wet steam and age for a minimum of 15 days before installation.
3. Fabricate poles with a hard, nonporous surface that is resistant to water, frost, and road and soil chemicals and that has a maximum water-absorption rate of 3 percent.

4. Cast aluminum nameplate into pole wall at approximately 5 feet (1.5 m) above ground line, listing name of manufacturer, Project identifier, overall height, and approximate weight.
5. Pole Brackets: Comply with ANSI C136.13.
6. Finish Color: Provided by color material complying with ASTM C 979, uniformly impregnated throughout the pole concrete. Color material shall provide a uniform, stable, permanent color and be as follows:
   a. Inert, and carbon free.
   b. Unaffected by environmental conditions and contaminants including, but not limited to, UV solar radiation, salts, and alkalis.
7. Finish Texture: Standard form **OR** Polished exposed aggregate **OR** Etched exposed aggregate, **as directed**.
   a. Exposed aggregate shall be of <**Insert aggregate type selected from manufacturers' lists**> type.

N. Pole Accessories
1. Duplex Receptacle: 120 V, 20 A in a weatherproof assembly complying with Division 16 Section "Wiring Devices" for ground-fault circuit-interrupter type.
   a. Surface mounted **OR** Recessed, **as directed**, 12 inches (300 mm) above finished grade.
   b. Nonmetallic polycarbonate plastic or reinforced fiberglass, weatherproof in use, cover, that when mounted results in NEMA 250, Type 3R **OR** Type 4X, **as directed**, enclosure.
   c. With cord opening.
   d. With lockable hasp and latch that complies with OSHA lockout and tag-out requirements.
2. Minimum 1800-W transformer, protected by replaceable fuses, mounted behind access cover.
3. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.
4. Transformer Type Base: Same material and color as pole. Coordinate dimensions to suit pole's base flange and accept ballast(s) **OR** indicated accessories, **as directed**.
5. Decorative accessories, supplied by decorative pole manufacturer, include the following:
   a. Banner Arms: <**Insert material**>.
   b. Flag Holders: <**Insert material**>.
   c. Ladder Rests: <**Insert material**>.

O. Lowering System For Luminaires
1. Arrange system to lower luminaire **OR** luminaire assembly, **as directed**, to a servicing position within 36 inches (900 mm) of finished grade in winds up to 30 mph (49 km/h) and to provide for manual plug connection to electrical power in the lowered position for testing.
2. Coordinate with luminaire and pole manufacturers for assembly details, wind-load and vibration analysis, and compatibility of materials for electrolysis-free attachment and connection for luminaire mounting assembly, lowering device, lowering cable, and portable winch.
3. Structural and Mechanical Design: Use a minimum safety factor of 5.0 for static and dynamic loads of load-bearing components, including cable.
4. Luminaire Mounting and Disconnect Arrangement: Multiple ring **OR** carriage, **as directed**,-mounted luminaires, arranged for lowering and rising as a group.
   a. Electrical cable for normal operating power to luminaires manually disconnects inside pole base, using weatherproof multipin connector, and shall be arranged to move within the pole during lowering and rising of luminaire assembly.
      OR
      Electrical cable for normal operating power to luminaires automatically disconnects at a weatherproof multipin connector within the pole-top lowering head at the beginning of the lowering cycle and reconnects when luminaire or luminaire assembly is raised to the operating position.
5. Lowering Device: Weatherproof, cast-aluminum housing and multiple mechanical latches. Moving parts of latching assembly shall be located in the portion of the unit that is lowered to the servicing position. Positive latching in the operating position shall be indicated to the operator at the base of the pole by a clear visual signal, or by other means acceptable to the Owner or authorities having jurisdiction.

6. Lowering Cable: Zinc-electroplated- or stainless-steel aircraft cable.
7. Portable Winch: Manual **OR** 120-V electric, **as directed**, type. One required.
   a. Winch Power Connection: Cord and plug.
   b. Winch Raise-Lower Control: Remote-control station with 15 feet (5 m) of cable.
8. Winch Transformer: Portable, totally enclosed, encapsulated, single-phase, dry type. Primary rated at lighting-circuit voltage; secondary rated at 120 V. Permanent, primary and secondary, twist-locking plug connectors on pigtails shall match pole-base power outlet and winch plug.

1.3 EXECUTION

A. Luminaire Installation
   1. Install lamps in each luminaire.
   2. Fasten luminaire to indicated structural supports.
      a. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
   3. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation, **as directed**.

B. Pole Installation
   1. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
   2. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:
      a. Fire Hydrants and Storm Drainage Piping: 60 inches (1520 mm).
      b. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet (3 m).
      c. Trees: 15 feet (5 m) from tree trunk.
   3. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-place Concrete".
   4. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
      a. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
      b. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
      c. Install base covers unless otherwise indicated.
      d. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
   5. Embedded Poles with Tamped Earth Backfill: Set poles to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
      a. Dig holes large enough to permit use of tampers in the full depth of hole.
      b. Backfill in 6-inch (150-mm) layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.
   6. Embedded Poles with Concrete Backfill: Set poles in augered holes to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
      a. Make holes 6 inches (150 mm) in diameter larger than pole diameter.
      b. Fill augered hole around pole with air-entrained concrete having a minimum compressive strength of 3000 psi (20 MPa) at 28 days, and finish in a dome above finished grade.
      c. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through concrete dome. Arrange to drain condensation from interior of pole.
      d. Cure concrete a minimum of 72 hours before performing work on pole.
   7. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch- (150-mm-) wide, unpaved gap between the pole or pole foundation and the edge of adjacent

concrete slab. Fill unpaved ring with pea gravel to a level 1 inch (25 mm) below top of concrete slab.

8. Raise and set poles using web fabric slings (not chain or cable).

C. Bollard Luminaire Installation
   1. Align units for optimum directional alignment of light distribution.
   2. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-place Concrete".

D. Installation Of Individual Ground-Mounting Luminaires
   1. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-place Concrete".

E. Corrosion Prevention
   1. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
   2. Steel Conduits: Comply with Division 26 Section "Raceway And Boxes For Electrical Systems". In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

F. Grounding
   1. Ground metal poles and support structures according to Division 26 Section "Grounding And Bonding For Electrical Systems".
      a. Install grounding electrode for each pole unless otherwise indicated.
      b. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
   2. Ground nonmetallic poles and support structures according to Division 26 Section "Grounding And Bonding For Electrical Systems".
      a. Install grounding electrode for each pole.
      b. Install grounding conductor and conductor protector.
      c. Ground metallic components of pole accessories and foundations.

G. Field Quality Control
   1. Inspect each installed fixture for damage. Replace damaged fixtures and components.
   2. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
      a. Verify operation of photoelectric controls.
   3. Illumination Tests:
      a. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):
         1) IESNA LM-5, "Photometric Measurements of Area and Sports Lighting Installations."
         2) IESNA LM-50, "Photometric Measurements of Roadway Lighting Installations."
         3) IESNA LM-52, "Photometric Measurements of Roadway Sign Installations."
         4) IESNA LM-64, "Photometric Measurements of Parking Areas."
         5) IESNA LM-72, "Directional Positioning of Photometric Data."
   4. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

H. Demonstration
   1. Train the Owner's maintenance personnel to adjust, operate, and maintain luminaire lowering devices.

END OF SECTION 02 84 16 00a

Task	Specification	Specification Description
02 84 16 00	01 95 26 00a	Interior Lighting
02 86 00 00	02 41 16 13	Selective Demolition
02 86 00 00	02 61 00 00	Excavation And Handling Of Contaminated Material
02 86 00 00	02 61 13 00	Underground Storage Tank Removal
02 86 00 00	02 61 13 00a	Precision Testing Of Underground Fuel Oil Tanks
02 86 00 00	02 61 13 00b	Hydrostatic Pressure Testing Of Air Receiving Tanks
02 86 00 00	02 81 00 00	Disposal Of Hazardous Materials

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SECTION 02 87 13 33 - MOLD REMEDIATION

1.1 GENERAL

A. Description Of Work
1. This specification covers the removal and disposal of mold. 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. List of all personnel to be involved in the work with their training and certifications.
2. List of all products and procedures proposed for use in performance of the work.
3. Test reports.
4. Certificates.

C. References
1. U.S. EPA “Mold Remediation in Schools and Commercial Buildings”
2. U.S. EPA “A Brief Guide to Mold, Moisture, and Your Home”

D. Quality Assurance
1. Conform to all Federal, State, and Local regulations which govern the handling and disposal of mold materials.

1.2 PRODUCT - (Not Used)

1.3 EXECUTION

A. Environmental Assessment: The presence of mold, water damage, or musty odors shall be addressed immediately. In all instances, any source(s) of water must be stopped and the extent of water damaged determined. Water damaged materials shall be dried and repaired. Mold damaged materials shall be remediated in accordance with this document.
1. Visual Inspection: A visual inspection is the most important initial step in identifying a possible contamination problem. The extent of any water damage and mold growth shall be visually assessed. This assessment is important in determining remedial strategies. Ventilation systems shall also be visually checked, particularly for damp filters but also for damp conditions elsewhere in the system and overall cleanliness. Ceiling tiles, gypsum wallboard (sheetrock), cardboard, paper, and other cellulosic surfaces shall be given careful attention during a visual inspection. The use of equipment such as a boroscope, to view spaces in ductwork or behind walls, or a moisture meter, to detect moisture in building materials, may be helpful in identifying hidden sources of fungal growth and the extent of water damage.
2. Bulk/Surface Sampling
a. Bulk or surface sampling is not required to undertake a remediation. Remediation of visually identified fungal contamination shall proceed without further evaluation.
b. Bulk or surface samples may need to be collected to identify specific fungal contaminants as part of a medical evaluation if occupants are experiencing symptoms which may be related to fungal exposure or to identify the presence or absence of mold if a visual inspection is equivocal (e.g., discoloration, and staining).
c. An individual trained in appropriate sampling methodology shall perform bulk or surface sampling. Bulk samples shall be collected from visibly moldy surfaces by scraping or cutting materials with a clean tool into a clean plastic bag. Surface samples shall be collected by wiping a measured area with a sterile swab or by stripping the suspect surface

with clear tape. Surface sampling is less destructive than bulk sampling. Other sampling methods may also be available. A laboratory specializing in mycology shall be consulted for specific sampling and delivery instructions.

3. Air Monitoring
   a. Air sampling for fungi shall not be part of a routine assessment. This is because decisions about appropriate remediation strategies can usually be made on the basis of a visual inspection. In addition, air-sampling methods for some fungi are prone to false negative results and therefore cannot be used to definitively rule out contamination.
   b. Air monitoring may be necessary if an individual(s) has been diagnosed with a disease that is or may be associated with a fungal exposure (e.g., pulmonary hemorrhage/hemosiderosis, and aspergillosis).
   c. Air monitoring may be necessary if there is evidence from a visual inspection or bulk sampling that ventilation systems may be contaminated. The purpose of such air monitoring is to assess the extent of contamination throughout a building. It is preferable to conduct sampling while ventilation systems are operating.
   d. Air monitoring may be necessary if the presence of mold is suspected (e.g., musty odors) but cannot be identified by a visual inspection or bulk sampling (e.g., mold growth behind walls). The purpose of such air monitoring is to determine the location and/or extent of contamination.
   e. If air monitoring is performed, for comparative purposes, outdoor air samples shall be collected concurrently at an air intake, if possible, and at a location representative of outdoor air. For additional information on air sampling, refer to the American Conference of Governmental Industrial Hygienists' document, "Bioaerosols: Assessment and Control."
   f. Personnel conducting the sampling shall be trained in proper air sampling methods for microbial contaminants. A laboratory specializing in mycology shall be consulted for specific sampling and shipping instructions.
4. Analysis of Environmental Samples
   a. Microscopic identification of the spores/colonies requires considerable expertise. These services are not routinely available from commercial laboratories. Documented quality control in the laboratories used for analysis of the bulk/surface and air samples is necessary. The American Industrial Hygiene Association (AIHA) offers accreditation to microbial laboratories (Environmental Microbiology Laboratory Accreditation Program (EMLAP)). Accredited laboratories must participate in quarterly proficiency testing (Environmental Microbiology Proficiency Analytical Testing Program (EMPAT)).
5. Evaluation of bulk/surface and air sampling data shall be performed by an experienced health professional. The presence of few or trace amounts of fungal spores in bulk/surface sampling shall be considered background. Amounts greater than this or the presence of fungal fragments (e.g., hyphae, and conidiophores) may suggest fungal colonization, growth, and/or accumulation at or near the sampled location. Air samples shall be evaluated by means of comparison (i.e., indoors to outdoors) and by fungal type (e.g., genera, and species). In general, the levels and types of fungi found should be similar indoors (in non-problem buildings) as compared to the outdoor air. Differences in the levels or types of fungi found in air samples may indicate that moisture sources and resultant fungal growth may be problematic.

B. Remediation
1. General
   a. **In all situations, the underlying cause of water accumulation must be rectified or fungal growth will recur.** Any initial water infiltration shall be stopped and cleaned immediately. An immediate response (within 24 to 48 hours) and thorough clean up, drying, and/or removal of water damaged materials will prevent or limit mold growth. If the source of water is elevated humidity, relative humidity shall be maintained at levels below 60% to inhibit mold growth. Emphasis shall be on ensuring proper repairs of the building infrastructure, so that water damage and moisture buildup does not recur.
   b. Five different levels of abatement are described below. The size of the area impacted by fungal contamination primarily determines the type of remediation. The sizing levels below

are based on professional judgment and practicality; currently there is not adequate data to relate the extent of contamination to frequency or severity of health effects. **The goal of remediation is to remove or clean contaminated materials in a way that prevents the emission of fungi and dust contaminated with fungi from leaving a work area and entering an occupied or non-abatement area, while protecting the health of workers performing the abatement.** The listed remediation methods were designed to achieve this goal, however, due to the general nature of these methods it is the responsibility of the people conducting remediation to ensure the methods enacted are adequate. The listed remediation methods are not meant to exclude other similarly effective methods. Any changes to the remediation methods listed in these guidelines, however, shall be carefully considered prior to implementation.

c. Non-porous (e.g., metals, glass, and hard plastics) and semi-porous (e.g., wood, and concrete) materials that are structurally sound and are visibly moldy can be cleaned and reused. Cleaning shall be done using a detergent solution. Porous materials such as ceiling tiles and insulation, and wallboards with more than a small area of contamination shall be removed and discarded. Porous materials (e.g., wallboard, and fabrics) that can be cleaned, can be reused, but should be discarded if possible. A professional restoration consultant shall be contacted when restoring porous materials with more than a small area of fungal contamination. All materials to be reused shall be dry and visibly free from mold. Routine inspections shall be conducted to confirm the effectiveness of remediation work.

d. The use of gaseous, vapor-phase, or aerosolized biocides for remedial purposes is **not** recommended. The use of biocides in this manner can pose health concerns for people in occupied spaces of the building and for people returning to the treated space if used improperly. Furthermore, the effectiveness of these treatments is unproven and does not address the possible health concerns from the presence of the remaining non-viable mold. For additional information on the use of biocides for remedial purposes, refer to the American Conference of Governmental Industrial Hygienists' document, "Bioaerosols: Assessment and Control."

2. ***Level I***: **Small Isolated Areas** (10 sq. ft or less) - e.g., ceiling tiles, small areas on walls

   a. Remediation can be conducted by regular building maintenance staff. Such persons shall receive training on proper clean up methods, personal protection, and potential health hazards. This training can be performed as part of a program to comply with the requirements of the OSHA Hazard Communication Standard (29 CFR 1910.1200).

   b. Respiratory protection (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended. Gloves and eye protection shall be worn.

   c. The work area shall be unoccupied. Vacating people from spaces adjacent to the work area is not necessary but is recommended in the presence of infants (less than 12 months old), persons recovering from recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity, pneumonitis, and severe allergies).

   d. Containment of the work area is not necessary. Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.

   e. Contaminated materials that cannot be cleaned shall be removed from the building in a sealed plastic bag. There are no special requirements for the disposal of moldy materials.

   f. The work area and areas used by remedial workers for egress shall be cleaned with a damp cloth and/or mop and a detergent solution.

   g. All areas shall be left dry and visibly free from contamination and debris.

3. ***Level II*: Mid-Sized Isolated Areas** (10 - 30 sq. ft.) - e.g., individual wallboard panels.

   a. Remediation can be conducted by regular building maintenance staff. Such persons shall receive training on proper clean up methods, personal protection, and potential health hazards. This training can be performed as part of a program to comply with the requirements of the OSHA Hazard Communication Standard (29 CFR 1910.1200).

   b. Respiratory protection (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended. Gloves and eye protection shall be worn.

c. The work area shall be unoccupied. Vacating people from spaces adjacent to the work area is not necessary but is recommended in the presence of infants (less than 12 months old), persons having undergone recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity, pneumonitis, and severe allergies).
d. The work area shall be covered with a plastic sheet(s) and sealed with tape before remediation, to contain dust/debris.
e. Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.
f. Contaminated materials that cannot be cleaned shall be removed from the building in sealed plastic bags. There are no special requirements for the disposal of moldy materials.
g. The work area and areas used by remedial workers for egress shall be HEPA vacuumed (a vacuum equipped with a High-Efficiency Particulate Air filter) and cleaned with a damp cloth and/or mop and a detergent solution.
h. All areas shall be left dry and visibly free from contamination and debris.

4. ***Level III*: Large Isolated Areas** (30 - 100 square feet) - e.g., several wallboard panels.
   a. A health and safety professional with experience performing microbial investigations shall be consulted prior to remediation activities to provide oversight for the project.
   b. The following procedures *at a minimum* are recommended:
      1) Personnel trained in the handling of hazardous materials and equipped with respiratory protection, (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended. Gloves and eye protection shall be worn.
      2) The work area and areas directly adjacent shall be covered with a plastic sheet(s) and taped before remediation, to contain dust/debris.
      3) Seal ventilation ducts/grills in the work area and areas directly adjacent with plastic sheeting.
      4) The work area and areas directly adjacent shall be unoccupied. Further vacating of people from spaces near the work area is recommended in the presence of infants (less than 12 months old), persons having undergone recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity, pneumonitis, and severe allergies).
      5) Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.
      6) Contaminated materials that cannot be cleaned shall be removed from the building in sealed plastic bags. There are no special requirements for the disposal of moldy materials.
      7) The work area and surrounding areas shall be HEPA vacuumed and cleaned with a damp cloth and/or mop and a detergent solution.
      8) All areas shall be left dry and visibly free from contamination and debris.
   c. If abatement procedures are expected to generate a lot of dust (e.g., abrasive cleaning of contaminated surfaces, demolition of plaster walls) or the visible concentration of the fungi is heavy (blanket coverage as opposed to patchy), then it is recommended that the remediation procedures for Level IV are followed.

5. ***Level IV*: Extensive Contamination** (greater than 100 contiguous square feet in an area)
   a. A health and safety professional with experience performing microbial investigations shall be consulted prior to remediation activities to provide oversight for the project. The following procedures are recommended:
      1) Personnel trained in the handling of hazardous materials equipped with:
         a) Full-face respirators with high efficiency particulate air (HEPA) cartridges
         b) Disposable protective clothing covering both head and shoes
         c) Gloves
      2) Containment of the affected area:

a) Complete isolation of work area from occupied spaces using plastic sheeting sealed with duct tape (including ventilation ducts/grills, fixtures, and any other openings)
b) The use of an exhaust fan with a HEPA filter to generate negative pressurization
c) Airlocks and decontamination room

3) Vacating people from spaces adjacent to the work area is not necessary but is recommended in the presence of infants (less than 12 months old), persons having undergone recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity, pneumonitis, and severe allergies).
4) Contaminated materials that cannot be cleaned shall be removed from the building in sealed plastic bags. The outside of the bags shall be cleaned with a damp cloth and a detergent solution or HEPA vacuumed in the decontamination chamber prior to their transport to uncontaminated areas of the building. There are no special requirements for the disposal of moldy materials.
5) The contained area and decontamination room shall be HEPA vacuumed and cleaned with a damp cloth and/or mop with a detergent solution and be visibly clean prior to the removal of isolation barriers.
6) Air monitoring shall be conducted prior to occupancy to determine if the area is fit to reoccupy.

6. ***Level V***: Remediation of HVAC Systems
   a. A Small Isolated Area of Contamination (<10 square feet) in the HVAC System
      1) Remediation can be conducted by regular building maintenance staff. Such persons shall receive training on proper clean up methods, personal protection, and potential health hazards. This training can be performed as part of a program to comply with the requirements of the OSHA Hazard Communication Standard (29 CFR 1910.1200).
      2) Respiratory protection (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended. Gloves and eye protection shall be worn.
      3) The HVAC system shall be shut down prior to any remedial activities.
      4) The work area shall be covered with a plastic sheet(s) and sealed with tape before remediation, to contain dust/debris.
      5) Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.
      6) Growth supporting materials that are contaminated, such as the paper on the insulation of interior lined ducts and filters, shall be removed. Other contaminated materials that cannot be cleaned shall be removed in sealed plastic bags. There are no special requirements for the disposal of moldy materials.
      7) The work area and areas immediately surrounding the work area shall be HEPA vacuumed and cleaned with a damp cloth and/or mop and a detergent solution.
      8) All areas shall be left dry and visibly free from contamination and debris.
      9) A variety of biocides are recommended by HVAC manufacturers for use with HVAC components, such as, cooling coils and condensation pans. HVAC manufacturers shall be consulted for the products they recommend for use in their systems.
   b. Areas of Contamination (>10 square feet) in the HVAC System: A health and safety professional with experience performing microbial investigations shall be consulted prior to remediation activities to provide oversight for remediation projects involving more than a small isolated area in an HVAC system. The following procedures are recommended:
      1) Personnel trained in the handling of hazardous materials equipped with:
         a) Respiratory protection (e.g., N95 disposable respirator), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134), is recommended.
         b) Gloves and eye protection

c) Full-face respirators with HEPA cartridges and disposable protective clothing covering both head and shoes shall be worn if contamination is greater than 30 square feet.

2) The HVAC system shall be shut down prior to any remedial activities.

3) Containment of the affected area:
   a) Complete isolation of work area from the other areas of the HVAC system using plastic sheeting sealed with duct tape.
   b) The use of an exhaust fan with a HEPA filter to generate negative pressurization.
   c) Airlocks and decontamination room if contamination is greater than 30 square feet.

4) Growth supporting materials that are contaminated, such as the paper on the insulation of interior lined ducts and filters, shall be removed. Other contaminated materials that cannot be cleaned should be removed in sealed plastic bags. When a decontamination chamber is present, the outside of the bags shall be cleaned with a damp cloth and a detergent solution or HEPA vacuumed prior to their transport to uncontaminated areas of the building. There are no special requirements for the disposal of moldy materials.

5) The contained area and decontamination room shall be HEPA vacuumed and cleaned with a damp cloth and/or mop and a detergent solution prior to the removal of isolation barriers.

6) All areas shall be left dry and visibly free from contamination and debris.

7) Air monitoring shall be conducted prior to re-occupancy with the HVAC system in operation to determine if the area(s) served by the system are fit to reoccupy.

8) A variety of biocides are recommended by HVAC manufacturers for use with HVAC components, such as, cooling coils and condensation pans. HVAC manufacturers shall be consulted for the products they recommend for use in their systems.

7. Hazard Communication: When fungal growth requiring large-scale remediation is found, the building owner, management, and/or employer shall notify occupants in the affected area(s) of its presence. Notification shall include a description of the remedial measures to be taken and a timetable for completion. Group meetings held before and after remediation with full disclosure of plans and results can be an effective communication mechanism. Individuals with persistent health problems that appear to be related to bioaerosol exposure should see their physicians for a referral to practitioners who are trained in occupational/environmental medicine or related specialties and are knowledgeable about these types of exposures. Individuals seeking medical attention shall be provided with a copy of all inspection results and interpretation to give to their medical practitioners.

END OF SECTION 02 87 13 33

SECTION 02 87 16 13 - BIRD AND BIRD WASTE ABATEMENT

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for bird and bird waste abatement. Products shall be as follows or as directed by the 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 Of Work
1. Work Included - Conventional Enclosure for Removal of Birds and Bird Waste
   a. Seal off penetrations on perimeter walls into the work area (critical barriers) and establish a decontamination facility for workers.
   b. Coordinate activities with the demolition and well capping activities.
2. Work Included - Removal and disposal of birds and bird waste.
   a. Establish work area by installing construction barrier tape around removal area.
   b. Remove and properly dispose of bulk contamination debris.
   c. Mist bird waste and contaminated material with Biocide or the equivalent (i.e. Sanogene, Oxine, or Envirocon).
   d. Remove and properly dispose of contaminated waste material from all building components.
   e. Utilize low pressure washers or scrub brushes to clean all wall surfaces of bird waste.

C. Quality Criteria
1. Qualifications for Performance of Work
   a. Contractor (or subcontractor engaged to perform the Work of this Section) shall:
      1) Be a licensed bird waste abatement contractor in accordance with the Statutes of the State in which the work is to be performed. Submit notarized documentation confirming current licensure.
      2) Have a record of not less than five years successful experience in bird waste removal or asbestos removal.
2. Reference Standards
   a. Acknowledge, by the executing of the Contract, awareness and familiarity with the contents and requirements of the following regulations, codes, and standards, and assume responsibility for the performance of the Work in strict compliance therewith and for every instance of failure to comply therewith.
   b. Where conflict among requirements or with the Contract Documents exists, the more stringent requirements shall apply.
      1) USEPA Regional National Emissions Standards for Hazardous Air Pollutants (NESHAPS)
      2) U.S. Occupational and Safety and Health Administration (OSHA)
      3) U.S. EPA Office of Pesticide and Toxic Substances Guidance Document
      4) U.S. Department of Transportation, Hazardous Substances: Final Rule (49 CFR 171 and 172), Federal Register November 21, 1986 and corrected February 17, 1987.
      5) Statutes of the State in which the Work is to be Performed: Licensure for Asbestos Consultants and Contractors.
      6) All state, county, and city codes and ordinances as applicable. Make available for review at the site one copy of EPA, OSHA, and applicable State, County, and City Regulations governing the Work.
3. Patent/Copyright Compliance: Contractor shall determine the applicability of any process patents that may be employed and shall be responsible for the payment of all fees, royalties and licenses that may be required for the use of any patented or licensed process. Contractor shall hold the Owner, Engineer and Testing Laboratory harmless for failure to obtain any licenses and to pay any applicable fees and royalties.

D. Product Handling
   1. Deliver all materials in the original packages, containers, or bundles bearing the name of the manufacturer and the brand name.
   2. Store all materials subject to damage off the ground, away from wet or damp surfaces, and under cover sufficient to prevent damage or contamination.
   3. Remove from the premises all damaged or deteriorating materials. Dispose of materials that become contaminated with waste in accordance with applicable regulatory standards.

E. Worksite Conditions
   1. Worker and Visitor Procedures: The Contractor is hereby advised that the birds and bird wastes have been determined to cause diseases by inhalation and Contractor shall provide workers and qualified visitors with respirators that, as a minimum, shall meet the requirements of current applicable OSHA regulations, and protective clothing during preparation of system of enclosures, prior to commencing, during actual removal, and until final clean-up is completed. Also all personnel assigned to work on this project shall attend a training/awareness class for the purpose of explaining the hazards of improperly handling these materials and proper control measures to take in order to protect themselves.

F. Personnel Protection
   1. General
      a. Provide respiratory protection in accordance with OSHA regulations 29 CFR 1910-134 and in accordance with the following paragraphs.
         1) Prior to commencement of work, all workers shall be instructed by the Contractor and shall be knowledgeable in the appropriate procedures of personnel protection and waste removal.
         2) Where respirators with disposable filters are used, provide sufficient filters for replacement as necessary by the workers, or as required by applicable regulations.
         3) Permit no visitors, except for governmental inspectors having jurisdiction, or as authorized by Engineer or the Owner, in the work areas after commencement of waste disturbance or removal. Provide authorized visitors with suitable respirators.
         4) Provide workers with sufficient sets of protective disposable clothing, consisting of full-body coveralls, head covers, gloves, and foot covers, of sizes to properly fit individual workers.
         5) Provide authorized visitors with a set of suitable protective disposable clothing, headgear, eye protection, and/or footwear of sizes to properly fit visitors whenever they are required to enter the work area, to a maximum of six sets per day.
         6) Provide, in addition to respirators and protective clothing provided for authorized visitors, protective clothing and respirators for use by Testing Laboratory's representative. Furnish protective clothing in as many sets as required for full-time monitoring by Testing Laboratory.
         7) Provide and post the decontamination and work procedures to be followed by workers.
   2. Respiratory Protection Program
      a. Maintain a respiratory protection program that contains all the elements of the OSHA regulations. Provide a copy to the Engineer for approval.
      b. Appoint a respiratory protection program administrator, who shall be responsible for the program, maintaining all documentation, instructing workers and providing fit tests. Respiratory protection administrator is to be qualified under OSHA requirements and to have attended and passed, as a minimum, OSHA training institute 2-week course on respiratory protection or NIOSH course "Occupational Respiratory Protection." Respiratory protection program administer is to be on-site daily during abatement activities. All written programs and directions are to be in English and/or the language of the abatement workers if they are not fluent in English.
      c. The Contractor is advised that the minimum respiratory requirements as called for in this section and on any drawings/sketches shall be applied unless reported measures indicate

that a lower form of respiratory protection is acceptable according to the appropriate OSHA regulations and the more strict sections of the specification.

3. Respiratory Protection Requirements
   a. Workers shall be provided with respiratory protection equipment. The respirators are to be sanitized and maintained in accordance with the manufacturer's specification. Appropriate respirator selection will be dependent upon the work to be performed and the level of exposure, as given below.
   b. For the clean-up, as a minimum, the use of full-faced air-purifying respirators is required for all preparation, removal and cleaning work.
   c. This specification requires that workers shall wear suitable respiratory protection at all times whenever a potential for exposure to bird and bird waste exists.

1.2 PRODUCTS

A. Materials
1. Polyethylene/Plastic sheeting shall be of the thicknesses specified, not less than 6 mil, in sizes to minimize the frequency of joints. Utilize reinforced plastic sheeting in specified thicknesses on floors.
2. Tape shall be glass fiber or other type capable of sealing joints of adjacent sheets of plastic and for attachment of plastic sheet to finished or unfinished surfaces of dissimilar materials under both dry and wet conditions.
3. Sodium Hypochlorite ("bleach")
4. Impermeable Containers shall be suitable to receive and retain contaminated materials until disposal at an approved site and shall be labeled in accordance with U.S. DOT 49 CFR 171 and 172, and containers shall be both air- and water-tight. Use a minimum of two types of impermeable containers: 1) six millimeter-thick (mil) plastic bags sized to fit within the drum; and 2) metal or fiber drums with tightly fitting lids.
5. Other Materials: Provide all other materials, such as lumber, nails, and hardware, that may be required to construct and dismantle the decontamination area and the barriers that isolate the work area(s).
6. Caulking shall be non-shrinking caulk to be used where insulated pipes continue through areas such as walls and ceilings. Contractor shall determine and submit proof that caulk proposed for use is compatible with the temperature conditions of the surfaces to which it is to be applied.
   a. Tools And Equipment
      1) Water Sprayer - utilize airless or other low pressure sprayer for amended water application.
      2) Air Purifying Equipment (for internal recirculation in the work area) shall be HEPA Filtration Systems or Electronic Precipitators. Ensure that no internal air movement system or purification equipment exhausts contaminated air from the work area(s) outside the work area.
      3) Diminished Air Pressure Equipment shall comply with ANSI 29.2-7, local exhaust ventilation.
      4) Scaffolding shall be as required to accomplish the specified work and shall meet all applicable safety regulations.
      5) Transportation - as required for loading, temporary storage, transit, and unloading of contaminated waste without exposure to persons or property.

1.3 EXECUTION

A. Procedures
1. All personnel assigned to perform the work shall attend a training/awareness class for the purpose of explaining the hazards of improperly handling the waste and the proper control measures to take in order to protect themselves. These work procedures shall be discussed with

each individual followed by the individual acknowledging receipt of this training by completing the pertinent information on a Hazardous Awareness Training Form

2. The majority of diseases related to bird waste is related to the inhalation of the airborne dust released by the waste. All personnel performing removal/decontamination waste shall therefore wear Powered Air Purifying Respirators (PAPR) equipped with combination Organic Vapor and High Efficiency Particulate Air (HEPA) filters while handling the waste.
3. Workers shall wear non-porous gloves and boots during all preparatory and removal operations.
4. When entering the building, the removal/decontamination personnel shall mist all surfaces having visible remnants of waste, using a diluted sodium hypochlorite ("bleach") and water solution. This solution shall be diluted at a ratio of 10 parts water to 1 part bleach for a 10 to 1 ration (10:1). The waste shall be continuously misted during occupancy in order to keep airborne dust emissions from the waste to a minimurn.
5. Remove all birds from the building and seal all openings into the building. The main purpose of this is to eliminate the availability for future bird access into the building. The openings may be temporarily sealed or closed up in many ways, including boarding up windows/doors, polyethylene sheeting, or other convenient and cost effective means. It is not the intention of this task to complete seal the building airtight.
6. Designate an area of the facility for the purpose of storing the waste prior to loading for transportation to the appropriate landfill. The area designated shall have easy access to the door which will be utilized as the waste load-out.

END OF SECTION 02 87 16 13

Task	Specification	Specification Description
02 89 00 00	01 22 16 00	No Specification Required
02 89 00 00	02 83 19 13	Removal And Disposal Of Lead-Containing Paint
02 89 00 00	02 83 19 13a	Lead Paint Related Abatement Procedures
02 89 00 00	02 83 19 13b	XRF Testing For Lead-Based Paint
02 89 00 00	02 83 19 13c	Lead Dust Wipe, Air And Tclp Sampling And Analysis

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SECTION 03 01 30 71 - 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 the 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 the 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 03 01 30 71a - 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.
5. LEED Submittals:
a. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials, certificates indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating distance to Project, cost for each regional material, and fraction by weight that is considered regional.
b. Shop Drawings: Show locations and extent of waterproofing and details of substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.
1) Include setting drawings showing layout, sizes, sections, profiles, and joint details of pedestal-supported concrete pavers.
c. Samples: For each exposed product and for each color and texture specified, including the following products:
1) 8-by-8-inch (200-by-200-mm) square of waterproofing and flashing sheet.
2) 8-by-8-inch (200-by-200-mm) square of insulation.
3) 4-by-4-inch (100-by-100-mm) square of drainage panel.
4) Plaza-deck paver, 4-by-4-inch (100-by-100-mm) square **OR** full sized, **as directed**, in each color and texture required.
5) Paver pedestal assembly.

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 Final 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 33 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 32 Section "Unit Paving".
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 32 Section "Unit Paving".
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 32 Section(s) "Unit Paving" 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 03 01 30 71a

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Task	Specification	Specification Description
03 01 30 71	01 22 16 00	No Specification Required

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SECTION 03 05 00 00 - CAST-IN-PLACE CONCRETE

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for cast-in-place 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 concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
a. Footings.
b. Foundation walls.
c. Slabs-on-grade.
d. Suspended slabs.
e. Concrete toppings.
f. Building frame members.
g. Building walls.

C. Definitions
1. 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.

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.
4. Shop Drawings: For steel reinforcement and formwork. 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, acceptable to authorities having jurisdiction, **as directed**, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
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 7, "Lightweight Concrete", **as directed**.
b. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
4. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

5. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling
1. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement, **as directed**.
2. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

1.2 PRODUCTS

A. Form-Facing Materials
1. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
2. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
3. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce 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. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.
6. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch (19 by 19 mm), minimum.
7. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
8. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
   a. Formulate form-release agent with rust inhibitor for steel form-facing materials.
9. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
   a. Furnish units that will leave no corrodible metal closer than 1 inch (25 mm) to the plane of exposed concrete surface.
   b. Furnish ties that, when removed, will leave holes no larger than 1 inch (25 mm) in diameter in concrete surface.
   c. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

B. Steel Reinforcement
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 I **OR** II, **as directed**, zinc coated after fabrication and bending.
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. Stainless-Steel Reinforcing Bars: ASTM A 955/A 955M, Grade 60 (Grade 420), Type 304 **OR** 316L, **as directed**, deformed.

7. 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.
8. Plain-Steel Wire: ASTM A 82, as drawn **OR** galvanized, **as directed**.
9. Deformed-Steel Wire: ASTM A 496.
10. Epoxy-Coated Wire: ASTM A 884/A 884M, Class A, Type 1 coated, as-drawn, plain-steel-wire **OR** deformed-steel wire, **as directed**, with less than 2 percent damaged coating in each 12-inch (300-mm) wire length.
11. Plain-Steel Welded Wire Reinforcement: ASTM A 1064, plain, fabricated from as-drawn steel wire into flat sheets.
12. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet.
13. Galvanized-Steel Welded Wire Reinforcement: ASTM A 1064, plain, fabricated from galvanized steel wire into flat sheets.
14. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A coated, Type 1, plain **OR** deformed, **as directed**, steel.

C. Reinforcement Accessories
1. 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.
2. Epoxy-Coated Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), plain-steel bars, ASTM A 775/A 775M epoxy coated.
3. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775/A 775M.
4. Zinc Repair Material: ASTM A 780, zinc-based solder, paint containing zinc dust, or sprayed zinc.
5. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
   a. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
   b. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
   c. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.

D. 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 **OR** V, **as directed**, gray **OR** white, **as directed**. Supplement with the following:
      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.
   b. Blended Hydraulic Cement: ASTM C 595, Type IS, portland blast-furnace slag **OR** IP, portland-pozzolan **OR** I (PM), pozzolan-modified portland **OR** I (SM), slag-modified Portland, **as directed**, cement.
2. Silica Fume: ASTM C 1240, amorphous silica.
3. Normal-Weight Aggregates: ASTM C 33, graded, 1-1/2-inch (38-mm) **OR** 1-inch (25-mm) **OR** 3/4-inch (19-mm), **as directed**, nominal maximum coarse-aggregate size.
   a. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
4. Lightweight Aggregate: ASTM C 330, 1-inch (25-mm) **OR** 3/4-inch (19-mm) **OR** 1/2-inch (13-mm) **OR** 3/8-inch (10-mm), **as directed**, nominal maximum aggregate size.
5. Water: ASTM C 94/C 94M and potable, **as directed**.

E. 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. Set-Accelerating 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 and complying with ASTM C 494/C 494M, Type C.
4. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.
5. 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**.

F. Fiber Reinforcement
1. Carbon-Steel Fiber: ASTM A 820, deformed, minimum of 1.5 inches (38 mm) **OR** 2 inches (50 mm) **OR** 2.4 inches (60 mm), **as directed**, long, and aspect ratio of 35 to 40 **OR** 45 to 50 **OR** 60 to 65, **as directed**.
   a. Fiber: Type 1, cold-drawn wire **OR** 2, cut sheet, **as directed**.
2. Synthetic Micro-Fiber: Monofilament or fibrillated polypropylene micro-fibers engineered and designed for use in concrete, complying with ASTM C 1116/ C 1116M , Type III, 1/2 to 1-1/2 inches (13 to 38 mm) **OR** 1 to 2-1/4 inches (25 to 57 mm)long.
3. Synthetic Macro-Fiber: Polyolefin macro-fibers engineered and designed for use in concrete, complying with ASTM C 1116/C 1116M, Type III, 1 to 2-1/4 inches (25 to 57 mm) long.

G. Waterstops
1. Flexible Rubber Waterstops: CE CRD-C 513, with factory-installed metal eyelets, **as directed**, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
   a. Profile: Flat, dumbbell with center bulb **OR** Flat, dumbbell without center bulb **OR** Ribbed with center bulb **OR** Ribbed without center bulb **OR** As indicated, **as directed**.
   b. Dimensions: 4 inches by 3/16 inch thick (100 mm by 4.75 mm thick) **OR** 6 inches by 3/8 inch thick (150 mm by 10 mm thick) **OR** 9 inches by 3/8 inch thick (225 mm by 10 mm thick), **as directed**; nontapered.
2. Chemically Resistant Flexible Waterstops: Thermoplastic elastomer rubber waterstops with factory-installed metal eyelets, **as directed**, for embedding in concrete to prevent passage of fluids through joints; resistant to oils, solvents, and chemicals. Factory fabricate corners, intersections, and directional changes.
   a. Profile: Flat, dumbbell with center bulb **OR** Flat, dumbbell without center bulb **OR** Ribbed with center bulb **OR** Ribbed without center bulb **OR** As indicated, **as directed**.
   b. Dimensions: 4 inches by 3/16 inch thick (100 mm by 4.75 mm thick) **OR** 6 inches by 3/16 inch thick (150 mm by 4.75 mm thick) **OR** 6 inches by 3/8 inch thick (150 mm by 10 mm thick) **OR** 9 inches by 3/16 inch thick (225 mm by 4.75 mm thick) **OR** 9 inches by 3/8 inch thick (225 mm by 10 mm thick), **as directed**; nontapered.
3. Flexible PVC Waterstops: CE CRD-C 572, with factory-installed metal eyelets, **as directed**, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

a. Profile: Flat, dumbbell with center bulb **OR** Flat, dumbbell without center bulb **OR** Ribbed with center bulb **OR** Ribbed without center bulb **OR** As indicated, **as directed**.
b. Dimensions: 4 inches by 3/16 inch thick (100 mm by 4.75 mm thick) **OR** 6 inches by 3/8 inch thick (150 mm by 10 mm thick) **OR** 9 inches by 3/8 inch thick (225 mm by 10 mm thick), **as directed**; nontapered.

4. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch (19 by 25 mm).
5. Self-Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free hydrophilic polymer modified chloroprene rubber, for adhesive bonding to concrete, 3/8 by 3/4 inch (10 by 19 mm).

H. Vapor Retarders
1. Plastic Vapor Retarder:
a. ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape.
b. ASTM E 1745, Class B. Include manufacturer's recommended adhesive or pressure-sensitive tape.
c. ASTM E 1745, Class C, or polyethylene sheet, ASTM D 4397, not less than 10 mils (0.25 mm) thick, **as directed**. Include manufacturer's recommended adhesive or pressure-sensitive joint tape.
2. Bituminous Vapor Retarder: 110-mil- (2.8-mm-) thick, semiflexible, 7-ply sheet membrane consisting of reinforced core and carrier sheet with fortified asphalt layers, protective weathercoating, and removable plastic release liner. Furnish manufacturer's accessories including bonding asphalt, pointing mastics, and self-adhering joint tape.
a. Water-Vapor Permeance: 0.00 grains/h x sq. ft. x inches Hg (0.00 ng/Pa x s x sq. m); ASTM E 154.
b. Tensile Strength: 140 lbf/in. (24.5 kN/m); ASTM E 154.
c. Puncture Resistance: 90 lbf (400N); ASTM E 154.
3. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D 448, 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.
4. Fine-Graded Granular Material: Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D 448, Size 10, with 100 percent passing a 3/8-inch (9.5-mm) sieve, 10 to 30 percent passing a No. 100 (0.15-mm) sieve, and at least 5 percent passing No. 200 (0.075-mm) sieve; complying with deleterious substance limits of ASTM C 33 for fine aggregates.

I. Floor And Slab Treatments
1. Slip-Resistive Emery Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive, 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 with 100 percent passing 3/8-inch (9.5-mm) **OR** No. 4 (4.75-mm) **OR** No. 8 (2.36-mm), **as directed**, sieve.
2. Slip-Resistive Aluminum Granule Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of not less than 95 percent fused aluminum-oxide granules.
3. Emery Dry-Shake Floor Hardener: Pigmented **OR** Unpigmented, **as directed**, factory-packaged, dry combination of portland cement, graded emery aggregate, and plasticizing admixture; with emery aggregate consisting of no less than 60 percent of total aggregate content.
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**.
4. Metallic Dry-Shake Floor Hardener: Pigmented **OR** Unpigmented, **as directed**, factory-packaged, dry combination of portland cement, graded metallic aggregate, rust inhibitors, and plasticizing admixture; with metallic aggregate consisting of no less than 65 percent of total aggregate content.

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**.

5. Unpigmented Mineral Dry-Shake Floor Hardener: Factory-packaged dry combination of portland cement, graded quartz aggregate, and plasticizing admixture.
6. Pigmented Mineral Dry-Shake Floor 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.
   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**.
7. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; colorless; that penetrates, hardens, and densifies concrete surfaces.

J. Liquid Floor Treatments
1. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.
2. Penetrating Liquid Floor Treatments for Polished Concrete Finish: Clear, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and is suitable for polished concrete surfaces.

K. Curing Materials
1. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
2. 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.
3. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
4. Water: Potable.
5. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
6. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering, **as directed**.
7. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, 18 to 25 percent solids, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering, **as directed**.
8. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
9. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

L. Related Materials
1. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber **OR** ASTM D 1752, cork or self-expanding cork, **as directed**.
2. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 **OR** aromatic polyurea with a Type A shore durometer hardness range of 90 to 95, **as directed**, per ASTM D 2240.
3. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
4. 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, and as follows:
   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.
5. Reglets: Fabricate reglets of not less than 0.0217-inch- (0.55-mm-) thick, galvanized steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

6. Dovetail Anchor Slots: Hot-dip galvanized steel sheet, not less than 0.0336 inch (0.85 mm) thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

M. Repair Materials
1. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch (3.2 mm) and that can be feathered at edges to match adjacent floor elevations.
   a. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
   b. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
   c. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by underlayment manufacturer.
   d. Compressive Strength: Not less than 4100 psi (29 MPa) at 28 days when tested according to ASTM C 109/C 109M.
2. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch (3.2 mm) and that can be feathered at edges to match adjacent floor elevations.
   a. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
   b. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
   c. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by topping manufacturer.
   d. Compressive Strength: Not less than 5000 psi (34.5 MPa) at 28 days when tested according to ASTM C 109/C 109M.

N. Concrete Mixtures, General
1. Prepare design mixtures for each type and strength of concrete, proportioned on the 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 mixture designs based on laboratory trial mixtures.
2. Cementitious Materials: 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 **OR** Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows, **as directed**
   a. Fly Ash: 25 percent.
   b. Combined Fly Ash and Pozzolan: 25 percent.
   c. Ground Granulated Blast-Furnace Slag: 50 percent.
   d. Combined Fly Ash or Pozzolan and Ground Granulated Blast-Furnace Slag: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
   e. Silica Fume: 10 percent.
   f. Combined Fly Ash, Pozzolans, and Silica Fume: 35 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
   g. Combined Fly Ash or Pozzolans, Ground Granulated Blast-Furnace Slag, and Silica Fume: 50 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
3. 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.
4. Admixtures: Use admixtures according to manufacturer's written instructions.
   a. Use water-reducing **OR** high-range water-reducing **OR** plasticizing, **as directed**, admixture 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.

c. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
d. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

5. 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.

O. Concrete Mixtures For Building Elements

1. Footings: Proportion normal-weight concrete mixture as follows:
   a. Minimum Compressive Strength: 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**, at 28 days.
   b. Maximum Water-Cementitious Materials Ratio: 0.50 **OR** 0.45 **OR** 0.40, **as directed**.
   c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 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.
2. Foundation Walls: Proportion normal-weight concrete mixture as follows:
   a. Minimum Compressive Strength: 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**, at 28 days.
   b. Maximum Water-Cementitious Materials Ratio: 0.50 **OR** 0.45 **OR** 0.40, **as directed**.
   c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 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. Slabs-on-Grade: Proportion normal-weight concrete mixture as follows:
   a. Minimum Compressive Strength: 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**, at 28 days.
   b. Minimum Cementitious Materials Content: 470 lb/cu. yd. (279 kg/cu. m) **OR** 520 lb/cu. yd. (309 kg/cu. m) **OR** 540 lb/cu. yd. (320 kg/cu. m), **as directed**.
   c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm), **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) Do not allow air content of troweled finished floors to exceed 3 percent.
   e. Steel-Fiber Reinforcement: Add to concrete mixture, according to manufacturer's written instructions, at a rate of 50 lb/cu. yd. (29.7 kg/cu. m).
   f. 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**.
4. Suspended Slabs: Proportion normal-weight concrete mixture as follows:
   a. Minimum Compressive Strength: 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**, at 28 days.

b. Minimum Cementitious Materials Content: 470 lb/cu. yd. (279 kg/cu. m) **OR** 520 lb/cu. yd. (309 kg/cu. m) **OR** 540 lb/cu. yd. (320 kg/cu. m), **as directed**.
c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm), **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) Do not allow air content of troweled finished floors to exceed 3 percent.
e. Steel-Fiber Reinforcement: Add to concrete mixture, according to manufacturer's written instructions, at a rate of 50 lb/cu. yd. (29.7 kg/cu. m).
f. 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**.

5. Suspended Slabs: Proportion structural lightweight concrete mixture as follows:
a. Minimum Compressive Strength: 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**, at 28 days.
b. Calculated Equilibrium Unit Weight: 115 lb/cu. ft. (1842 kg/cu. m) **OR** 110 lb/cu. ft. (1762 kg/cu. m) **OR** 105 lb/cu. ft. (1682 kg/cu. m), **as directed**, plus or minus 3 lb/cu. ft. (48.1 kg/cu. m) as determined by ASTM C 567.
c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm), **as directed**, plus or minus 1 inch (25 mm).
d. Air Content:
1) 6 percent, plus or minus 2 percent at point of delivery for nominal maximum aggregate size greater than 3/8 inch (10 mm).
2) 7 percent, plus or minus 2 percent at point of delivery for nominal maximum aggregate size 3/8 inch (10 mm) or less.
3) Do not allow air content of troweled finished floors to exceed 3 percent.
e. Steel-Fiber Reinforcement: Add to concrete mixture, according to manufacturer's written instructions, at a rate of 50 lb/cu. yd. (29.7 kg/cu. m).
f. 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**.

6. Concrete Toppings: Proportion normal-weight concrete mixture as follows:
a. Minimum Compressive Strength: 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**, at 28 days.
b. Minimum Cementitious Materials Content: 470 lb/cu. yd. (279 kg/cu. m) **OR** 520 lb/cu. yd. (309 kg/cu. m) **OR** 540 lb/cu. yd. (320 kg/cu. m), **as directed**.
c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm), **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) Do not allow air content of troweled finished toppings to exceed 3 percent.
e. Steel-Fiber Reinforcement: Add to concrete mixture, according to manufacturer's written instructions, at a rate of 50 lb/cu. yd. (29.7 kg/cu. m).
f. 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**.

7. Building Frame Members: Proportion normal-weight concrete mixture as follows:
a. Minimum Compressive Strength: 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**, at 28 days.
b. Maximum Water-Cementitious Materials Ratio: 0.50 **OR** 0.45 **OR** 0.40, **as directed**.

c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 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.

8. Building Walls: Proportion normal-weight concrete mixture as follows:
a. Minimum Compressive Strength: 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**, at 28 days.
b. Maximum Water-Cementitious Materials Ratio: 0.50 **OR** 0.45 **OR** 0.40, **as directed**.
c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 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.

P. Fabricating Reinforcement
1. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

Q. Concrete Mixing
1. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116, **as directed**, and furnish batch ticket information.
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 mixer capacity 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 mixer capacity 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, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

1.3 EXECUTION

A. Formwork
1. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
2. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
3. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
a. Class A, 1/8 inch (3.2 mm) for smooth-formed finished surfaces.

b. Class B, 1/4 inch (6 mm) **OR** Class C, 1/2 inch (13 mm) **OR** Class D, 1 inch (25 mm), **as directed**, for rough-formed finished surfaces.

4. Construct forms tight enough to prevent loss of concrete mortar.
5. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
   a. Install keyways, reglets, recesses, and the like, for easy removal.
   b. Do not use rust-stained steel form-facing material.
6. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
7. 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.
8. Chamfer **OR** Do not chamfer, **as directed**, exterior corners and edges of permanently exposed concrete.
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.

B. Embedded Items
   1. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
      a. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
      b. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
      c. Install dovetail anchor slots in concrete structures as indicated.

C. Removing And Reusing Forms
   1. General: 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. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 70 percent of, **as directed**, its 28-day design compressive strength.
      b. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
   2. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
   3. 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 exposed concrete surfaces unless approved by the Owner.

D. Shores And Reshores

1. Comply with ACI 318 (ACI 318M) and ACI 301 for design, installation, and removal of shoring and reshoring.
   a. Do not remove shoring or reshoring until measurement of slab tolerances is complete.
2. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.
3. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

E. Vapor Retarders
1. Plastic Vapor Retarders: Place, protect, and repair vapor retarders according to ASTM E 1643 and manufacturer's written instructions.
   a. Lap joints 6 inches (150 mm) and seal with manufacturer's recommended tape.
2. Bituminous Vapor Retarders: Place, protect, and repair vapor retarders according to manufacturer's written instructions.
3. Granular Course: Cover vapor retarder with granular fill **OR** fine-graded granular material, **as directed**, moisten, and compact with mechanical equipment to elevation tolerances of plus 0 inch (0 mm) or minus 3/4 inch (19 mm).
   a. Place and compact a 1/2-inch- (13-mm-) thick layer of fine-graded granular material over granular fill.

F. Steel Reinforcement
1. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
   a. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
2. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
3. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
   a. Weld reinforcing bars according to AWS D1.4, where indicated.
4. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
5. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.
6. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M. Use epoxy-coated steel wire ties to fasten epoxy-coated steel reinforcement.
7. Zinc-Coated Reinforcement: Repair cut and damaged zinc coatings with zinc repair material according to ASTM A 780. Use galvanized steel wire ties to fasten zinc-coated steel reinforcement.

G. Joints
1. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
2. Construction Joints: Install 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. Do not continue reinforcement through sides of strip placements of floors and slabs.
   b. Form keyed joints as indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
   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 directed**. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
f. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
g. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

3. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
   a. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch (3.2 mm). Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
   b. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3.2-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
4. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
   a. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
   b. Terminate full-width joint-filler strips not less than 1/2 inch (13 mm) or more than 1 inch (25 mm) below finished concrete surface where joint sealants, specified in Division 07 Section "Joint Sealants", are indicated.
   c. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

H. Waterstops
1. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.
2. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, adhesive bonding, mechanically fastening, and firmly pressing into place. Install in longest lengths practicable.

I. Concrete Placement
1. Before placing concrete, verify that installation of formwork, 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 in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. 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 301.
   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. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

5. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
   a. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
   b. Maintain reinforcement in position on chairs during concrete placement.
   c. Screed slab surfaces with a straightedge and strike off to correct elevations.
   d. Slope surfaces uniformly to drains where required.
   e. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
6. 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 or chemical accelerators unless otherwise specified and approved in mixture designs.
7. 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.

J. Finishing Formed Surfaces
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 that exceed specified limits on formed-surface irregularities.
   a. Apply to concrete surfaces not exposed to public view.
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. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
   a. Apply to concrete surfaces exposed to public view, **OR** to receive a rubbed finish, **OR** to be covered with a coating or covering material applied directly to concrete, **as directed**.
3. Rubbed Finish: Apply the following to smooth-formed 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 adjacent surfaces. 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 adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

4. 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. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

K. Finishing Floors And Slabs

1. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
2. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch (6 mm) in 1 direction.
   a. Apply scratch finish to surfaces indicated and to receive concrete floor toppings **OR** to receive mortar setting beds for bonded cementitious floor finishes, **as directed**.
3. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
   a. Apply float finish to surfaces indicated **OR** to receive trowel finish **OR** to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo, **as directed**.
4. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
   a. Apply a trowel finish to surfaces indicated **OR** exposed to view **OR** to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system, **as directed**.
   b. Finish surfaces to the following tolerances, according to ASTM E 1155 (ASTM E 1155M), for a randomly trafficked floor surface:
      1) Specified overall values of flatness, F(F) 25; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and of levelness, F(L) 15.
      2) Specified overall values of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17; for slabs-on-grade.
      3) Specified overall values of flatness, F(F) 30; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 15; for suspended slabs.
      4) Specified overall values of flatness, F(F) 45; and of levelness, F(L) 35; with minimum local values of flatness, F(F) 30; and of levelness, F(L) 24.
   c. Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-foot- (3.05-m-) long straightedge resting on 2 high spots and placed anywhere on the surface does not exceed 1/4 inch (6 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/8 inch (3.2 mm), **as directed**.
5. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated **OR** where ceramic or quarry tile is to be installed by either thickset or thin-set method, **as directed**. While concrete is still plastic, slightly scarify surface with a fine broom.
   a. Comply with flatness and levelness tolerances for trowel finished floor surfaces.
6. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
   a. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with the Owner before application.

7. Slip-Resistive Finish: Before final floating, apply slip-resistive aggregate **OR** aluminum granule, **as directed**, finish where indicated and to concrete stair treads, platforms, and ramps. Apply according to manufacturer's written instructions and as follows:
   a. Uniformly spread 25 lb/100 sq. ft. (12 kg/10 sq. m) of dampened slip-resistive aggregate **OR** aluminum granules, **as directed**, over surface in 1 or 2 applications. Tamp aggregate flush with surface, but do not force below surface.
   b. After broadcasting and tamping, apply float finish.
   c. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive aggregate **OR** aluminum granules, **as directed**.
8. Dry-Shake Floor Hardener Finish: After initial floating, apply dry-shake floor hardener to surfaces according to manufacturer's written instructions and as follows:
   a. Uniformly apply dry-shake floor hardener at a rate of 100 lb/100 sq. ft. (49 kg/10 sq. m), **as directed**, unless greater amount is recommended by manufacturer.
   b. Uniformly distribute approximately two-thirds of dry-shake floor hardener over surface by hand or with mechanical spreader, and embed by power floating. Follow power floating with a second dry-shake floor hardener application, uniformly distributing remainder of material, and embed by power floating.
   c. After final floating, apply a trowel finish. Cure concrete with curing compound recommended by dry-shake floor hardener manufacturer and apply immediately after final finishing.

L. Miscellaneous Concrete Items
1. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
2. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
3. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.
4. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel-finish concrete surfaces.

M. 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 ACI 301 for hot-weather protection during curing.
2. Evaporation Retarder: Apply evaporation retarder to unformed 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.
3. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
4. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
5. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
   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 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 using cover material and waterproof tape.
   1) Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
   2) Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
   3) Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.

c. Curing 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. Maintain continuity of coating and repair damage during curing period.
   1) After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.

d. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a 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.

N. Liquid Floor Treatments
1. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.
   a. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
   b. Do not apply to concrete that is less than three **OR** seven **OR** 14 **OR** 28, **as directed**, days' old.
   c. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.
2. Polished Concrete Floor Treatment: Apply polished concrete finish system to cured and prepared slabs to match.
   a. Machine grind floor surfaces to receive polished finishes level and smooth and to depth required to reveal aggregate to match.
   b. Apply penetrating liquid floor treatment for polished concrete in polishing sequence and according to manufacturer's written instructions, allowing recommended drying time between successive coats.
   c. Continue polishing with progressively finer grit diamond polishing pads to gloss level to match approved mockup.
   d. Control and dispose of waste products produced by grinding and polishing operations.
   e. Neutralize and clean polished floor surfaces.
3. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

O. Joint Filling
1. Prepare, clean, and install joint filler according to manufacturer's written instructions.
   a. Defer joint filling until concrete has aged at least one **OR** six, **as directed**, month(s). Do not fill joints until construction traffic has permanently ceased.

2. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
3. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches (50 mm) deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

P. Concrete Surface Repairs
1. Defective Concrete: Repair and patch defective areas when approved by the Owner. Remove and replace concrete that cannot be repaired and patched to the Owner's approval.
2. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 (1.18-mm) sieve, using only enough water for handling and placing.
3. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
    a. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch (13 mm) in any dimension in solid concrete, but not less than 1 inch (25 mm) in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
    b. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
    c. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by the Owner.
4. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
    a. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch (0.25 mm) wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
    b. After concrete has cured at least 14 days, correct high areas by grinding.
    c. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
    d. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
    e. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch (6 mm) to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
    f. Repair defective areas, except random cracks and single holes 1 inch (25 mm) or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch (19-mm) clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
    g. Repair random cracks and single holes 1 inch (25 mm) or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt,

and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

5. Perform structural repairs of concrete, subject to the Owner's approval, using epoxy adhesive and patching mortar.
6. Repair materials and installation not specified above may be used, subject to the Owner's approval.

Q. Field Quality Control
1. Testing and Inspecting: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
2. Inspections:
   a. Steel reinforcement placement.
   b. Steel reinforcement welding.
   c. Headed bolts and studs.
   d. Verification of use of required design mixture.
   e. Concrete placement, including conveying and depositing.
   f. Curing procedures and maintenance of curing temperature.
   g. Verification of concrete strength before removal of shores and forms from beams and slabs.
3. Concrete Tests: 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 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, for normal-weight concrete; ASTM C 173/C 173M, volumetric method, for structural lightweight concrete, **as directed**; 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 80 deg F (27 deg C) and above, and one test for each composite sample.
   e. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
   f. Compression Test Specimens: ASTM C 31/C 31M.
      1) Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
      2) Cast and field cure two sets of two standard cylinder specimens for each composite sample.
   g. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
      1) Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
      2) A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
   h. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
   i. Strength of each concrete mixture will be satisfactory if every 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).

j. 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.

k. 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.

l. 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. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by the Owner.

m. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

n. Correct deficiencies in the Work that test reports and inspections indicate dos not comply with the Contract Documents.

4. Measure floor and slab flatness and levelness according to ASTM E 1155 (ASTM E 1155M) within 24 **OR** 48, **as directed**, hours of finishing.

R. Protection Of Liquid Floor Treatments

1. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION 03 05 00 00

Task	Specification	Specification Description
03 11 13 00	01 22 16 00	No Specification Required
03 11 13 00	03 05 00 00	Cast-In-Place Concrete

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SECTION 03 11 16 00 - RUSTICATED CONCRETE FINISHES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of rusticated concrete finishes. 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. Sample: A sample of finish expected shall be erected on site. Completed work shall approximate the sample. Work determined by the contracting officer not to be similar shall be removed and replaced without further expense to the Owner.

1.2 PRODUCTS

A. Overlaid Plywood: DOC PS 1, B-B High Density Overlaid Concrete Form, Class I.

B. Plywood: DOC PS 1, B-B (Concrete Form) Plywood, Class I, Exterior Grade or better, mill-oiled and edge-sealed, with each piece bearing legible inspection mark.

C. Chamfer Strips: Clear white pine with surface against concrete to be planed, metal, PVC, or rubber.

D. Form Liners: Provide commercially available molds and form-facing materials of metal, plastic, mood, or another material that is nonreactive with concrete and dimensionally stable to produce repetitive concrete surfaces.

1.3 EXECUTION

A. Form Construction: Forms shall be constructed to provide required sizes, shapes, lines, and dimensions and to provide continuous, straight, smooth exposed surfaces. Forms shall be fabricated for easy removal without hammering or prying against concrete surfaces. The number of joints shall be minimized. Joints shall be made watertight to prevent leakage of cement paste. Provisions shall be made for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, inserts, and other features required in the work.

B. Form Coatings: Forms shall be oiled with form-coating compounds that will not bond with, stain, nor adversely effect concrete surfaces, and will not impair subsequent treatments of concrete surfaces.

C. Finish: Fins and other projections shall be completely removed and smoothed. A smooth rubbed finish shall be provided not less than one day after form removal.

END OF SECTION 03 11 16 00

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SECTION 03 11 16 00a - 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 03 11 16 00a

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Task	Specification	Specification Description
03 11 16 00	03 05 00 00	Cast-In-Place Concrete
03 11 23 00	01 22 16 00	No Specification Required
03 11 23 00	03 05 00 00	Cast-In-Place Concrete
03 15 13 13	03 05 00 00	Cast-In-Place Concrete
03 15 13 16	03 05 00 00	Cast-In-Place Concrete
03 15 16 00	03 05 00 00	Cast-In-Place Concrete
03 15 19 00	05 50 00 00	Metal Fabrications
03 21 11 00	03 05 00 00	Cast-In-Place Concrete
03 21 16 00	03 05 00 00	Cast-In-Place Concrete

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SECTION 03 31 13 00 - 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 1064/A 1064M, 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 31 Section "Earth Moving".
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 32 Section "Unit Paving".
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 Final Completion inspections.

END OF SECTION 03 31 13 00

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SECTION 03 31 13 00a - 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 03 31 13 00a

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SECTION 03 31 13 00b - 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 03 31 13 00b

SECTION 03 31 13 00c - STEEL REINFORCED PORTLAND CEMENT CONCRETE OVERLAYS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of steel reinforced 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. Steel Reinforcement: All reinforcement shall be free from loose flaky rust, loose scale, oil, grease, mud, or other coatings that might reduce bond. Bar mats shall comply with ASTM A 184. Welded steel wire fabric shall comply with ASTM A 1064. Tie bars shall be deformed bars in compliance with ASTM A 615, A 616, or A 617. 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. Reinforcement Steel shall be installed by the strike-off method wherein the concrete is deposited on the subgrade and struck to the indicated elevation of the steel. The reinforcement shall be laid upon the prestruck surface.

C. Concrete Placement: Concrete shall be placed within 45 minutes from the time all ingredients are charged into the mixing drum.

D. Vibration: In the final phases of placing, surface vibrating equipment shall be used, and the duration of vibration shall not exceed 20 seconds.

E. Joints shall be saw cut and in alignment with underlying existing joints.

F. 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.

G. 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 03 31 13 00c

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SECTION 03 31 13 00d - FIBER REINFORCED PORTLAND CEMENT CONCRETE OVERLAYS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of fiber reinforced 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. Steel Fibers: The fibers shall be made from low carbon steel. The following sizes of steel are acceptable:
1. 0.010-inch x 0.022-inch flat steel fiber,
2. 0.010-inch x 0.50-inch round steel fiber,
3. 0.016-inch x 1.0-inch round steel fiber,
4. 0.016-inch x 0.75-inch round steel fiber with 0.010-inch x 0.020-inch flat section along the length of the fiber
5. 2.5-inch x 0.025-inch round steel fibers.

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. Reinforcement Steel shall be installed by the strike-off method wherein the concrete is deposited on the subgrade and struck to the indicated elevation of the steel. The reinforcement shall be laid upon the prestruck surface.

C. Concrete Placement: Concrete shall be placed within 45 minutes from the time all ingredients are charged into the mixing drum.

D. Vibration: In the final phases of placing, surface vibrating equipment shall be used, and the duration of vibration shall not exceed 20 seconds.

E. Joints shall be saw cut and in alignment with underlying existing joints.

F. 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. Broom Finishing: Burlap drag finishing will not be allowed as this brings the steel fibers to the surface. Finishing shall be accomplished using a stiff broom.
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.

G. 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 03 31 13 00d

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Task	Specification	Specification Description
03 31 13 00	03 05 00 00	Cast-In-Place Concrete
03 31 13 00	03 11 16 00a	Cast-In-Place Architectural Concrete
03 35 16 00	03 05 00 00	Cast-In-Place Concrete

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SECTION 03 35 23 00 - EXPOSED AGGREGATE SURFACE CONCRETE WALLS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of exposed aggregate surface concrete walls. 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. Submit product data and manufacturer's application instruction.
2. Shop drawings shall be submitted for approval.

1.2 PRODUCTS

A. Concrete Materials and Mixing
1. Portland Cement: ASTM C 150, Type 1 or 1A.
   a. Shrinkage-Compensating Cement: Portland cement containing a stable expansive chemical compound such as calcium sulfoaluminate.
   b. Aggregate: ASTM C 33; aggregate for exposed aggregate concrete shall match existing, if appropriate.
   c. Admixtures: Submit manufacturer's literature for all admixtures proposed for the work.
   d. Curing Compounds: ASTM C 309, Type 1.
   e. Epoxy Bonding Agent: Sika or approved equal.

B. Concrete Formwork, Reinforcement, and Accessories
1. Formwork: Plywood form and liners shall be minimum grade B-B High Density Concrete Form Overlay, Class I, complying with ANSI A199.1.
2. Reinforcement:
   a. Reinforcement Bars: ASTM A 615, Grade 40 or Grade 60.
   b. Welded Wire Fabric: ASTM A 1064. Where welded wire fabric is needed, use No. 6 gauge wire at 6-inch spacing in each direction.
   c. Accessories for proper installation of reinforcement shall comply with CRSI "Manual of Standard Practice for Reinforced Concrete Construction."
   d. Reinforcement fabrication shall comply with ACI 318 and ACI 315.

C. Curing and Climatic Conditions
1. Comply with ACI 306 and ACI 305 for protecting and curing concrete in cold and hot weather.
2. Immediately after finishing, begin curing flatwork by covering with constantly saturated moisture retaining fabrics, impervious sheeting, or membrane curing compounds.
3. Apply membrane curing compounds as required.

1.3 EXECUTION

A. Preparation when attaching to existing surfaces:
1. Remove all defective material by chipping and cutting to sound concrete in order to secure a solid foundation.
2. Square cut or undercut the edges to a minimum depth of one inch to form key.
3. Cut concrete out from behind exposed reinforcing bars and rods.
4. All exposed reinforcing shall be cleaned of rust and primed.

B. Installation
   1. Formwork requirements:
      a. Formwork shall comply with ACI 347. Joints in forms shall be horizontal or vertical.
      b. Use plywood, fiberglass, or metal forms.
   2. Reinforcement shall be repaired when rusted through. Rods at least l2 inches long shall be wired to the failed rods. In closing gaps, rods shall lap existing rods by at least 12 inches or 30 diameters, whichever is greater.
   3. Mixing and transporting concrete: Ready-mixed concrete shall be mixed and delivered to the project in compliance with ASTM C 94. Job-mixed concrete shall comply with the requirements of ACI 318.
   4. Mixing epoxy-resin patching mortar: Mix thoroughly with a power mixer at low speeds (150 - 400 rpm) until material attains uniform color and consistency (minimum time of two to three minutes at 70 F).

END OF SECTION 03 35 23 00

Task	Specification	Specification Description
03 35 23 00	03 05 00 00	Cast-In-Place Concrete
03 35 26 00	03 05 00 00	Cast-In-Place Concrete
03 35 33 00	03 05 00 00	Cast-In-Place Concrete
03 35 63 00	03 05 00 00	Cast-In-Place Concrete
03 35 66 00	03 05 00 00	Cast-In-Place Concrete
03 35 83 00	03 05 00 00	Cast-In-Place Concrete

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SECTION 03 37 13 00 - SHOTCRETE

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for shotcrete. 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 shotcrete applied by dry-mix or wet-mix process.

C. Definitions
1. Shotcrete: Mortar or concrete pneumatically projected onto a surface at high velocity.
2. Dry-Mix Shotcrete: Shotcrete with most of the water added at nozzle.
3. Wet-Mix Shotcrete: Shotcrete with ingredients, including mixing water, mixed before introduction into delivery hose.

D. Submittals
1. Product Data: For manufactured materials and products including reinforcement and forming accessories, shotcrete materials, admixtures, and curing compounds.
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: For details of fabricating, bending, and placing reinforcement. Include support and anchor details, number and location of splices, and special reinforcement required for openings through shotcrete structures.
4. Samples: Approximately 24 by 24 by 2 inches (600 by 600 by 50 mm), to illustrate quality of finishes, colors, and textures of exposed surfaces of shotcrete.
5. Design Mixes: For each shotcrete mix.
6. Material Test Reports: For shotcrete materials.
7. Material Certificates: For each material item, signed by manufacturers.
8. Field quality-control test reports.

E. Quality Assurance
1. Installer Qualifications: A qualified installer employing nozzle operators for the Project, each of whom attains mean core grades not exceeding 2.5, according to ACI 506.2, on preconstruction tests **OR** is ACI Shotcrete Nozzleman certified in Dry-Mix Process for Vertical Position **OR** is ACI Shotcrete Nozzleman certified in Dry-Mix Process for Vertical and Overhead Positions **OR** is ACI Shotcrete Nozzleman certified in Wet-Mix Process for Vertical Position **OR** is ACI Shotcrete Nozzleman certified in Wet-Mix Process for Vertical and Overhead Positions as appropriate to the required shotcrete work**, as directed**.
2. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, and acceptable to authorities having jurisdiction, **as directed**.
3. Comply with provisions of the following, unless more stringent requirements are indicated:
   a. ACI 301, "Specifications for Structural Concrete."
   b. ACI 506.2, "Specification for Shotcrete."
4. Preinstallation Conference: Conduct conference at Project site.
5. Shotcrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design shotcrete mixtures.

F. Project Conditions
1. Cold-Weather Shotcreting: Protect shotcrete work from physical damage or reduced strength caused by frost, freezing, or low temperatures according to ACI 306.1 and as follows:
a. Discontinue shotcreting when ambient temperature is 40 deg F (4.4 deg C) and falling. Uniformly heat water and aggregates before mixing to obtain a shotcrete shooting temperature of not less than 50 deg F (10 deg C) and not more than 90 deg F (32 deg C).
b. Do not use frozen materials or materials containing ice or snow.
c. Do not place shotcrete on frozen surfaces or surfaces containing frozen materials.
d. Do not use calcium chloride, salt, or other materials containing antifreeze agents.
2. Hot-Weather Shotcreting: Mix, place, and protect shotcrete according to ACI 305R when hot-weather conditions and high temperatures would seriously impair quality and strength of shotcrete, and as follows:
a. Cool ingredients before mixing to maintain shotcrete temperature at time of placement below 100 deg F (38 deg C) for dry mix or 90 deg F (32 deg C) for wet mix.
b. Reduce temperature of reinforcing steel and receiving surfaces below 100 deg F (38 deg C) before shotcreting.

1.2 PRODUCTS

A. Form Materials
1. Forms: Form-facing panels that will provide continuous, straight, smooth, concrete surfaces. Furnish panels in largest practicable sizes to minimize number of joints.

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 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.
5. Plain-Steel Wire: ASTM A 82, as drawn **OR** galvanized, **as directed**.
6. Plain-Steel-Welded Wire Fabric: ASTM A 1064, fabricated from as-drawn **OR** galvanized, **as directed**, steel wire into flat sheets.
7. Deformed-Steel-Welded Wire Fabric: ASTM A 497, flat sheet.
8. Supports: Bolsters, chairs, spacers, ties, and other devices for spacing, supporting, and fastening reinforcing steel in place according to CRSI's "Manual of Standard Practice" and as follows:
a. For uncoated reinforcement, use all-plastic **OR** CRSI Class 1, plastic-protected **OR** CRSI Class 2, stainless-steel, **as directed**, bar supports.
b. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire **OR** all-plastic, **as directed**, bar supports.
c. Retain paragraph and subparagraph below if devices are required to anchor, support, or space steel reinforcement.
9. Reinforcing Anchors: ASTM A 36/A 36M, unheaded rods or ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), hex-head bolts; carbon steel; and carbon-steel nuts.
a. Finish: Plain, uncoated **OR** Hot-dip zinc coating, ASTM A 153/A 153M, Class C, **as directed**.

C. Shotcrete Materials
1. Portland Cement: ASTM C 150, Type I **OR** III, **as directed**. Use only one brand and type of cement for Project.

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 **OR** IP **OR** I(PM) **OR** I(SM), **as directed**.
3. Silica Fume: ASTM C 1240, amorphous silica.
4. Normal-Weight Aggregates: ASTM C 33, from a single source, and as follows:
   a. Aggregate Gradation: ACI 506R, Gradation No. 1 with 100 percent passing 3/8-inch (10-mm) **OR** 2 with 100 percent passing 1/2-inch (13-mm), **as directed**, sieve.
   b. Coarse-Aggregate Class: 3S **OR** 3M **OR** 1N, **as directed**.
5. Lightweight Aggregates: ASTM C 330.
   a. Aggregate Gradation: ACI 506R, Gradation No. 1 with 100 percent passing 3/8-inch (10-mm) **OR** 2 with 100 percent passing 1/2-inch (13-mm), **as directed** sieve.
6. Coloring Agent: ASTM C 979, synthetic mineral-oxide pigments or colored, water-reducing admixtures, free of carbon black; color stable, 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**.
7. Water: Potable, complying with ASTM C 94/C 94M, free from deleterious materials that may affect color stability, setting, or strength of shotcrete.
8. Carbon-Steel Fiber: ASTM C 1116, Type 1, carbon-steel fiber and ASTM A 820, Type 1, cold-drawn wire **OR** cut sheet, **as directed**, not less than 1 inch (25 mm) long.
9. Synthetic Fiber: Fibrillated polypropylene fibers engineered and designed for use in shotcrete, complying with ASTM C 1116, Type III, not less than 3/4 inch (19 mm) long.
10. Ground Wire: High-strength steel wire, 0.8 to 1 mm in diameter.
11. Joint Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.

D. Chemical Admixtures
1. General: ASTM C 1141, Class A or B, but limited to the following admixture materials. Provide admixtures for shotcrete that contains not more than 0.1 percent chloride ions. Certify compatibility of admixtures with each other and with other cementitious materials.
   a. Air-Entraining Admixture: ASTM C 260.
   b. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
   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. Accelerating Admixture: ASTM C 494/C 494M, Type C.

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) dry.
2. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
3. Water: Potable.
4. Clear, Waterborne **OR** Solvent-Borne, **as directed**, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

F. Shotcrete Mixtures, General
1. Prepare design mixes for each type and strength of shotcrete.
   a. Limit use of fly ash **OR** ground granulated blast-furnace slag **OR** silica fume, **as directed**, to not exceed, in combination, 25 percent of portland cement by weight.
2. Limit water-soluble chloride ions to maximum percentage by weight of cement or cementitious materials permitted by ACI 301.
3. Admixtures: When included in shotcrete design mixes, use admixtures and retarding admixtures according to manufacturer's written instructions.
4. Carbon-Steel Fiber: Uniformly disperse in shotcrete mix, according to manufacturer's written instructions, at a rate of 50 lb/cu. yd. (30 kg/cu. m) **OR** 100 lb/cu. yd. (60 kg/cu. m), **as directed**.
5. Synthetic Fiber: Uniformly disperse in shotcrete mix, according to manufacturer's written instructions, at a rate of 1.5 lb/cu. yd. (0.90 kg/cu. m) **OR** 5 lb/cu. yd. (3 kg/cu. m), **as directed**.

6. Design-Mix Adjustments: Subject to compliance with requirements, shotcrete design-mix adjustments may be proposed when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.

G. Shotcrete Mixtures
1. Proportion dry mixtures by field test data methods and wet mixtures according to ACI 211.1 and ACI 301, using materials to be used on Project, to provide shotcrete with the following properties:
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), **as directed**.
b. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight, wet-mix shotcrete having an air content before pumping of 7 **OR** 8, **as directed**, percent with a tolerance of plus or minus 1-1/2 percent.

H. Shotcrete Equipment
1. Mixing Equipment: Capable of thoroughly mixing shotcrete materials in sufficient quantities to maintain continuous placement.
2. Dry-Mix Delivery Equipment: Capable of discharging aggregate-cement mixture into delivery hose under close control and maintaining continuous stream of uniformly mixed materials at required velocity to discharge nozzle. Equip discharge nozzle with manually operated water-injection system for directing even distribution of water to aggregate-cement mixture.
a. Provide uniform, steady supply of clean, compressed air to maintain constant nozzle velocity while simultaneously operating blow pipe for cleaning away rebound.
b. Provide water supply with uniform pressure at discharge nozzle to ensure uniform mixing with aggregate-cement mix. Provide water pump to system if line water pressure is inadequate.
3. Wet-Mix Delivery Equipment: Capable of discharging aggregate-cement-water mixture accurately, uniformly, and continuously.

I. Batching And Mixing
1. Dry-Mix Process: Measure mix proportions by weight batching according to ASTM C 94/C 94M or by volume batching complying with ASTM C 685/C 685M requirements.
a. In volume batching, adjust fine-aggregate volume for bulking. Test fine-aggregate moisture content at least once daily to determine extent of bulking.
b. Prepackaged shotcrete materials may be used at Contractor's option. Predampen prepackaged shotcrete materials and mix before use.
2. Wet-Mix Process: Measure, batch, mix, and deliver shotcrete according to ASTM C 94/C 94M and ASTM C 1116, **as directed**, and furnish batch ticket information.
a. Comply with ASTM C 685/C 685M when shotcrete ingredients are delivered dry and proportioned and mixed on-site.

1.3 EXECUTION

A. Preparation
1. Concrete or Masonry: Before applying shotcrete, remove unsound or loose materials and contaminants that may inhibit shotcrete bonding. Chip or scarify areas to be repaired to extent necessary to provide sound substrate. Cut edges square and 1/2 inch (13 mm) deep at perimeter of work, tapering remaining shoulder at 1:1 slope into cavity to eliminate square shoulders. Dampen surfaces before shotcreting.
a. Abrasive blast or hydroblast existing surfaces that do not require chipping to remove paint, oil, grease, or other contaminants and to provide roughened surface for proper shotcrete bonding.
2. Earth: Compact and trim to line and grade before placing shotcrete. Do not place shotcrete on frozen surfaces. Dampen surfaces before shotcreting.

3. Rock: Clean rock surfaces of loose materials, mud, and other foreign matter that might weaken shotcrete bonding.
4. Steel: Clean steel surfaces by abrasive blasting according to SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

B. Forms
1. General: Design, erect, support, brace, and maintain forms, according to ACI 301, to support shotcrete and construction loads and to facilitate shotcreting. Construct forms so shotcrete members and structures are secured to prevent excessive vibration or deflection during shotcreting.
   a. Fabricate forms to be readily removable without impact, shock, or damage to shotcrete surfaces and adjacent materials.
   b. Construct forms to required sizes, shapes, lines, and dimensions using ground wires and depth gages to obtain accurate alignment, location, and grades in finished structures. Construct forms to prevent mortar leakage but permit escape of air and rebound during shotcreting. Provide for openings, offsets, blocking, screeds, anchorages, inserts, and other features required in the Work.
2. Form openings, chases, recesses, bulkheads, keyways, and screeds in formwork. Determine sizes and locations from trades providing such items. Accurately place and securely support items built into forms.

C. 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, and other materials that weaken shotcrete bonding.
3. Securely embed reinforcing anchors into existing substrates, located as required.
4. Accurately position, support, and rigidly secure reinforcement against displacement by formwork, construction, or shotcreting. Locate and support reinforcement by metal chairs, runners, bolsters, spacers, and hangers, as required.
5. Place reinforcement to obtain minimum coverage for shotcrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during shotcreting. Set wire ties with ends directed into shotcrete, not toward exposed shotcrete surfaces.
6. Install welded wire fabric 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.

D. Joints
1. Construction Joints: Locate and install construction joints tapered to a 1:1 slope where joint is not subject to compression loads and square where joint is perpendicular to main reinforcement. Continue reinforcement through construction joints, unless otherwise indicated.
2. Contraction Joints: Construct contraction joints in shotcrete using saw cuts 1/8-inch- (3-mm-) wide-by-1/3 slab depth or joint-filler strips 1/4-inch- (6-mm-) wide-by-1/3 shotcrete depth, unless otherwise indicated.
   a. After shotcrete has cured, remove strip inserts and clean groove of loose debris.
   b. Space joints at 15 feet (4.5 m) o.c. **OR** centers indicated, **as directed**, horizontally and vertically.
   c. Tool edges round on each side of strip inserts if floated or troweled finishes are required.

E. Alignment Control
1. Ground Wires: Install ground wires to establish thickness and planes of shotcrete surfaces. Install ground wires at corners and offsets not established by forms. Pull ground wires taut and position adjustment devices to permit additional tightening.

F. Embedded Items

1. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by shotcrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

G. Application
1. Apply temporary protective coverings and protect adjacent surfaces against deposit of rebound and overspray or impact from nozzle stream.
2. Moisten wood forms immediately before placing shotcrete where form coatings are not used.
3. Apply shotcrete according to ACI 506.2.
4. Apply dry-mix shotcrete materials within 45 minutes after predampening and wet-mix shotcrete materials within 90 minutes after batching.
5. Deposit shotcrete continuously in multiple passes, to required thickness, without cold joints and laminations developing. Place shotcrete with nozzle held perpendicular to receiving surface. Begin shotcreting in corners and recesses.
6. Remove and dispose of rebound and overspray materials during shotcreting to maintain clean surfaces and to prevent rebound entrapment.
7. Maintain reinforcement in position during shotcreting. Place shotcrete to completely encase reinforcement and other embedded items. Maintain steel reinforcement free of overspray and prevent buildup against front face during shotcreting.
8. Do not place subsequent lifts until previous lift of shotcrete is capable of supporting new shotcrete.
9. Do not permit shotcrete to sag, slough, or dislodge.
10. Remove hardened overspray, rebound, and laitance from shotcrete surfaces to receive additional layers of shotcrete; dampen surfaces before shotcreting.
11. Do not disturb shotcrete surfaces before beginning finishing operations.
12. Remove ground wires or other alignment control devices after shotcrete placement.
13. Shotcrete Core Grade: Apply shotcrete to achieve mean core grades not exceeding 2.5 according to ACI 506.2, with no single core grade exceeding 3.0.
14. Installation Tolerances: Place shotcrete without exceeding installation tolerances permitted by ACI 117R, increased by a factor of 2.

H. Surface Finishes
1. General: Finish shotcrete according to descriptions in ACI 506R for the following finishes:
2. Natural Finish:
   a. Gun Finish: Natural undisturbed finish.
   b. Rod Finish: Rough-textured finish obtained by cutting or screeding exposed face of shotcrete to plane by rod or straightedge after initial set, and wood-float finished **OR** and steel-trowel finished**as directed**.
   c. Broom Finish: Rough-textured finish obtained by screeding exposed face of shotcrete to required plane by rod, cutting screed, or trowel, and brooming after initial set.
3. Flash-Coat Finish: After screeding and rodding surface, apply up to 1/4-inch (6-mm) coat of shotcrete using ACI 506R, Gradation No. 1, fine-screened sand modified with maximum aggregate size not exceeding No. 4 (4.75-mm) sieve to provide a finely textured finish.
4. Flash-Coat and Final Finish: After screeding and rodding surface, apply up to 1/4-inch (6-mm) coat of shotcrete using ACI 506R, Gradation No. 1, fine-screened sand modified with maximum aggregate size not exceeding No. 4 (4.75-mm) sieve and apply wood-float **OR** rubber-float **OR** brush-float **OR** steel-trowel, **as directed**, finish.
5. Finish-Coat Finish: After screeding and rodding surface, apply shotcrete finish coat, 1/4 to 1 inch (6 to 25 mm) thick, using ACI 506R, Gradation No. 1, fine-screened sand modified with maximum aggregate size not exceeding No. 4 (4.75-mm) sieve to provide a finish of uniform texture and appearance.
6. Finish-Coat and Final Finish: After screeding and rodding surface, apply shotcrete finish coat, 1/4 to 1 inch (6 to 25 mm) thick, using ACI 506R, Gradation No. 1, fine-screened sand modified with

maximum aggregate size not exceeding No. 4 (4.75-mm) sieve and apply wood-float **OR** rubber-float **OR** brush-float **OR** steel-trowel, **as directed**, finish.

I. Curing
   1. Protect freshly placed shotcrete from premature drying and excessive cold or hot temperatures.
   2. Start initial curing as soon as free water has disappeared from shotcrete surface after placing and finishing.
   3. Curing Exposed Surfaces: Cure shotcrete by one of the following methods:
      a. Moisture Curing: Keep surfaces continuously moist for at least seven days with water, continuous water-fog spray, water-saturated absorptive covers, or moisture-retaining covers. Lap and seal sides and ends of covers.
      b. Curing Compound: Apply curing compound uniformly in continuous operation by power spray 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.
         1) Apply curing compound to natural- or gun-finished shotcrete at rate of 1 gal./100 sq. ft. (1 L/2.5 sq. m).
   4. Curing Formed Surfaces: Cure formed shotcrete surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.

J. Form Removal
   1. Forms not supporting weight of shotcrete may be removed after curing at not less than 50 deg F (10 deg C) for 24 consecutive hours after gunning, provided shotcrete is hard enough not to be damaged by form-removal operations and provided curing and protecting operations are maintained.
      a. Leave forms supporting weight of shotcrete in place until shotcrete has attained design compressive strength. Determine compressive strength of in-place shotcrete by testing representative field-cured specimens of shotcrete.
      b. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
   2. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing materials are unacceptable for exposed surfaces. Apply new form-coating compound as specified for new formwork.

K. Field Quality Control
   1. Engage a qualified independent testing agency to sample materials, visually grade cores, perform tests, and submit reports during shotcreting.
   2. Air Content: ASTM C 173/C 173M, volumetric method or ASTM C 231, pressure method; 1 test for each compressive-strength test for each mix of air-entrained, wet-mix shotcrete measured before pumping.
   3. Shotcrete Temperature: ASTM C 1064/C 1064M; 1 test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and 1 test for each set of compressive-strength specimens.
   4. Test Panels: Make a test panel, reinforced as in structure, for each shotcrete mix and for each workday or for every 50 cu. yd. (38 cu. m) of shotcrete placed; whichever is less. Produce test panels with dimensions of 24 by 24 inches (600 by 600 mm) minimum and of average thickness of shotcrete, but not less than 4-1/2 inches (115 mm). From each test panel, testing agency will obtain six test specimens: one set of three specimens unreinforced and one set of three specimens reinforced.
      a. Test each set of unreinforced specimens for compressive strength according to ASTM C 1140 and construction testing requirements in ACI 506.2.
      b. Visually inspect each set of reinforced shotcrete cores taken from test panels and determine mean core grades according to ACI 506.2.

5. In-Place Shotcrete: Take a set of 3 unreinforced cores for each mix and for each workday or for every 50 cu. yd. (38 cu. m) of shotcrete placed; whichever is less. Test cores for compressive strength according to ACI 506.2 and ASTM C 42. Do not cut steel reinforcement.
6. Strength of shotcrete will be considered satisfactory when mean compressive strength of each set of 3 unreinforced cores equals or exceeds 85 percent of specified compressive strength, with no individual core less than 75 percent of specified compressive strength.
    a. Mean compressive strength of each set of 3 unreinforced cubes shall equal or exceed design compressive strength with no individual cube less than 88 percent of specified compressive strength.

L. Repairs
1. Remove and replace shotcrete that is delaminated or exhibits laminations, voids, or sand/rock pockets exceeding limits for specified core grade of shotcrete.
    a. Remove unsound or loose materials and contaminants that may inhibit bond of shotcrete repairs. Chip or scarify areas to be repaired to extent necessary to provide sound substrate. Cut edges square and 1/2 inch (13 mm) deep at perimeter of work, tapering remaining shoulder at 1:1 slope into cavity to eliminate square shoulders. Dampen surfaces and apply new shotcrete.
2. Repair core holes from in-place testing according to repair provisions in ACI 301 and match adjacent finish, texture, and color.

M. Cleaning
1. Remove and dispose of rebound and overspray materials from final shotcrete surfaces and areas not intended for shotcrete placement.

END OF SECTION 03 37 13 00

SECTION 03 37 13 00a - 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 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 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. Stainless-Steel Plates: ASTM A 240/A 240M or ASTM A 666, Type 304.
2. 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.
3. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.
4. 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.

5. Malleable-Iron Castings: ASTM A 47/ A 47M, Grade 32510 (Grade 22010).
6. Carbon-Steel Castings: ASTM A 27/A 27M, Grade 60-30 (Grade 415-205).
7. 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**.
8. Reglets: PVC extrusions **OR** Stainless steel, ASTM A 240/A 240M, Type 304, 0.016 inch (0.40 mm) thick, **as directed**.

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 03 37 13 00a

Task	Specification	Specification Description
03 39 13 00	03 11 16 00a	Cast-In-Place Architectural Concrete
03 39 23 23	03 05 00 00	Cast-In-Place Concrete
03 39 33 00	03 05 00 00	Cast-In-Place Concrete

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SECTION 03 48 29 00 - 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 1064, 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 "Exterior 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 03 48 29 00

Task	Specification	Specification Description
03 48 49 00	03 48 29 00	Plant-Precast Structural Concrete

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SECTION 03 51 13 00 - CEMENTITIOUS WOOD-FIBER DECK

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for cementitious wood-fiber 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. Monolithic cementitious wood-fiber units.
b. Composite cementitious wood-fiber units.
c. Insulated composite cementitious wood-fiber units.
d. Subpurlin tees.

C. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Show fabrication and installation details for cementitious wood-fiber deck. Include details at supports, reinforcement at openings, and attachment to other work.
3. Samples: Show texture, finish, and edge and end configurations of monolithic **OR** composite **OR** insulated composite, **as directed,** cementitious wood-fiber units, 12 inches (305 mm) **OR** 24 inches (610 mm), **as directed,** long by width of unit.
a. Include unit with galvanized steel edge channel.

D. Quality Assurance
1. Fire-Test-Response Characteristics: Provide cementitious wood-fiber units that comply with the following requirements:
a. Fire-response testing performed by UL, ITS, or another testing and inspecting agency acceptable to authorities having jurisdiction and that performs testing and follow-up services.
b. Surface-Burning Characteristics: Maximum flame-spread and smoke-developed indices of 25 and 50, respectively, as determined by testing identical products per ASTM E 84.
c. Fire-resistance-rated assemblies indicated by design designations from UL's "Fire Resistance Directory," ITS's "Directory of Listed Products," or the listings of another testing and inspecting agency are identical in materials and construction to those tested per ASTM E 119.
d. Products are identified with appropriate markings of applicable testing and inspecting agency.

E. Delivery, Storage, And Handling
1. Protect cementitious wood-fiber units from moisture.
2. Store units on elevated platforms at the Project site in a dry, well-ventilated, covered space and stack according to manufacturer's written recommendations.
3. Handle units to prevent chipping, breaking, cracking, staining, soiling, warping, or other physical damage. Discard damaged units at time of installation.

1.2 PRODUCTS

A. Materials
1. Cementitious Wood-Fiber Units, General: Manufacturer's standard factory-cast structural units complying with the following requirements:

a. Composition: Chemically processed long wood fibers mixed with Portland cement, ASTM C 150, Type III or magnesium oxysulfate hydraulic cement, pressure bonded to produce units of thicknesses and sizes indicated:
b. Properties: As follows, determined according to test method indicated:
1) Noise Reduction Coefficient: NRC 0.55 **OR** 0.60 **OR** 0.65 **OR** 0.70 **OR** 0.75 **OR** 0.80, **as directed**; ASTM C 423.
2) Light Reflectance: 60 percent; ASTM E 1349.
c. Finish: Manufacturer's standard natural or prime-painted finish.

2. Oriented-Strand-Board Sheathing: APA-rated sheathing, Exposure 1 complying with DOC PS 2.
3. Polyisocyanurate-Foam Insulation: 2 lb/cu. ft. (32 kg/cu. m) nominal density, 35 lbf/sq. in. (240 kPa) compressive strength per ASTM D 1621.
4. Extruded-Polystyrene Insulation: ASTM C 578, Type IV.
5. Expanded-Polystyrene Insulation: ASTM C 578, Type I.

B. Monolithic Cementitious Wood-Fiber Units
1. Tile: Manufacturer's standard rabbet-edged, cementitious wood-fiber units.
2. Plank: Manufacturer's standard tongue-and-groove-edged, cementitious wood-fiber units.
3. Channel-Reinforced Plank: Manufacturer's standard tongue-and-groove-edged, cementitious wood-fiber planks with factory-installed, cold-formed, 0.0598-inch- (1.52-mm-) thick, galvanized steel channel set in grooved edge.
4. Concealed-Tee Plank: Manufacturer's standard cementitious wood-fiber units, with edges kerfed, back rabbeted, and beveled.

C. Composite Cementitious Wood-Fiber Units
1. Composite Tile: Manufacturer's standard factory-laminated composite deck units consisting of a rabbet-edged, cementitious wood-fiber tile base and top layer of oriented-strand-board sheathing, 7/16 inch (11 mm) thick.
2. Composite Plank: Manufacturer's standard factory-laminated composite deck units consisting of a standard tongue-and-groove-edged, cementitious wood-fiber plank base and top layer of oriented-strand-board sheathing, 7/16 inch (11 mm) thick.
3. Composite Channel-Reinforced Plank: Manufacturer's standard factory-laminated composite deck units consisting of a standard tongue-and-groove-edged, cementitious wood-fiber plank base with factory-installed, cold-formed, 0.0598-inch- (1.52-mm-) thick, galvanized steel channel set in grooved edge, and top layer of oriented-strand-board sheathing, 7/16 inch (11 mm) thick.

D. Insulated Composite Cementitious Wood-Fiber Units
1. Insulated Composite Tile: Manufacturer's standard factory-laminated composite deck units consisting of a rabbet-edged, cementitious wood-fiber tile base, insulation, and top layer; and as follows:
a. Insulation: Polyisocyanurate **OR** Extruded polystyrene **OR** Expanded polystyrene, **as directed**.
b. Top Layer: Manufacturer's standard asphalt-free, glass-fiber-reinforced, black felt facing **OR** 7/16-inch- (11-mm-) thick, oriented-strand board, **as directed**.
2. Insulated Composite Plank: Manufacturer's standard factory-laminated composite deck units consisting of a standard tongue-and-groove-edged, cementitious wood-fiber plank base, insulation, and top layer; and as follows:
a. Insulation: Polyisocyanurate **OR** Extruded polystyrene **OR** Expanded polystyrene, **as directed**.
b. Top Layer: Manufacturer's standard asphalt-free, glass-fiber-reinforced, black felt facing **OR** 7/16-inch- (11-mm-) thick, oriented-strand-board, **as directed**.
3. Insulated Composite Channel-Reinforced Plank: Manufacturer's standard factory-laminated composite deck units consisting of a standard tongue-and-groove-edged, cementitious wood-fiber plank base with factory-installed, cold-formed, 0.0598-inch- (1.52-mm-) thick, galvanized steel channel set in grooved edge, insulation, and top layer; and as follows:

a. Insulation: Polyisocyanurate **OR** Extruded polystyrene **OR** Expanded polystyrene, **as directed**.
b. Top Layer: Manufacturer's standard asphalt-free, glass-fiber-reinforced, black felt facing **OR** 7/16-inch- (11-mm-) thick, oriented-strand board, **as directed**.

E. Subpurlins
1. Bulb-Tee Subpurlins: Hot-rolled steel bulb tees complying with ASTM A 499 of length required to span three support spacings; shop painted with metal primer.

F. Accessories
1. Gypsum Concrete Grout: Factory-packaged, gypsum concrete grout formulation recommended by cementitious wood-fiber unit manufacturer with a minimum compressive strength of 500 psi (3.45 MPa).
2. Anchor Clips: Manufacturer's standard formed anchor clips of 0.0478-inch- (1.21-mm-) thick minimum, galvanized steel sheet, of type and configuration required for deck system indicated.
3. Screws: Manufacturer's recommended corrosion-resistant screw fasteners and washers, self-drilling, self-tapping, of length required for deck and structural framing indicated.
4. Nails: Manufacturer's recommended corrosion-resistant nails of size and length required for deck and structural framing indicated.
5. Adhesive: Manufacturer's recommended construction adhesive complying with APA AFG-01.
6. Filler Strips: Insulation strips, same as used in manufacture of insulated composite cementitious wood-fiber units.
7. Polyethylene Film: 0.004 inch (0.10 mm) thick, complying with ASTM D 4397.

1.3 EXECUTION

A. Installation
1. Comply with manufacturer's written instructions for installing cementitious wood-fiber deck.
a. Install fastenings according to manufacturer's written instructions, unless otherwise indicated **OR** as indicated, **as directed**.
2. Deck Interruptions: Provide barrier seals or blocking at overhangs to form wind seals and at partitions and walls to form sound seals, unless otherwise indicated.

B. Form-Deck Installation
1. Tile and Subpurlin Form Deck: Space subpurlin members as indicated. Attach subpurlins to each support with 3/4-inch- (19-mm-) long minimum, fillet welds on both sides of flanges at ends of members and on alternate sides at intermediate structural supports.
a. Lay tile with rabbeted edges supported on subpurlins, and shim or block in place to prevent dislocation during placing of fill.
b. Lay tile with square-cut ends concealed and supported on cross subpurlins **OR** over supporting purlins or beams, **as directed**.
c. Lay tile with tongue-and-groove ends exposed in pattern indicated.
d. Fill void with gypsum concrete grout where edge joints meet subpurlins. Strike grout flush with top of tile and feather uneven top surfaces to a plane.
e. Provide shoring of sufficient strength to withstand weight of cast-in-place fill and construction traffic. Design, install, and remove shoring according to Division 03 Section "Cast-in-place Concrete".
2. Plank Form Deck: Install planks progressively with long dimension perpendicular to supports and with end joints in alternate rows, staggered and centered over supports, unless otherwise indicated. Tightly nest tongue-and-groove edges and tightly butt end joints.
a. Cut panels to provide starter units.
b. Continuously support plank edges and ends at perimeter of building and at openings in deck.

c. Provide shoring of sufficient strength to withstand weight of cast-in-place fill and construction traffic. Design, install, and remove shoring according to Division 03 Section "Cast-in-place Concrete".
d. Cover exposed edges and ends of form planks with polyethylene film before pouring cast-in-place fill to prevent paste or mixing water from penetrating deck and seeping through to bottom face. Remove exposed film after cast-in-place fill has set.

3. Concealed-Tee Plank Deck: Install planks progressively with long dimension perpendicular to supports and with end joints in alternate rows, staggered and centered over supports, unless otherwise indicated. Install flange of bulb tee into kerfed edge and tightly butt adjoining plank to engage other flange. Tightly nest tongue-and-groove **OR** butt square, **as directed,** end joints.
   a. Cut panels to provide starter units.
   b. Continuously support plank edges and ends at perimeter of building and at openings in deck.
   c. Fill void with gypsum concrete grout where edge joints meet subpurlins. Strike grout flush with top of plank and feather uneven top surfaces to a plane.
   d. Provide shoring of sufficient strength to withstand weight of cast-in-place fill and construction traffic. Design, install, and remove shoring according to Division 03 Section "Cast-in-place Concrete".

C. Roof Deck Installation
1. Tile and Subpurlin Roof Deck: Space subpurlin members as indicated. Attach subpurlins to each support with 3/4-inch- (19-mm-) long minimum, fillet welds on both sides of flanges at ends of members and on alternate sides at intermediate structural supports.
   a. Lay tile with rabbeted edges supported on subpurlins.
   b. Lay tile with square-cut ends concealed and supported on cross subpurlins **OR** over supporting purlins or beams, **as directed**.
   c. Lay tile with tongue-and-groove ends exposed in pattern indicated.
   d. Fill void with gypsum concrete grout where edge joints meet subpurlins. Strike grout flush with top of tile and feather uneven top surfaces to a plane.
   e. Fill void with gypsum concrete grout where edge joints meet subpurlins. Strike grout flush with top surface of cementitious wood-fiber base. Fill remainder of joint with filler strips of insulation.
2. Plank Roof Deck: Install planks progressively with long dimension perpendicular to supports and with end joints in alternate rows, staggered and centered over supports, unless otherwise indicated. Tightly nest tongue-and-groove edges and tightly butt end joints.
   a. Cut panels to provide starter units.
   b. Continuously support plank edges and ends at perimeter of building and at openings in deck.
   c. Mechanically fasten planks to supports and perimeter members.
   d. Adhesively and mechanically fasten planks to supports and perimeter members. Apply adhesive to tongue-and-groove edges.
3. Concealed-Tee Plank Roof Deck: Install planks progressively with long dimension perpendicular to supports and with end joints in alternate rows, staggered and centered over supports, unless otherwise indicated. Install flange of bulb tee into kerfed edge and tightly butt adjoining plank to engage other flange. Tightly nest tongue-and-groove **OR** butt square, **as directed,** end joints.
   a. Cut panels to provide starter units.
   b. Continuously support plank edges and ends at perimeter of building and at openings in deck.
   c. Mechanically fasten planks to supports and perimeter members.
   d. Adhesively and mechanically fasten planks to supports and perimeter members. Apply adhesive to tongue-and-groove edges.
   e. Fill void with gypsum concrete grout where edge joints meet subpurlins. Strike grout flush with top of plank and feather uneven top surfaces to a plane.

D. Cleaning And Protection

1. Protect top surfaces of deck from damage caused by construction operations.
2. Protect exposed bottom surfaces of deck from soiling and damage during handling and construction.
3. Clean exposed bottom surfaces of completed deck and touch up minor damage to surfaces as approved.
4. Provide final protection and maintain conditions in a manner acceptable to manufacturer and Installer that ensures that cementitious wood-fiber deck is without damage or deterioration at time of Final Completion.
5. Remove and replace deteriorated and damaged deck units.

END OF SECTION 03 51 13 00

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SECTION 03 51 16 00 - 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 03 51 16 00

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SECTION 03 51 16 00a - 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 03 51 16 00a

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SECTION 03 51 16 00b - GYPSUM CONCRETE DECKS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of gypsum concrete decks. Products 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. Gypsum Concrete: ASTM C 317, Class A.

B. Formboards:
1. Gypsum Board: ASTM C 318.
2. Mineral Fiber Board: ASTM C612.
3. Glass Fiber Board: Lightweight, rigid, composed of pressed glass fibers.

C. Bulb Tees: ASTM A 499, Grade 50.

D. Reinforcing Mesh:
1. Welded Wire Fabric: ASTM A 1064, galvanized, 12 x 48-W0.5 x W0.5.
2. Woven Wire Fabric: ASTM A 82, galvanized, 19 gauge wire, 2-inch hexagonal mesh.

1.3 EXECUTION

A. Support System: Sub-purlins shall be spaced to support formboards and rigidly attached to main supports. Formboards shall fit snugly at sub-purlins and at wall, curbs, and openings.

B. Reinforcement: Lay wire fabric continuously over sub-purlins. Do not lap side of reinforcement.

C. Gypsum Concrete: Gypsum concrete shall be placed continuously without interruption until entire panel or section is complete. Immediately after placement, screed, level, and trowel smooth.

END OF SECTION 03 51 16 00b

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SECTION 03 53 00 00 - CONCRETE FLOOR TOPPING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for concrete floor topping. 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. Emery-aggregate concrete floor topping.
b. Iron-aggregate concrete floor topping.

C. Submittals
1. Product Data: For each type of product indicated.
2. Product Test Reports.
3. Field quality-control test reports.

D. Quality Assurance
1. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
2. 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, mixing with other components, and application.
2. Store materials to comply with manufacturer's written instructions to prevent deterioration from moisture or other detrimental effects.

F. Project Conditions
1. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature and moisture content, ambient temperature and humidity, ventilation, and other conditions affecting concrete floor topping performance.
a. Place concrete floor topping only when ambient temperature and temperature of base slabs are between 50 and 86 deg F (10 and 30 deg C).
2. Close areas to traffic during topping application and, after application, for time period recommended in writing by manufacturer.

1.2 PRODUCTS

A. Concrete Floor Toppings
1. Emery-Aggregate Concrete Floor Topping: Factory-prepared and dry-packaged mixture of graded, crushed emery aggregate containing not less than 50 percent aluminum oxide, not less than 24 percent ferric oxide, and not more than 8 percent silica; portland cement or blended hydraulic cement; plasticizers; and other admixtures to which only water needs to be added at Project site.
a. Compressive Strength (28 Days): 10,000 psi (69 MPa); ASTM C 109/C 109M.
2. Iron-Aggregate Concrete Floor Topping: Factory-prepared and dry-packaged mixture of graded iron aggregate, portland cement, plasticizers, and other admixtures to which only water needs to be added at Project site.

a. Compressive Strength (28 Days): 12,000 psi (83 MPa); ASTM C 109/C 109M.

B. Curing Materials
1. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.
2. 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.
3. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
4. Water: Potable.
5. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, 25 percent solids content, minimum.

C. Related Materials
1. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A Shore durometer hardness of 80 **OR** aromatic polyurea with a Type A Shore durometer hardness range of 90 to 95, **as directed**, per ASTM D 2240.
2. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.
3. Portland Cement: ASTM C 150, Type I or II.
4. Sand: ASTM C 404, fine aggregate passing No. 16 (1.18-mm) sieve.
5. Water: Potable.
6. Acrylic-Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
7. Epoxy Adhesive: ASTM C 881/C 881M, Type V, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade to suit requirements.

D. Mixing
1. Bonding Slurry: Mix portland cement with water to a thick paint consistency.
OR
Bonding Slurry: Mix 1 part portland cement and 1-1/2 **OR** 2 **OR** 2-1/2, **as directed**, parts sand with water and an acrylic-bonding agent according to manufacturer's written instructions, **as directed**, to a thick paint consistency.
2. Floor Topping: Mix concrete floor topping materials and water in appropriate drum-type batch machine mixer or truck mixer according to manufacturer's written instructions.

1.3 EXECUTION

A. Examination
1. Examine substrates, with Installer present, for conditions affecting performance of concrete floor topping.
2. Verify that base concrete slabs comply with scratch finish requirements specified in Division 03 Section "Cast-in-place Concrete".
3. Verify that base slabs are visibly dry and free of moisture. Test for capillary moisture by the plastic sheet method according to ASTM D 4263.
4. Proceed with application only after unsatisfactory conditions have been corrected.

B. Preparation
1. Existing Concrete: Remove existing surface treatments and deteriorated and unsound concrete. Mechanically abrade base slabs to produce a heavily scarified surface profile with an amplitude of 1/4 inch (6 mm.)
a. Prepare and clean existing base slabs according to concrete floor topping manufacturer's written instructions. Fill voids, cracks, and cavities in base slabs.
b. Mechanically remove contaminants from existing concrete that might impair bond of floor topping.

c. Saw cut contraction and construction joints in existing concrete to a depth of 1/2 inch (13 mm) and fill with semirigid joint filler.
d. To both sides of joint edges and at perimeter of existing base slab mechanically remove a 4-inch- (100-mm-) wide and 0- to 1-inch (0- to 25-mm-) deep, tapered wedge of concrete and retexture surface **OR** install concrete nails in manufacturer's recommended staggered pattern, **as directed**.

2. Install joint-filler strips where topping abuts vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
   a. Extend joint-filler strips full width and depth of joint, terminating flush with topping surface, unless otherwise indicated.
   b. Terminate full-width, joint-filler strips 1/2 inch (13 mm) below topping surface where joint sealants, specified in Division 07 Section "Joint Sealants", are indicated.
   c. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

C. Floor Topping Application
1. Start floor topping application in presence of manufacturer's technical representative.
2. Monolithic Floor Topping: After textured-float finish is applied to fresh concrete of base slabs specified in Division 03 Section "Cast-in-place Concrete", place concrete floor topping while concrete is still plastic.
3. Deferred Floor Topping: Within 72 hours of placing base slabs, mix and scrub bonding slurry into dampened concrete to a thickness of 1/16 to 1/8 inch (1.6 to 3 mm), without puddling. Place floor topping while slurry is still tacky.
4. Existing Concrete: Apply epoxy-bonding adhesive, mixed according to manufacturer's written instructions, and scrub into dry base slabs to a thickness of 1/16 to 1/8 inch (1.6 to 3 mm), without puddling. Place floor topping while adhesive is still tacky.
5. Place concrete floor topping continuously in a single layer, tamping and consolidating to achieve tight contact with bonding surface. Do not permit cold joints or seams to develop within pour strip.
   a. Screed surface with a straightedge and strike off to correct elevations.
   b. Slope surfaces uniformly where indicated.
   c. Begin initial floating using bull floats to form a uniform and open-textured surface plane free of humps or hollows.
6. Finishing: Consolidate surface with power-driven floats as soon as concrete floor topping can support equipment and operator. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until concrete floor topping surface has a uniform, smooth, granular texture.
   1) Hard Trowel Finish: After floating surface, apply first trowel finish and consolidate concrete floor topping by power-driven trowel without allowing blisters to develop. Continue troweling passes and restraighten until surface is smooth and uniform in texture.
   2) Finish surfaces to specified overall values of flatness, F(F) 25; and levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and levelness, F(L) 15, and measure **OR** notify independent testing agency to permit measurement, **as directed**, within 24 hours according to ASTM E 1155 (ASTM E 1155M) for a randomly trafficked floor surface.
   3) Finish and measure surface so gap at any point between surface and an unleveled freestanding 10-foot- (3-m-) long straightedge, resting on 2 high spots and placed anywhere on the surface, does not exceed 1/4 inch (6 mm).
7. Construction Joints: Construct joints true to line with faces perpendicular to surface plane of concrete floor topping, at locations indicated or as approved by the Owner.
   a. Coat face of construction joint with epoxy adhesive at locations where concrete floor topping is placed against hardened or partially hardened concrete floor topping.
8. Contraction Joints: Form weakened-plane contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3-mm-) wide joints into concrete

floor topping when cutting action will not tear, abrade, or otherwise damage surface and before random contraction cracks develop.

a. Form joints in concrete floor topping over contraction joints in base slabs, unless otherwise indicated.
b. Construct contraction joints for a combined depth equal to topping thickness and not less than one-fourth of base-slab thickness.
c. Construct contraction joints for a depth equal to one-half of concrete floor topping thickness, but not less than 1/2 inch (13 mm) deep.

D. Protecting And Curing
1. General: Protect freshly placed concrete floor topping from premature drying and excessive cold or hot temperatures.
2. Evaporation Retarder: Apply evaporation retarder to concrete floor topping surfaces in hot, dry, or windy conditions before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying floor topping, but before float finishing.
3. Begin curing immediately after finishing concrete floor topping. Cure by one or a combination of the following methods, according to concrete floor topping manufacturer's written instructions:
a. Moisture Curing: Keep surfaces continuously moist for not less than 7 days with water **OR** continuous water-fog spray **OR** absorptive cover, water saturated and kept continuously wet. Cover topping surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers, **as directed**.
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 using cover material and waterproof tape.
c. Curing Compound: Apply uniformly in two coats in continuous operations 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.

E. Joint Filling
1. Prepare and clean contraction joints and install semirigid joint filler, according to manufacturer's written instructions, once topping has fully cured.
2. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
3. Install semirigid joint filler full depth of contraction joints. Overfill joint and trim semirigid joint filler flush with top of joint after hardening.

F. Repairs
1. Defective Topping: Repair and patch defective concrete floor topping areas, including areas that have not bonded to concrete substrate.

G. 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 completed applications of concrete floor toppings shall take place in successive stages, in areas of extent and using methods as follows:
a. Sample Sets: At point of placement, a set of 3 molded-cube samples shall be taken from the topping mix for the first 1000 sq. ft. (93 sq. m), plus 1 set of samples for each subsequent 5000 sq. ft. (464 sq. m) of topping, or fraction thereof, but not less than 6 samples for each day's placement. Samples shall be tested according to ASTM C 109/C 109M for compliance with compressive-strength requirements.

b. Concrete floor topping shall be tested for delamination by dragging a steel chain over the surface.
c. Concrete floor topping shall be tested for compliance with surface flatness and levelness tolerances.

3. Remove and replace applications of concrete floor topping where test results 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 03 53 00 00

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SECTION 03 54 16 00 - CEMENT-BASED UNDERLAYMENT

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for hydraulic cement-based underlayment. 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 hydraulic-cement-based, polymer-modified, self-leveling underlayment for application below interior floor coverings.

C. Action Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
a. Product Data for Credit IEQ 4.2: For priming and sealing coatings, documentation including printed statement of VOC content.
3. Shop Drawings: Include plans indicating substrates, locations, and average depths of underlayment based on survey of substrate conditions.

D. Informational Submittals
1. Qualification Data: For qualified Installer.
2. Product Certificates: Signed by manufacturers of underlayment and floor-covering systems certifying that products are compatible.
3. Minutes of preinstallation conference.

E. Quality Assurance
1. Installer Qualifications: Installer who is approved by manufacturer for application of underlayment products required for this Project.
2. Product Compatibility: Manufacturers of underlayment and floor-covering systems certify in writing that products are compatible.
3. Fire-Resistance Ratings: Where indicated, provide hydraulic-cement underlayment systems 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.
4. Sound Transmission Characteristics: Where indicated, provide hydraulic-cement underlayment systems identical to those of assemblies tested for STC and IIC ratings per ASTM E 90 and ASTM E 492 by a qualified testing agency.

F. Delivery, Storage, And Handling
1. Store materials to comply with manufacturer's written instructions to prevent deterioration from moisture or other detrimental effects.

G. Project Conditions
1. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature, ventilation, ambient temperature and humidity, and other conditions affecting underlayment performance.
a. Place hydraulic-cement-based underlayments only when ambient temperature and temperature of substrates are between 50 and 80 deg F (10 and 27 deg C).

1.2 PRODUCTS

A. Hydraulic-Cement-Based Underlayments
1. Underlayment: Hydraulic-cement-based, polymer-modified, self-leveling product that can be applied in minimum uniform thicknesses of 1/4 inch (6 mm) and that can be feathered at edges to match adjacent floor elevations.
a. Cement Binder: ASTM C 150, portland cement, or hydraulic or blended hydraulic cement as defined by ASTM C 219.
b. Compressive Strength: Not less than 4100 psi (28 MPa) at 28 days when tested according to ASTM C 109/C 109M.
c. Underlayment Additive: Resilient-emulsion product of underlayment manufacturer formulated for use with underlayment when applied to substrate and conditions indicated.
2. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3 to 6 mm); or coarse sand as recommended by underlayment manufacturer.
a. Provide aggregate when recommended in writing by underlayment manufacturer for underlayment thickness required.
3. Water: Potable and at a temperature of not more than 70 deg F (21 deg C).
4. Reinforcement: For underlayment applied to wood substrates, provide galvanized metal lath or other corrosion-resistant reinforcement recommended in writing by underlayment manufacturer.
5. Primer: Product of underlayment manufacturer recommended in writing for substrate, conditions, and application indicated.
6. Corrosion-Resistant Coating: Recommended in writing by underlayment manufacturer for metal substrates.

B. Accessories
1. Sound Mat
2. Sound Reduction Board

1.3 EXECUTION

A. Examination
1. Examine substrates, with Installer present, for conditions affecting performance.
a. Proceed with application only after unsatisfactory conditions have been corrected.

B. Preparation
1. General: Prepare and clean substrate according to manufacturer's written instructions.
a. Treat nonmoving substrate cracks according to manufacturer's written instructions to prevent cracks from telegraphing (reflecting) through underlayment.
b. Fill substrate voids to prevent underlayment from leaking.
2. Concrete Substrates: Mechanically remove, according to manufacturer's written instructions, laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants that might impair underlayment bond.
a. Moisture Testing: Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates do not exceed a maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/100 sq. m) in 24 hours.
3. Wood Substrates: Mechanically fasten loose boards and panels to eliminate substrate movement and squeaks. Sand to remove coatings that might impair underlayment bond and remove sanding dust.
a. Install underlayment reinforcement recommended in writing by manufacturer.
4. Metal Substrates: Mechanically remove, according to manufacturer's written instructions, rust, foreign matter, and other contaminants that might impair underlayment bond. Apply corrosion-resistant coating compatible with underlayment if recommended in writing by underlayment manufacturer.

5. Nonporous Substrates: For ceramic tile, quarry tile, and terrazzo substrates, remove waxes, sealants, and other contaminants that might impair underlayment bond, and prepare surfaces according to manufacturer's written instructions.
6. Adhesion Tests: After substrate preparation, test substrate for adhesion with underlayment according to manufacturer's written instructions.
7. Sound Control Mat and Board: Install sound control materials according to manufacturer's written instructions.
    a. Do not install mechanical fasteners that penetrate through the sound control materials.

C. Application
1. General: Mix and apply underlayment components according to manufacturer's written instructions.
    a. Close areas to traffic during underlayment application and for time period after application recommended in writing by manufacturer.
    b. Coordinate application of components to provide optimum underlayment-to-substrate and intercoat adhesion.
    c. At substrate expansion, isolation, and other moving joints, allow joint of same width to continue through underlayment.
2. Apply primer over prepared substrate at manufacturer's recommended spreading rate.
3. Apply underlayment to produce uniform, level surface.
    a. Apply a final layer without aggregate to product surface.
    b. Feather edges to match adjacent floor elevations.
4. Cure underlayment according to manufacturer's written instructions. Prevent contamination during application and curing processes.
5. Do not install floor coverings over underlayment until after time period recommended in writing by underlayment manufacturer.
6. Remove and replace underlayment areas that evidence lack of bond with substrate, including areas that emit a "hollow" sound when tapped.

D. Protection
1. Protect underlayment from concentrated and rolling loads for remainder of construction period.

END OF SECTION 03 54 16 00

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Task	Specification	Specification Description
03 61 16 00	01 22 16 00	No Specification Required
03 62 13 00	03 48 29 00	Plant-Precast Structural Concrete
03 62 16 00	03 48 29 00	Plant-Precast Structural Concrete
03 64 23 00	03 48 29 00	Plant-Precast Structural Concrete
03 64 26 00	01 22 16 00	No Specification Required

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SECTION 04 01 20 91 - 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 the 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 the 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 the 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 the 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 04 01 20 91

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Task	Specification	Specification Description
04 01 20 91	03 01 30 71	Concrete Rehabilitation
04 01 20 91	01 54 23 00a	Unit Masonry Assemblies

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SECTION 04 01 40 91 - 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".
    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 31 Section "Earth Moving".
    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 the Owner's property.

END OF SECTION 04 01 40 91

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SECTION 04 01 40 91a - STONE RESTORATION AND CLEANING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for stone 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 stone assemblies consisting of stone restoration and cleaning as follows:
   a. Unused anchor removal.
   b. Repairing stone masonry, including replacing whole and partial units.
   c. Painting steel uncovered during the work.
   d. Repointing joints.
   e. Preliminary cleaning, including removing plant growth.
   f. Cleaning exposed stone surfaces.
   g. Stone consolidation treatment.

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. Stone Terminology: ASTM C 119.
6. Face Bedding: Setting of stone with the natural bedding planes (strata) vertical and parallel to the wall plane rather than horizontal or "naturally bedded," which holds bedding planes together by gravity.

D. Preconstruction Testing
1. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on stone units as follows:
   a. Existing Stone: Test each type of existing stone indicated for replacement, according to ASTM C 170 for compressive strength, wet and dry, perpendicular and parallel to rift; ASTM C 99 for modulus of rupture, wet and dry, perpendicular and parallel to rift; and ASTM C 97 for absorption and bulk specific gravity. Carefully remove five existing stones from locations designated by the Owner. Take testing samples from these stones.
   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 Stone: Test each proposed type of replacement stone, according to ASTM C 170 for compressive strength, ASTM C 99 for modulus of rupture, and ASTM C 97 for absorption and bulk specific gravity.

E. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: For the following:

a. Replacement stone units and their jointing, showing relation of existing to new units.
b. Partial replacement stone units (dutchmen).
c. Setting number of each new stone unit and its location on the structure in annotated plans and elevations.
d. Provisions for expansion joints or other sealant joints.
e. Provisions for flashing, lighting fixtures, conduits, and weep holes as required.
f. Replacement and repair anchors, including drilled-in pins. Include details of anchors within individual stone units, with locations of anchors and dimensions of holes and recesses in stone required for anchors, including direction and angle of holes for pins.

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 stone 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 or new stone masonry is not sufficient experience for stone 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 stone restoration and cleaning work is in progress. Supervisors shall not be changed during Project except for causes beyond 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 stone 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. 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. Stone Repair: Prepare sample areas for each type of stone 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: Four stone units replaced.
2) Partial Stone Replacement: Two partial stone replacements (dutchman repairs).
3) Stone Plug Repair: Two stone plug repairs for each type of stone indicated to be plugged.
4) Crack Injection: Apply crack injection in 2 separate areas, each approximately 36 inches (900 mm) long.
5) Patching: Three small holes at least 1 inch (25 mm) in diameter.
b. Repointing: Rake out joints in 2 separate areas, each approximately 36 inches (900 mm) high by 48 inches (1200 mm) wide, for each type of repointing required and repoint one of the areas.
c. Consolidation: Apply stone consolidation treatment to an area approximately 4 sq. ft. (0.4 sq. m).
d. Cleaning: Clean an area approximately 25 sq. ft. (2.3 sq. m) for each type of stone and surface condition.
3. Preinstallation Conference: Conduct conference at Project site.

G. Delivery, Storage, And Handling
1. Deliver stone units to Project site strapped together in suitable packs or pallets or in heavy-duty crates.

2. Deliver each piece of granite 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 stone restoration and cleaning work to be performed according to manufacturers' written instructions and specified requirements.
2. Repair stone 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 stone repair and mortar-joint pointing unless otherwise indicated:
   a. When air temperature is below 40 deg F (4 deg C), heat mortar ingredients, repair materials, and existing stone 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.
4. Hot-Weather Requirements: Protect stone repair and mortar-joint pointing when temperature and humidity conditions produce excessive evaporation of water from mortar and patching 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.
5. For manufactured repair materials, perform work within the environmental limits set by each manufacturer.
6. Clean stone 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.
7. Apply stone consolidation treatment only when surface and air temperatures are between 50 and 90 deg F (10 and 32 deg C) and rain is not expected within 24 hours.

1.2 PRODUCTS

A. Stone Materials
1. Stone: Provide natural building stone of variety, color, texture, grain, veining, finish, size, and shape to match existing stone and with physical properties within 10 percent of those determined from preconstruction testing of selected existing stone.
   a. For existing stone that exhibits a range of colors, texture, grain, veining, finishes, sizes, or shapes, provide stone that proportionally matches that range rather than stone that matches an individual color, texture, grain, veining, finish, size, or shape within that range.
2. Stone: Provide natural building stone of variety, color, texture, grain, veining, finish, and physical properties to match the Owner's sample. Match existing stone in size and shape.
   a. For the Owner's sample that exhibits a range of colors, texture, grain, veining, finishes, sizes, or shapes, provide stone that proportionally matches that range rather than stone that matches an individual color, texture, grain, veining, finish, size, or shape within that range.

3. Quarrying New Stone: Have quarry clearly label the direction of bedding planes when rough stone is quarried, to facilitate cutting stones so that natural bedding planes will be as required in "Cutting New Stone" Paragraph.
4. Cutting New Stone: Regardless of how existing stone was cut and set, cut each new stone so that, when it is set in final position, natural bedding planes are essentially horizontal except for arches, where bedding planes are essentially radial or vertical, but perpendicular to the wall plane.
5. Salvaged Stone: Obtain salvaged stone from the Owner from location shown on Drawings. Clean off residual mortar.

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. Stone Patching Compound: Factory-mixed cementitious product that is custom manufactured for patching stone.
   a. Use formulation that is vapor- and water permeable (equal to or more than the stone), exhibits low shrinkage, has lower modulus of elasticity than the stone units being repaired, and develops high bond strength to all types of stone.
   b. Use formulation having working qualities and retardation control to permit forming and sculpturing where necessary.
   c. Formulate patching compound in colors, textures, and grain to match stone being patched. Provide sufficient number of **OR** not less than three, **as directed**, colors to enable matching each piece of stone.
2. Cementitious Crack Filler: An ultrafine superplasticized grout that can be injected into cracks, is suitable for application to wet or dry cracks, exhibits low shrinkage, and develops high bond strength to all types of stone.
3. Stone-to-Stone Adhesive: 2-part polyester or epoxy-resin stone adhesive with a 15- to 45-minute cure at 70 deg F (21 deg C) or 1-part cementitious stone adhesive, recommended by adhesive manufacturer for type of stone repair indicated, and matching stone color.
4. Stone Consolidation Treatment: Ready-to-use product designed for consolidation of stone that has deteriorated due to weathering and exposure to pollutants. Treatment shall be composed of silicic-ethyl esters, a neutral catalyst, and solvents.
5. Stone Consolidation and Water-Repellent Treatment: Ready-to-use product designed for consolidation and water-repellent treatment of stone that has deteriorated due to weathering and exposure to pollutants. Treatment shall be composed of silicic-ethyl esters, a neutral catalyst, a silane water repellent, and solvents.

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. One-Part Limestone Cleaner: Manufacturer's standard one-part acidic formulation for cleaning limestone.
10. Two-Part Limestone 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. Stone Anchors and Pins: Type and size indicated or, if not indicated, to match existing anchors in size and type. Fabricate anchors and pins from Type 304 **OR** Type 316, **as directed**, stainless steel.
3. 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 stonework 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.
4. 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 applicable.

5. 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.
6. 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.
7. 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 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).
8. 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.
   b. Historic mix, **as directed.**
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 Stone: 1 part white portland cement, 1 part lime, and 6 parts sand **OR** 1 part white portland cement, 2 parts lime, and 6 parts sand **OR** 1 part white portland cement, 6 parts lime, and 12 parts sand, **as directed**.
      1) Add mortar pigments to produce mortar colors required.
   b. Rebuilding (Setting) Mortar: Same as pointing mortar except mortar pigments are not required, **as directed**.

c. Rebuilding (Setting) Mortar: 1 part white portland cement, 1 part lime, and 6 parts sand **OR** 1 part white portland cement, 2 parts lime, and 6 parts sand **OR** 1 part white portland cement, 6 parts lime, and 12 parts sand, **as directed**.
d. 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 Unpolished Stone: Dilute with water to produce hydrofluoric acid content of 3 percent or less, but not greater than that recommended by chemical-cleaner manufacturer.
a. Use only on unpolished granite, unpolished dolomite marble, and siliceous sandstone.
3. Acidic Cleaner for Polished Stone: Dilute with water to concentration demonstrated by testing that does not etch or otherwise damage polished surface, but not greater than that recommended by chemical-cleaner manufacturer.
a. Use only on polished granite and polished dolomite marble.

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 stone 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 stone during winds of sufficient force to spread cleaning solutions to unprotected surfaces.
d. Neutralize and collect alkaline and acid wastes for disposal off the 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 stone 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 stone and other surfaces.
d. Clean mortar splatters from scaffolding at end of each day.
4. Remove gutters and downspouts adjacent to stone and store where indicated during stone restoration and cleaning. Reinstall when stone 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 stone 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 stone.
   b. Where directed, if an item cannot be removed without damaging surrounding stone, 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 stone 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 **OR** Plug, **as directed**, the hole where each item was removed unless directed to remove and replace the stone unit.

C. Stone Removal And Replacement
1. At locations indicated, remove stone that has deteriorated or is damaged beyond repair or is to be reused. Carefully demolish or remove entire units from joint to joint, without damaging surrounding stone, in a manner that permits replacement with full-size units.
2. Support and protect remaining stonework 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 stone or unit masonry backup, rotted wood, rusted metal, and other deteriorated items.
4. Remove in an undamaged condition as many whole stone units as possible.
   a. Remove mortar, loose particles, and soil from stone by cleaning with hand chisels, brushes, and water.
   b. Remove sealants by cutting close to stone with utility knife and cleaning with solvents.
   c. Store stone for reuse. Store off ground, on skids, and protected from weather.
   d. Deliver cleaned stone not required for reuse to the Owner unless otherwise indicated.
5. Clean stone surrounding removal areas by removing mortar, dust, and loose particles in preparation for replacement.
6. Replace removed damaged stone with other removed stone and salvaged stone in good quality, where possible, or with new stone matching existing stone, including size. Do not use broken units unless they can be cut to usable size.
7. Do not allow face bedding of stone. Before setting, inspect to verify that each stone has been cut so that, when it is set in final position, natural bedding planes are essentially horizontal except for arches, where bedding planes are essentially radial or vertical, but perpendicular to the wall. Reject and replace stone with vertical bedding planes except as required for arches, lintels, and copings.
8. Install replacement stone into bonding and coursing pattern of existing stone. If cutting is required, use a motor-driven saw designed to cut stone with clean, sharp, unchipped edges. Finish edges to blend with appearance of edges of existing stone.
   a. Maintain joint width for replacement stone to match existing joints.
   b. Use setting buttons or shims to set stone accurately spaced with uniform joints.
9. Set replacement stone with completely filled bed, head, and collar joints. Butter vertical joints for full width before setting and set units in full bed of mortar unless otherwise indicated. Replace existing anchors with new anchors of size and type indicated.
   a. Tool exposed mortar joints in repaired areas to match joints of surrounding existing stonework.
   b. Rake out mortar used for laying stone before mortar sets and point new mortar joints in repaired area to comply with requirements for repointing existing stone, 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. Painting Steel Uncovered During The Work

1. Inspect steel exposed during stone 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.

E. Partial Stone Replacement
1. Remove defective portion of existing stone unit (backing stone). Carefully remove defective portion of stone by making vertical and horizontal saw cuts at face of backing stone and demolishing defective material to depth required for fitting partial replacement (dutchman).
   a. Make edges of backing stone at cuts smooth and square to each other and to finished surface; essentially rectangular. Make back of removal area flat and parallel to stone face.
   b. Do not overcut at corners and intersections. Hand trim to produce clean sharp corners with no rounding and no damage to existing work to remain.
   c. If existing stone that is to remain becomes damaged, remove damaged area and enlarge partial replacement as required.
2. Remove mortar from joints that abut area of stone removal to same depth as stone was removed. Remove loose mortar particles and other debris from surfaces to be bonded and surfaces of adjacent stone units that will receive mortar by cleaning with stiff-fiber brush.
3. Cut and trim partial replacement to accurately fit area where material was removed from backing stone. Fabricate to size required to produce joints between partial replacement and backing stone of no more than 1/16 inch (1.6 mm) in width, and joints between partial replacement and other stones that match existing joints between stones. Cut partial replacement so that, when it is set in final position, natural bedding planes will match the orientation of bedding planes of the backing stone unless otherwise indicated.
4. Pinning: Before applying adhesive, prepare for mechanical anchorage consisting of 1/4-inch- (6-mm-) diameter, plain **OR** threaded, **as directed**, stainless-steel pins set into 1/4-inch- (6-mm-) diameter holes drilled at a 45-degree downward angle through face of partial replacement and into backing stone. Center and space pins between 3 and 5 inches (75 and 125 mm) apart and at least 2 inches (50 mm) from any edge. Insert pins at least 2 inches (50 mm) into backing stone and 2 inches (50 mm) into partial replacement with end countersunk at least 3/4 inch (19 mm) from exposed face of partial replacement.
5. Concealed Pinning: Before applying adhesive, prepare for concealed mechanical anchorage consisting of 1/4-inch- (6-mm-) diameter, plain **OR** threaded, **as directed**, stainless-steel pins set into 1/4-inch- (6-mm-) diameter holes drilled into backing stone and into, but not through, the partial replacement. Center and space pins between 3 and 5 inches (75 and 125 mm) apart and at least 2 inches (50 mm) from any edge. Insert pins at least 2 inches (50 mm) into backing stone and 2 inches (50 mm) into partial replacement, but no closer than 3/4 inch (19 mm) from exposed face of partial replacement.
6. Apply stone-to-stone adhesive to comply with adhesive manufacturer's written instructions. Coat bonding surfaces of backing stone and partial replacement, completely filling all crevices and voids.
7. Apply partial replacement while adhesive is still tacky and hold securely in place until adhesive has cured. Use shims, clamps, wedges, or other devices as necessary to align face of partial replacement with face of backing stone.
8. Clean adhesive residue from exposed surfaces and patch chipped areas and exposed drill holes as specified in "Stone Patching" Article.

F. Stone Plug Repair
1. Remove cylindrical piece of damaged stone by core-drilling perpendicular to stone surface.

2. Prepare a replacement plug by core-drilling replacement stone. Use a drill sized to produce a core that will fit into hole drilled in damaged stone with only minimum gap necessary for adhesive. Cut and install plug so that, when it is set in final position, natural bedding planes will match the orientation of bedding planes of the backing stone unless otherwise indicated.
3. Apply stone-to-stone adhesive to comply with adhesive manufacturer's written instructions. Coat bonding surfaces of existing stone and plug, completely filling all crevices and voids.
4. Apply plug while adhesive is still tacky and hold securely in place until adhesive has cured.
5. Clean adhesive residue from exposed surfaces.

G. Stone-Fragment Repair
1. Carefully remove cracked or fallen stone fragment indicated to be repaired. Reuse only stone fragment that is in sound condition.
2. Remove soil, loose particles, mortar, and other debris or foreign material, from fragment surfaces to be bonded and from parent stone where fragment had broken off, by cleaning with stiff-fiber brush.
3. Pinning: Before applying adhesive, prepare for mechanical anchorage consisting of 1/4-inch- (6-mm-) diameter, plain **OR** threaded, **as directed**, stainless-steel pins set into 1/4-inch- (6-mm-) diameter holes drilled at a 45-degree downward angle through face of fragment and into parent stone. Center and space pins between 3 and 5 inches (75 and 125 mm) apart and at least 2 inches (50 mm) from any edge. Insert pins at least 2 inches (50 mm) into parent stone and 2 inches (50 mm) into fragment with end countersunk at least 3/4 inch (19 mm) from exposed face of fragment.
4. Concealed Pinning: Before applying adhesive, prepare for concealed mechanical anchorage consisting of 1/4-inch- (6-mm-) diameter, plain **OR** threaded, **as directed**, stainless-steel pins set into 1/4-inch- (6-mm-) diameter holes drilled into parent stone and into, but not through, the fragment. Center and space pins between 3 and 5 inches (75 and 125 mm) apart and at least 2 inches (50 mm) from any edge. Insert pins at least 2 inches (50 mm) into parent stone and 2 inches (50 mm) into fragment, but no closer than 3/4 inch (19 mm) from exposed face of fragment.
5. Apply stone-to-stone adhesive to comply with adhesive manufacturer's written instructions. Coat bonding surfaces of fragment and parent stone, completely filling all crevices and voids.
6. Fit stone fragment onto parent stone while adhesive is still tacky and hold fragment securely in place until adhesive has cured. Use shims, clamps, wedges, or other devices as necessary to align face of fragment with face of parent stone.
7. Clean adhesive residue from exposed surfaces and patch chipped areas and exposed drill holes as specified in "Stone Patching" Article.

H. Crack Injection
1. General: Comply with cementitious crack-filler manufacturer's written instructions.
2. Drill 1/4-inch- (6-mm-) diameter injection holes as follows:
   a. Transverse Cracks Less Than 3/8 inch (9 mm) Wide: Drill holes through center of crack at 12 to 18 inches (300 to 500 mm) o.c.
   b. Transverse Cracks More Than 3/8 inch (9 mm) Wide: Drill holes through center of crack at 18 to 36 inches (500 to 900 mm) o.c.
   c. Delaminations: Drill holes at approximately 18 inches (500 mm) o.c. both vertically and horizontally.
   d. Drill holes 2 inches (50 mm) deep. Where possible drill holes in mortar joints.
3. Clean out drill holes and cracks with compressed air and water. Remove dirt and organic matter, loose material, sealants, and failed crack repair materials.
4. Place plastic injection ports in drilled holes and seal face of cracks between injection ports with clay or other nonstaining, removable plugging material. Leave openings at upper ends of cracks for air release.
5. Inject cementitious crack filler through ports sequentially, beginning at one end of area and working to opposite end; where possible, begin at lower end of injection area and work upward. Inject filler until it extrudes from adjacent ports. After port has been injected, plug with clay or

other suitable material and begin injecting filler at adjacent port, repeating process until all ports have been injected.

6. Clean cementitious crack filler from face of stone before it sets by scrubbing with water.
7. After cementitious crack filler has set, remove injection ports, plugging material, and excess filler. Patch injection holes and surface of cracks as specified in "Stone Patching" Article.

I. Stone Patching

1. Patch the following stone 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. Remove deteriorated material and remove adjacent material that has begun to deteriorate. 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.
4. Mask adjacent mortar joint or rake out for repointing if patch will extend to edge of stone unit.
5. Mix patching compound in individual batches to match each stone unit being patched. Combine one or more colors of patching compound, as needed, to produce exact match.
6. Brush-coat stone surfaces with slurry coat of patching compound according to manufacturer's written instructions.
7. 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.
   a. Trowel, scrape, or carve surface of patch to match texture and surrounding surface plane or contour of the stone. Shape and finish surface before or after curing, as determined by testing, to best match existing stone.
   b. Build patch up 1/4 inch (6 mm) above surrounding stone and carve surface to match adjoining stone after patching compound has hardened.
8. Keep each layer damp for 72 hours or until patching compound has set.
9. Remove and replace patches with hairline cracks or that show separation from stone at edges, and those that do not match adjoining stone in color or texture.

J. Cleaning Stone, 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 stone 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 stone.
      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 stone surfaces.
4. Water Application Methods:
   a. Water-Soak Application: Soak stone 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 stone and apply water in horizontal back and forth sweeping motion, overlapping previous strokes to produce uniform coverage.
5. Steam Cleaning: Apply steam to stone surfaces at the very low pressures indicated for each type of stonework. Hold nozzle at least 6 inches (150 mm) from surface of stone 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 stone 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), **unless directed otherwise**. 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.

K. Preliminary Cleaning
1. Removing Plant Growth: Completely remove visible plant, moss, and shrub growth from stone surfaces. Carefully remove plants, creepers, and vegetation by cutting at roots and allowing to dry as long as possible before removal. Remove loose soil or debris from open 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 stone with sharp chisel. Do not scratch or chip stone 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.

L. 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 stone 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 stone, 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 stone 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 stone, 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 stone 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.

M. Cleaning Stonework
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 stone 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 stone with cold **OR** hot, **as directed**, water applied by low-pressure spray.

b. Scrub stone 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 stone 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 stone 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 stone 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 stone 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 stone 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 stone with cold **OR** hot, **as directed**, water applied by low-pressure spray.
   b. Apply cleaner to stone 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 stone with cold water applied by low-pressure spray.
   b. Apply cleaner to stone 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 steam cleaning.

10. One-Part Limestone Chemical Cleaning:
    a. Wet stone with cold **OR** hot, **as directed**, water applied by low-pressure spray.
    b. Apply cleaner to stone by brush or low-pressure spray. Let cleaner remain on surface for period recommended by chemical-cleaner manufacturer.
    c. Immediately repeat application of one-part limestone cleaner as indicated above over the same area.
    d. Rinse with cold **OR** hot, **as directed**, water applied by medium-pressure spray to remove chemicals and soil.
11. Two-Part Limestone Chemical Cleaning:
    a. Wet stone with cold **OR** hot, **as directed**, water applied by low-pressure spray.
    b. Apply alkaline prewash cleaner to stone 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 stone 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.

N. Repointing Stonework
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, no matter how many passes it takes to remove, **as directed.**
    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 stone surfaces within raked-out joints to provide reveals with square backs and to expose stone for contact with pointing mortar. Brush, vacuum, or flush joints to remove dirt and loose debris.
    c. Do not spall edges of stone units or widen joints. Replace or patch damaged stone 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 stone, 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 stone has worn or rounded edges, slightly recess finished mortar surface below face of stone to avoid widened joint faces. Take care not to spread mortar beyond joint edges onto exposed stone 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 stonework 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 stone, allow mortar to harden at least 30 days before beginning cleaning work.

O. Stone Consolidation Treatment
1. Apply treatment to clean, dry surfaces according to manufacturer's written instructions. Remove areas of blind exfoliation, delamination, and flaking before applying.
2. Apply in cycles to small sections of stonework, not more than 100 sq. ft. (9 sq. m) in area. Each cycle shall consist of 3 successive saturating applications, applied at 5- to 15-minute intervals depending on drying conditions.
3. Apply by low-pressure spray to point of rejection in each application. Apply from bottom of section to top.
4. Apply 3 cycles, allowing treated surface to dry for 60 to 90 minutes between cycles.
5. Protect treated surfaces from rain for 48 hours after treatment.
6. Allow treated surfaces to dry for at least 21 days before repointing, patching, or applying water repellents or sealants.

P. Final Cleaning
1. After mortar has fully hardened, thoroughly clean exposed stone 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 nonstone 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 04 01 40 91a

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Task	Specification	Specification Description
04 01 40 91	04 01 20 91	Clay Masonry Restoration And Cleaning
04 01 50 52	04 01 20 91	Clay Masonry Restoration And Cleaning
04 05 13 26	01 54 23 00a	Unit Masonry Assemblies
04 05 16 26	01 54 23 00a	Unit Masonry Assemblies
04 05 19 13	01 54 23 00a	Unit Masonry Assemblies
04 05 19 16	01 54 23 00a	Unit Masonry Assemblies
04 05 23 13	01 54 23 00a	Unit Masonry Assemblies
04 05 23 16	01 22 16 00	No Specification Required
04 05 23 16	07 62 00 00	Sheet Metal Flashing And Trim
04 05 26 00	01 54 23 00	Scaffolding Tubular Steel
04 21 13 00	01 54 23 00a	Unit Masonry Assemblies
04 21 26 00	01 54 23 00a	Unit Masonry Assemblies
04 22 23 13	01 54 23 00a	Unit Masonry Assemblies
04 22 23 23	01 54 23 00a	Unit Masonry Assemblies
04 22 23 26	01 54 23 00a	Unit Masonry Assemblies
04 22 23 29	01 54 23 00a	Unit Masonry Assemblies
04 22 23 31	01 54 23 00a	Unit Masonry Assemblies

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SECTION 04 23 13 00 - 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
a. Glass block set in mortar.
b. Glass block set in silicone sealant.
c. 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. Action Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittals:
a. Product Data for Credit IEQ 4.1: For sealants used inside the weatherproofing system, documentation including printed statement of VOC content.
b. Laboratory Test Reports for Credit IEQ 4: For sealants used inside the weatherproofing system, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
3. Shop Drawings: Show fabrication and installation details for glass unit masonry, including vertical and horizontal coursing, anchors, reinforcement, and expansion strips and glass-block grid systems.
4. Provide Samples for each form, pattern, and color of glass block and color of joint material and glass-block grid material indicated or selected by the Owner.
5. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, documentation including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

E. Informational Submittals
1. Qualification Data: For qualified professional engineer.

F. 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** IBC Standard 715, **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**.

G. 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.

H. Project Conditions
1. 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.
2. 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.

I. Sequencing And Scheduling
1. Sequence and coordinate completion of glass unit masonry assemblies so sealants can be installed immediately after mortar has attained final set.

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. 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.
a. Square-Block Size: 5-3/4 inches (146 mm) **OR** 7-3/4 inches (197 mm) **OR** 11-3/4 inches (299 mm) **as directed**, square by 1-1/2 inches (38 mm) **OR** 3 inches (76 mm) thick, actual size, **as directed**.
b. Rectangular-Block Size: 3 by 7-3/4 inches (76 by 197 mm) **OR** 5-3/4 by 7-3/4 inches (146 by 197 mm), **as directed by** 1-1/2 inches (38 mm) **OR** 3 inches (76 mm) thick, actual size, **as directed**.
3. Glass Paver Block: Transparent, colorless, pressed glass units, with a smooth top surface and a decorative, light-diffusing, patterned bottom surface; **6 inches (152 mm) square by 1 inch (25 mm) OR 4-3/4 inches (120 mm) square by 1-9/16 inches (40 mm) OR 6-5/16 inches (160 mm) square by 1-3/16 inches (30 mm) OR 7-1/2 inches (190 mm) square by 1-1-15/16**

inches (50 mm) OR 7-1/2 inches (190 mm) square by 2-3/4 inches (70 mm) OR 7-7/8 inches (200 mm) square by 7/8 inch (22 mm) OR 7-7/8 inches (200 mm) square by 1-15/16 inches (50 mm) OR 4-5/8 inches (117 mm) in diameter by 2-3/8 inches (60 mm) thick, actual size, **as directed.**

a.

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 or white cement as required 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. Mortarless Installation System: System of aluminum or plastic perimeter framing, anchors, and spacers designed for installing glass block with sealant-filled joints.
4. 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.
5. 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.
6. 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.
7. 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.
8. Asphalt Emulsion: Cold-applied asphalt emulsion complying with ASTM D 1187 or ASTM D 1227.
9. 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.
10. Plastic-Foam Expansion Strips: Polyethylene foam complying with requirements of glass-block manufacturer; 3/8 inch (9 mm) thick by 4 inches (100 mm) **OR** 3-1/2 inches (89 mm) **OR** 2-1/2 inches (63 mm) wide, **as directed.**
   a. Use plastic-foam expansion strips for non-fire-rated assemblies **OR** fire-rated and non-fire-rated assemblies, **as directed**.
11. 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**.
a. Pigments shall not exceed 10 percent of portland cement by weight.
b. Pigments shall not exceed 5 percent of masonry cement by weight.
c. Mix to match sample.

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.
a. Mix to match sample.

1.3 EXECUTION

A. Examination
1. Examine sills, jambs, and heads surrounding glass unit masonry assemblies for compliance with requirements for installation tolerances and other conditions affecting performance.
a. Proceed with installation only after unsatisfactory conditions have been corrected.

B. 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 1/8 inch in 10 feet (3 mm in 3 m) , 1/4 inch in 20 feet (6 mm in 6 m) or 1/2 inch in 40 feet (12 mm in 12 m) or more.
    c. Variation of Location in Plan: For location of elements in plan do not vary from that indicated by more than plus or minus 1/4 inch (6 mm).
    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).
    e. For faces of adjacent exposed units, do not vary from flush alignment by more than 1/16 inch (1.5 mm).

C. Installing Glass Block With Sealant
1. General: Install mortarless glass-block systems according to manufacturer's written instructions.
   a. Fasten frames and anchors or clips securely to surrounding construction.
   b. Shim starting track as needed to make it level.
   c. Adhere glass block to starting track and spacers with silicone sealant.
2. After glass blocks are installed, apply sealant to completely fill channel around each glass block, and tool flush with exterior surface. Remove excess sealant and smears.

D. 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.

E. 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 04 23 13 00

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Task	Specification	Specification Description
04 23 13 00	01 54 23 00a	Unit Masonry Assemblies

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SECTION 04 41 00 00 - 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 04 41 00 00

SECTION 04 41 00 00a - 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 Final Completion, remove protective coverings and clean surfaces.

END OF SECTION 04 41 00 00a

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Task	Specification	Specification Description
04 42 43 00	04 41 00 00	Dimension Stone Cladding
04 42 43 00	04 01 40 91	Stone Masonry
04 42 43 00	04 41 00 00a	Interior Stone Facing
04 43 16 00	01 22 16 00	No Specification Required
04 43 16 00	04 41 00 00	Dimension Stone Cladding
04 43 16 00	04 01 40 91	Stone Masonry
04 43 16 00	04 41 00 00a	Interior Stone Facing

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SECTION 04 72 00 00 - 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 1064, 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 "Exterior 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 04 72 00 00

Task	Specification	Specification Description
04 72 00 00	03 48 29 00	Plant-Precast Structural Concrete
04 72 00 00	01 54 23 00a	Unit Masonry Assemblies

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Task	Specification	Specification Description
05 05 19 00	01 22 16 00	No Specification Required
05 05 19 00	05 50 00 00	Metal Fabrications

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SECTION 05 05 23 00 - 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, **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 the 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: 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 05 05 23 00

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Task	Specification	Specification Description
05 05 23 00	01 22 16 00	No Specification Required
05 05 23 00	05 50 00 00	Metal Fabrications

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SECTION 05 12 23 00 - 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 "Thermal 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 Final Completion.

END OF SECTION 05 12 23 00

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Task	Specification	Specification Description
05 12 23 00	05 05 23 00	Structural Steel
05 12 23 00	05 50 00 00	Metal Fabrications
05 13 00 00	05 50 00 00	Metal Fabrications

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SECTION 05 14 16 00 - STRUCTURAL ALUMINUM

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for structural aluminum. 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. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-aluminum fabricator to withstand loads indicated and comply with other information and restrictions indicated.
a. Select and complete connections using schematic details indicated and in accordance with minimum mechanical properties and applicable buckling formula constants published by The Aluminum Association's "Aluminum Construction Manual."

C. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Show fabrication of structural-aluminum components.
3. Welding certificates.
4. Mill test reports.
5. Source quality-control test reports.

D. Quality Assurance
1. Fabricator Qualifications: A qualified fabricator who has provided successful structural aluminum fabrication for a minimum of 5 years.
2. Welding: Qualify procedures and personnel according to AWS D1.2, "Structural Welding Code--Aluminum."
3. Comply with applicable provisions of The Aluminum Association's "Aluminum Construction Manual."
4. Preinstallation Conference: Conduct conference at Project site.

1.2 PRODUCTS

A. Structural-Aluminum Materials
1. W-Shapes, Channels, Angles, Plate and Bar, Cold-Formed Hollow Structural Sections, and Pipe: Structural shapes indicating minimum mechanical properties and applicable buckling formula constants are listed in Table 3.3.1, Section 3, of "Specifications for Aluminum Structures," Construction Manual Series Section 1, as published by The Aluminum Association. Applicable ASTM Designations include B209, B210, B211, B221, B241, B247, B308, and B429
2. Allowable Stresses:
a. Building Type Structures: Basic allowable tensile stresses for buildings, structural supports for highway signs, luminaires, traffic signals and similar structures shall be the lesser of the minimum yield strength divided by a factor of safety of 1.65, or the minimum ultimate tensile strength divided by a factor of safety of 1.95. Other allowable stresses for buildings and similar structures shall be based upon the factors of safety shown in Table 3.3.3 of "Specifications for Aluminum Structures."
b. Bridge Type Structures: Basic allowable tensile stresses for bridge type structures shall be the lesser of the minimum yield strength divided by a factor of safety of 1.85, or the minimum ultimate tensile strength divided by a factor of safety of 2.2. Other allowable

stresses for bridge and similar structures shall be based upon the factors of safety shown in Table 3.3.3 of “Specifications for Aluminum Structures.”

3. Welding Electrodes: Comply with AWS requirements.

B. Bolts and Connectors
   1. Rivets and Bolts:
      a. Aluminum alloys used for rivets and bolts shall be those listed in Tables 5.1.1b and 5.1.1c of “Specifications for Aluminum Structures.”
      b. Nuts:
         1) For bolts 1/4” and smaller: Alloy 2024-T4. For improved corrosion resistance, apply 0.0002” minimum thickness anodic coating.
         2) For bolts larger than 1/4”: 6061-T6 or 6262-T9.
         3) Flat Washers: Alclad 2024-T4.
         4) Spring Lock Washers: Alloy 7075-T6.
      c. Steel Bolts: Hot-dip galvanized, electro-galvanized, cadmium plated or aluminized steel bolts and Series 300 stainless steel bolts may be used instead of aluminum bolts. Plating thickness on steel shall be adequate to provide corrosion protection for the anticipated environ and service life.

C. Grout
   1. Cement Grout: Portland cement, ASTM C 150, Type I; and clean, natural sand, ASTM C 404, Size No. 2. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
   2. 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.
   3. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

D. Fabrication
   1. Structural Aluminum: Fabricate and assemble in shop to greatest extent possible. Fabricate according to The Aluminum Association’s “Aluminum Construction Manual.”

E. Source Quality Control
   1. Engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports. Comply with testing and inspection requirements of Part 1.3, Article "Field Quality Control."
   2. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

1.3 EXECUTION

A. Erection
   1. Examination: Verify elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments, with erector present, for compliance with requirements.
      a. Proceed with installation only after unsatisfactory conditions have been corrected.
   2. Set structural aluminum accurately in locations and to elevations indicated and according to The Aluminum Association’s “Aluminum Construction Manual.”
   3. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.
      a. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.

b. Weld plate washers to top of base plate.
c. Snug-tighten 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 base or bearing plate before packing with grout.
d. Promptly pack grout solidly between bearing surfaces and base or bearing 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.

4. Maintain erection tolerances of structural aluminum within The Aluminum Association's "Aluminum Construction Manual."

B. Field Connections
1. Bolts: Shop install bolts according to The Aluminum Association's "Aluminum Construction Manual" for type of bolt and type of joint specified.
2. Weld Connections: Comply with AWS D1.2 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
a. Comply with The Aluminum Association's "Aluminum Construction Manual" for bearing, adequacy of temporary connections, and alignment.

C. 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: Shop-bolted connections shall be tested and inspected according to The Aluminum Association's "Aluminum Construction Manual."
3. Welded Connections: Field welds shall be visually inspected according to AWS D1.2.
a. In addition to visual inspection, field welds shall be tested according to AWS D1.2.
4. Correct deficiencies in Work that test reports and inspections indicate are not in compliance with the Contract Documents.

END OF SECTION 05 14 16 00

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Task	Specification	Specification Description
05 14 16 00	01 22 16 00	No Specification Required

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SECTION 05 15 16 00 - 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 "Hollow Metal 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 Final 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 05 15 16 00

Task	Specification	Specification Description
05 15 16 00	05 50 00 00	Metal Fabrications
05 15 19 00	05 15 16 00	Ornamental Metal
05 41 00 00	05 12 23 00	Cold-Formed Metal Framing
05 43 00 00	01 22 16 00	No Specification Required
05 43 00 00	05 12 23 00	Cold-Formed Metal Framing
05 43 00 00	05 50 00 00	Metal Fabrications

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SECTION 05 50 00 00 - 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** 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. the 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 05 50 00 00

SECTION 05 51 13 00 - 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 1064/A 1064M, 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 1064/A 1064M 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 "Decorative Metal 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 05 51 13 00

SECTION 05 51 13 00a - 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 05 51 13 00a

Task	Specification	Specification Description
05 51 13 00	05 50 00 00	Metal Fabrications
05 51 19 00	05 50 00 00	Metal Fabrications
05 51 19 00	05 51 13 00	Metal Stairs
05 51 19 00	05 51 13 00a	Fabricated Spiral Stairs
05 51 33 13	05 50 00 00	Metal Fabrications
05 51 33 13	05 52 13 00	Pipe And Tube Railings
05 51 33 16	05 50 00 00	Metal Fabrications
05 51 33 23	05 50 00 00	Metal Fabrications
05 51 33 23	05 52 13 00	Pipe And Tube Railings

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SECTION 05 52 13 00 - 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 Final Completion.

END OF SECTION 05 52 13 00

Task	Specification	Specification Description
05 52 13 00	05 50 00 00	Metal Fabrications

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SECTION 05 53 13 00 - GRATINGS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for gratings. 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 bar gratings.
b. Expanded-metal gratings.
c. Formed-metal plank gratings.
d. Extruded-aluminum plank gratings.
e. Glass-fiber-reinforced plastic gratings.
f. Metal frames and supports for gratings.

C. Performance Requirements
1. Delegated Design: Design gratings, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Structural Performance: Gratings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.
a. Loads in subparagraphs below are examples based on the 2006 International Building Code and ASCE/SEI 7. Adjust to local Project requirements.
1) Floors (light manufacturing): Uniform load of 125 lbf/sq. ft. (6.00 kN/sq. m) or concentrated load of 2000 lbf (8.90 kN), whichever produces the greater stress.
2) Floors (heavy manufacturing): Uniform load of 250 lbf/sq. ft. (11.97 kN/sq. m) or concentrated load of 3000 lbf (13.40 kN), whichever produces the greater stress.
3) Walkways and Elevated Platforms Other Than Exits: Uniform load of 60 lbf/sq. ft. (2.87 kN/sq. m).
4) Walkways and Elevated Platforms Used as Exits: Uniform load of 100 lbf/sq. ft. (4.79 kN/sq. m).
5) Sidewalks and Vehicular Driveways, Subject to Trucking: Uniform load of 250 lbf/sq. ft. (11.97 kN/sq. m) or concentrated load of 8000 lbf (35.60 kN), whichever produces the greater stress.
6) Limit deflection to L/240 **OR** L/360, **as directed**, or 1/4 inch (6.4 mm), whichever is less.
3. Seismic Performance: Provide gratings capable of withstanding the effects of earthquake motions determined according to ASCE/SEI 7.

D. Submittals
1. Product Data: For the following:
a. Formed-metal plank gratings.
b. Extruded-aluminum plank gratings.
c. Glass-fiber-reinforced plastic gratings.
d. Clips and anchorage devices for gratings.
e. 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, sections, details, and attachments to other work.

4. 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.
5. Qualification Data: For qualified professional engineer.
6. Mill Certificates: Signed by manufacturers of stainless-steel sheet certifying that products furnished comply with requirements.
7. Welding certificates.
8. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

E. Quality Assurance
1. Metal Bar Grating Standards: Comply with NAAMM MBG 531, "Metal Bar Grating Manual" and NAAMM MBG 532, "Heavy-Duty Metal Bar Grating Manual."
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."

F. Project Conditions
1. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings 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 for gratings, grating frames, and supports. 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. 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 Bars for Bar Gratings: ASTM A 36/A 36M or steel strip, ASTM A 1011/A 1011M or ASTM A 1018/A 1018M.
4. Wire Rod for Bar Grating Crossbars: ASTM A 510 (ASTM A 510M).
5. Uncoated Steel Sheet: ASTM A 1011/A 1011M, structural steel, Grade 30 (Grade 205).
6. Galvanized-Steel Sheet: ASTM A 653/A 653M, structural quality, Grade 33 (Grade 230), with G90 (Z275) coating.
7. Expanded-Metal Carbon Steel: ASTM F 1267, Class 1.
8. Expanded-Metal Galvanized Steel: ASTM F 1267, Class 2, Grade A.
9. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304 **OR** Type 316, **as directed**.
10. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304 **OR** Type 316, **as directed**.
11. Expanded-Metal Stainless Steel: ASTM F 1267, Class 3, made from stainless-steel sheet, ASTM A 666, Type 304 **OR** Type 316, **as directed**.

B. Aluminum

1. Aluminum, General: Provide alloy and temper recommended by aluminum producer for type of use 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 Shapes: ASTM B 221 (ASTM B 221M), alloys as follows:
   a. 6061-T6 or 6063-T6, for bearing bars of gratings and shapes.
   b. 6061-T1, for grating crossbars.
3. Aluminum Sheet: ASTM B 209 (ASTM B 209M), Alloy 5052-H32.

C. 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.
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. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts, and, where indicated, flat washers; ASTM F 593 (ASTM F 738M) for bolts and ASTM F 594 (ASTM F 836M) for nuts, Alloy Group 1 (A1) **OR** Group 2 (A4), **as directed**.
4. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.
   a. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
5. Plain Washers: Round, ASME B18.22.1 (ASME B18.22M).
6. Lock Washers: Helical, spring type, ASME B18.21.1 (ASME B18.21.2M).
7. 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).

D. Miscellaneous Materials
1. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy that is 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.

E. Fabrication
1. Shop Assembly: Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. 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 material 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 from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.
4. Fit exposed connections accurately together to form hairline joints.
5. Welding: Comply with AWS recommendations and 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.
6. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.
   a. Fabricate toeplates to fit grating units and weld to units in shop unless otherwise indicated.
      OR
      Fabricate toeplates for attaching in the field.
   b. Toeplate Height: 4 inches (100 mm) unless otherwise indicated.

F. Metal Bar Gratings
1. Welded Steel Grating:
   a. Bearing Bar Spacing: 7/16 or 1/2 inch (11 or 13 mm) **OR** 11/16 inch (17 mm) **OR** 15/16 inch (24 mm) **OR** 1-3/16 inches (30 mm) **OR** 1-3/8 inches (35 mm) **OR** 1-7/8 inches (48 mm) **OR** 2-3/8 inches (60 mm), **as directed**, o.c.
   b. Bearing Bar Depth: 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** 1-1/4 inches (32 mm) **OR** 1-1/2 inches (38 mm) **OR** 1-3/4 inches (44 mm) **OR** 2 inches (51 mm) **OR** 2-1/4 inches (57 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) **OR** 4-1/2 inches (114 mm) **OR** 5 inches (127 mm) **OR** As required to comply with structural performance requirements, **as directed**.
   c. Bearing Bar Thickness: 1/8 inch (3.2 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/4 inch (6.4 mm) **OR** 3/8 inch (9.5 mm) **OR** As required to comply with structural performance requirements, **as directed**.
   d. Crossbar Spacing: 2 inches (51 mm) **OR** 4 inches (102 mm), **as directed**, o.c.
   e. Grating Mark W-11-4 (1 x 3/16) STEEL: 1-by-3/16-inch (25-by-4.8-mm) bearing bars at 11/16 inch (18 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
   f. Grating Mark W-15-4 (1 x 1/8) STEEL: 1-by-1/8-inch (25-by-3.2-mm) bearing bars at 15/16 inch (24 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
   g. Grating Mark W-19-4 (1-1/4 x 3/16) STEEL: 1-1/4-by-3/16-inch (32-by-4.8-mm) bearing bars at 1-3/16 inches (30 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
   h. Grating Mark W-19-4 (1-1/2 x 3/16) STEEL: 1-1/2-by-3/16-inch (38-by-4.8-mm) bearing bars at 1-3/16 inches (30 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
   i. Grating Mark W-19-4 (2 x 1/4) STEEL: 2-by-1/4-inch (51-by-6.4-mm) bearing bars at 1-3/16 inches (30 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
   j. Grating Mark W-30-4 (5 x 3/8) STEEL: 5-by-3/8-inch (127-by-9.5-mm) bearing bars at 1-7/8 inches (60 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
   k. Grating Mark: As indicated.
   l. Traffic Surface: Plain **OR** Serrated **OR** Knurled **OR** Applied abrasive finish consisting of aluminum-oxide aggregate in an epoxy-resin adhesive **OR** As indicated, **as directed**.
   m. Steel Finish: Shop primed **OR** Hot-dip galvanized with a coating weight of not less than 1.8 oz./sq. ft. (550 g/sq. m) of coated surface, **as directed**.
2. Pressure-Locked Steel Grating: Fabricated by pressing rectangular flush-top crossbars into slotted bearing bars or swaging crossbars between bearing bars.

a. Bearing Bar Spacing: 7/16 or 1/2 inch (11 or 13 mm) **OR** 11/16 inch (17 mm) **OR** 15/16 inch (24 mm) **OR** 1-3/16 inches (30 mm), **as directed**, o.c.
b. Bearing Bar Depth: 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** 1-1/4 inches (32 mm) **OR** 1-1/2 inches (38 mm) **OR** 1-3/4 inches (44 mm) **OR** 2 inches (51 mm) **OR** 2-1/4 inches (57 mm) **OR** 2-1/2 inches (64 mm) **OR** As required to comply with structural performance requirements, **as directed**.
c. Bearing Bar Thickness: 1/8 inch (3.2 mm) **OR** 3/16 inch (4.8 mm) **OR** As required to comply with structural performance requirements, **as directed**.
d. Crossbar Spacing: 2 inches (51 mm) **OR** 4 inches (102 mm), **as directed**, o.c.
e. Grating Mark P-11-4 (1 x 3/16) STEEL: 1-by-3/16-inch (25-by-4.8-mm) bearing bars at 11/16 inch (18 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
f. Grating Mark P-15-4 (1-1/4 x 1/8) STEEL: 1-1/4-by-1/8-inch (32-by-3.2-mm) bearing bars at 15/16 inch (24 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
g. Grating Mark P-19-4 (1-1/2 x 3/16) STEEL: 1-1/2-by-3/16-inch (38-by-4.8-mm) bearing bars at 1-3/16 inches (30 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
h. Grating Mark: As indicated.
i. Traffic Surface: Plain **OR** Serrated **OR** Knurled **OR** Applied abrasive finish consisting of aluminum-oxide aggregate in an epoxy-resin adhesive **OR** As indicated, **as directed**.
j. Steel Finish: Shop primed **OR** Hot-dip galvanized with a coating weight of not less than 1.8 oz./sq. ft. (550 g/sq. m) of coated surface, **as directed**.

3. Riveted Steel Grating:
   a. Bearing Bar Spacing: 3/4 inch (19 mm) **OR** 1-1/8 inches (29 mm) **OR** 2-5/16 inches (59 mm), **as directed**, clear.
   b. Bearing Bar Depth: 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** 1-1/4 inches (32 mm) **OR** 1-1/2 inches (38 mm) **OR** 1-3/4 inches (44 mm) **OR** 2 inches (51 mm) **OR** 2-1/4 inches (57 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) **OR** 4-1/2 inches (114 mm) **OR** 5 inches (127 mm) **OR** As required to comply with structural performance requirements, **as directed**.
   c. Bearing Bar Thickness: 1/8 inch (3.2 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/4 inch (6.4 mm) **OR** 3/8 inch (9.5 mm) **OR** As required to comply with structural performance requirements, **as directed**.
   d. Rivet Spacing: 3-1/2 inches (89 mm) **OR** 5 inches (127 mm) **OR** 7 inches (178 mm), **as directed**, o.c. along bearing bar.
   e. Grating Mark R-12-3-1/2 (1 x 1/8) STEEL: 1-by-1/8-inch (25-by-3.2-mm) bearing bars with 3/4-inch (19-mm) clear space between bearing bars, and rivets at 3-1/2 inches (89 mm) o.c. along bearing bar.
   f. Grating Mark R-18-7 (1-1/2 x 3/16) STEEL: 1-1/2-by-3/16-inch (38-by-4.8-mm) bearing bars with 1-1/8-inch (29-mm) clear space between bearing bars, and rivets at 7 inches (178 mm) o.c. along bearing bar.
   g. Grating Mark R-37-5 (4 x 1/4) STEEL: 4-by-1/4-inch (102-by-6.4-mm) bearing bars with 2-5/16-inch (59-mm) clear space between bearing bars, and rivets at 5 inches (127 mm) o.c. along bearing bar.
   h. Grating Mark R-37-5 (5 x 3/8) STEEL: 5-by-3/8-inch (127-by-9.5-mm) bearing bars with 2-5/16-inch (59-mm) clear space between bearing bars, and rivets at 5 inches (127 mm) o.c. along bearing bar.
   i. Grating Mark: As indicated.
   j. Traffic Surface: Plain **OR** Serrated **OR** Knurled **OR** Applied abrasive finish consisting of aluminum-oxide aggregate in an epoxy-resin adhesive **OR** As indicated, **as directed**.
   k. Steel Finish: Shop primed **OR** Hot-dip galvanized with a coating weight of not less than 1.8 oz./sq. ft. (550 g/sq. m) of coated surface, **as directed**.
4. Pressure-Locked, Stainless-Steel Grating: Fabricated by pressing rectangular flush-top crossbars into slotted bearing bars or swaging crossbars between bearing bars, **as directed**.
   a. Bearing Bar Spacing: 7/16 or 1/2 inch (11 or 13 mm) **OR** 11/16 inch (17 mm) **OR** 15/16 inch (24 mm) **OR** 1-3/16 inches (30 mm) **OR** 1-3/8 inches (35 mm) **OR** 1-7/8 inches (48 mm) **OR** 2-3/8 inches (60 mm), **as directed**, o.c.

b. Bearing Bar Depth: 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** 1-1/4 inches (32 mm) **OR** 1-1/2 inches (38 mm) **OR** 1-3/4 inches (44 mm) **OR** 2 inches (51 mm) **OR** 2-1/4 inches (57 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) **OR** 4-1/2 inches (114 mm) **OR** 5 inches (127 mm) **OR** As required to comply with structural performance requirements, **as directed**.
c. Bearing Bar Thickness: 1/8 inch (3.2 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/4 inch (6.4 mm) **OR** 3/8 inch (9.5 mm) **OR** As required to comply with structural performance requirements, **as directed**.
d. Crossbar Spacing: 2 inches (51 mm) **OR** 4 inches (102 mm), **as directed**, o.c.
e. Grating Mark P-11-4 (1 x 3/16) STAINLESS STEEL: 1-by-3/16-inch (25-by-4.8-mm) bearing bars at 11/16 inch (18 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
f. Grating Mark P-15-2 (1 x 1/8) STAINLESS STEEL: 1-by-1/8-inch (25-by-3.2-mm) bearing bars at 15/16 inch (24 mm) o.c., and crossbars at 2 inches (51 mm) o.c.
g. Grating Mark P-19-4 (1-1/2 x 3/16) STAINLESS STEEL: 1-1/2-by-3/16-inch (38-by-4.8-mm) bearing bars at 1-3/16 inches (30 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
h. Grating Mark P-30-4 (3 x 3/8) STAINLESS STEEL: 3-by-3/8-inch (76-by-9.5-mm) bearing bars at 1-7/8 inches (48 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
i. Grating Mark: As indicated.
j. Traffic Surface: Plain **OR** Serrated **OR** Knurled **OR** Applied abrasive finish consisting of aluminum-oxide aggregate in an epoxy-resin adhesive **OR** As indicated, **as directed**.
k. Finish: Mill finish **OR** Abrasive blasted **OR** Electropolished, **as directed**.

5. Pressure-Locked, Rectangular Bar Aluminum Grating: Fabricated by pressing rectangular flush-top crossbars into slotted bearing bars or swaging crossbars between bearing bars.
   a. Bearing Bar Spacing: 7/16 or 1/2 inch (11 or 13 mm) **OR** 11/16 inch (17.5 mm) **OR** 15/16 inch (24 mm) **OR** 1-3/16 inches (30 mm), **as directed**, o.c.
   b. Bearing Bar Depth: 1 inch (25 mm) **OR** 1-1/4 inches (32 mm) **OR** 1-1/2 inches (38 mm) **OR** 1-3/4 inches (44 mm) **OR** 2 inches (51 mm) **OR** 2-1/4 inches (57 mm) **OR** 2-1/2 inches (64 mm) **OR** As required to comply with structural performance requirements, **as directed**.
   c. Bearing Bar Thickness: 1/8 inch (3.2 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/4 inch (6.4 mm) **OR** As required to comply with structural performance requirements, **as directed**.
   d. Crossbar Spacing: 2 inches (51 mm) **OR** 4 inches (102 mm), **as directed**, o.c.
   e. Grating Mark P-7-4 (1 x 1/8) ALUMINUM: 1-by-1/8-inch (25-by-3.2-mm) bearing bars at 7/16 inch (11 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
   f. Grating Mark P-11-4 (1 x 3/16) ALUMINUM: 1-by-3/16-inch (25-by-4.8-mm) bearing bars at 11/16 inch (18 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
   g. Grating Mark P-15-4 (1-1/2 x 3/16) ALUMINUM: 1-1/2-by-3/16-inch (38-by-4.8-mm) bearing bars at 15/16 inch (24 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
   h. Grating Mark P-19-4 (2 x 3/16) ALUMINUM: 2-by-3/16-inch (51-by-4.8-mm) bearing bars at 1-3/16 inches (30 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
   i. Grating Mark: As indicated.
   j. Traffic Surface: Plain **OR** Applied abrasive finish consisting of aluminum-oxide aggregate in an epoxy-resin adhesive **OR** As indicated, **as directed**.
   k. Aluminum Finish: Mill finish **OR** Class I, clear, anodized finish, **as directed**.
6. Pressure-Locked, Aluminum I-Bar Grating: Fabricated by swaging crossbars between bearing bars.
   a. Bearing Bar Spacing: 7/16 or 1/2 inch (11 or 13 mm) **OR** 11/16 inch (17 mm) **OR** 15/16 inch (24 mm) **OR** 1-3/16 inches (30 mm), **as directed**, o.c.
   b. Bearing Bar Depth: 1 inch (25 mm) **OR** 1-1/4 inches (32 mm) **OR** 1-1/2 inches (38 mm) **OR** 1-3/4 inches (44 mm) **OR** 2 inches (51 mm) **OR** 2-1/4 inches (57 mm) **OR** 2-1/2 inches (64 mm) **OR** As required to comply with structural performance requirements, **as directed**.
   c. Bearing Bar Flange Width: 1/4 inch (6.4 mm).
   d. Crossbar Spacing: 2 inches (51 mm) **OR** 4 inches (102 mm), **as directed**, o.c.
   e. Grating Mark P-11-4 (1 I-Bar) ALUMINUM: 1-inch (25-mm) I-bar bearing bars at 11/16 inch (18 mm) o.c., and crossbars at 4 inches (102 mm) o.c.

f. Grating Mark P-15-2 (1 I-Bar) ALUMINUM: 1-inch (25-mm) I-bar bearing bars at 15/16 inch (24 mm) o.c., and crossbars at 2 inches (51 mm) o.c.
g. Grating Mark P-19-4 (1-1/2 I-Bar) ALUMINUM: 1-1/2-inch (38-mm) I-bar bearing bars at 1-3/16 inches (30 mm) o.c., and crossbars at 4 inches (102 mm) o.c.
h. Grating Mark: As indicated.
i. Traffic Surface: Plain **OR** Grooved **OR** Applied abrasive finish consisting of aluminum-oxide aggregate in an epoxy-resin adhesive **OR** As indicated, **as directed**.
j. Aluminum Finish: Mill finish **OR** Class I, clear, anodized finish, **as directed**.

7. Removable Grating Sections: Fabricate with banding bars attached by welding to entire perimeter of each section. Include anchors and fasteners of type indicated or, if not indicated, as recommended by manufacturer for attaching to supports.
   a. Provide no fewer than four weld lugs for each heavy-duty grating section, with each lug shop welded to two bearing bars.
   b. Provide no fewer than four saddle clips for each grating section composed of rectangular bearing bars 3/16 inch (4.8 mm) or less in thickness and spaced 15/16 inch (24 mm) or more o.c., with each clip designed and fabricated to fit over two bearing bars.
   c. Provide no fewer than four weld lugs for each grating section composed of rectangular bearing bars 3/16 inch (4.8 mm) or less in thickness and spaced less than 15/16 inch (24 mm) o.c., with each lug shop welded to three or more bearing bars. Interrupt intermediate bearing bars as necessary for fasteners securing grating to supports.
   d. Provide no fewer than four flange blocks for each section of aluminum I-bar grating, with block designed to fit over lower flange of I-shaped bearing bars.
   e. Furnish threaded bolts with nuts and washers for securing grating to supports.
   f. Furnish self-drilling fasteners with washers for securing grating to supports.
   g. Furnish galvanized malleable-iron flange clamp with galvanized bolt for securing grating to supports. Furnish as a system designed to be installed from above grating by one person.
8. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.
   a. Edge-band openings in grating that interrupt four or more bearing bars with bars of same size and material as bearing bars.
9. Do not notch bearing bars at supports to maintain elevation.

G. Expanded-Metal Gratings
1. Provide expanded-metal gratings in material, finish, style, size, thickness, weight, and type indicated or, if not indicated, as recommended by manufacturer for indicated applications and as needed to support indicated loads.
   a. Material: Steel **OR** Stainless steel **OR** Aluminum, **as directed**.
   b. Steel Finish: Unfinished, oiled **OR** Shop primed **OR** Galvanized, **as directed**.
   c. Stainless-Steel Finish: Mill finish, as fabricated.
   d. Aluminum Finish: Mill finish, as fabricated.
   e. Style Designation (for steel): 4.27 lb **OR** 3/4 number 9, **as directed**.
   f. Style Designation (for stainless steel): 1-1/2 number 9 **OR** 3/4 number 9, **as directed**.
   g. Size (for aluminum): 2 lb **OR** 3/4 0.188 **OR** 1-1/2 0.125, **as directed**.
   h. Type: I, expanded **OR** II, expanded and flattened, **as directed**.
2. Fabricate cutouts in grating sections for penetrations of sizes and at locations indicated. Cut openings neatly and accurately to size. Edge-band openings with bars having a thickness not less than overall grating thickness at contact points.
3. Where gratings are pierced by pipes, ducts, and structural members, cut openings neatly and accurately to size and weld a strap collar not less than 1/8 inch (3 mm) thick to the cut ends. Divide panels into sections only to extent required for installation where grating platforms and runways are to be placed around previously installed pipe, ducts, and structural members.

H. Formed-Metal Plank Gratings
1. C-shaped channels rolled from heavy sheet metal of thickness indicated, and punched in serrated diamond shape to produce raised slip-resistant surface and drainage holes.

a. Channel 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 **OR** As required to comply with structural performance requirements, **as directed**.
b. Channel Depth: 1-1/2 inches (38 mm) **OR** 2 inches (51 mm) **OR** 2-1/2 inches (64 mm) **OR** 3 inches (76 mm) **OR** As indicated **OR** As required to comply with structural performance requirements, **as directed**.
c. Material: 0.074-inch- (1.9-mm-) thick steel sheet, shop primed **OR** 0.104-inch- (2.65-mm-) thick steel sheet, shop primed **OR** 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** 0.074-inch- (1.9-mm-) thick steel sheet, hot-dip galvanized after fabrication **OR** 0.104-inch- (2.65-mm-) thick steel sheet, hot-dip galvanized after fabrication **OR** 0.062-inch- (1.6-mm-) thick, stainless-steel sheet **OR** 0.078-inch- (2.0-mm-) thick, stainless-steel sheet **OR** 0.080-inch- (2.0-mm-) thick aluminum sheet **OR** 0.100-inch- (2.5-mm-) thick aluminum sheet, **as directed**.

2. Fabricate cutouts in grating sections for penetrations of sizes and at locations indicated. Cut openings neatly and accurately to size. Edge-band openings with metal sheet or bars having a thickness not less than grating material.
3. Where gratings are pierced by pipes, ducts, and structural members, cut openings neatly and accurately to size and weld a strap collar not less than 1/8 inch (3 mm) thick to the cut ends. Divide panels into sections only to extent required for installation where grating platforms and runways are to be placed around previously installed pipe, ducts, and structural members.

I. Extruded-Aluminum Plank Gratings
1. Provide extruded-aluminum plank gratings in type, size, and finish indicated or, if not indicated, as recommended by manufacturer for indicated applications and as needed to support indicated loads.
a. Type: Extruded-aluminum planks approximately 6 inches (152 mm) wide with multiple flanges approximately 1.2 inches (30 mm) o.c., acting as bearing bars connected by a web that serves as a walking surface. Top surface has raised ribs to increase slip resistance.
b. Depth: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (51 mm) **OR** As required to comply with structural performance requirements, **as directed**.
c. Perforations: None **OR** Rectangular, 19/32 by 3 inches (15 by 76 mm), with adjacent rows staggered **OR** 19/32 inch (15 mm) square, with adjacent rows aligned, **as directed**.
d. Finish: Mill finish, as fabricated.
2. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.

J. Glass-Fiber-Reinforced Plastic Gratings
1. Molded Glass-Fiber-Reinforced Gratings: Bar gratings made by placing glass-fiber strands that have been saturated with thermosetting plastic resin in molds in alternating directions to form interlocking bars without voids and with a high resin content.
a. Configuration: 1-1/2-inch- (38-mm-) square mesh, 1 inch (25 mm) thick **OR** 1-1/2-inch- (38-mm-) square mesh, 1-1/4 inches (32 mm) thick **OR** 1-1/2-inch- (38-mm-) square mesh, 1-1/2 inches (38 mm) thick **OR** 2-inch- (51-mm-) square mesh, 2 inches (51 mm) thick **OR** 1-1/2-inch- (38-mm-) square mesh, thickness as required to comply with structural performance requirements **OR** As required to comply with structural performance requirements, **as directed**.
b. Weight: 2.5 lb/sq. ft. (12.2 kg/sq. m) **OR** 2.7 lb/sq. ft. (13.2 kg/sq. m) **OR** 3.2 lb/sq. ft. (15.6 kg/sq. m) **OR** 3.5 lb/sq. ft. (17.1 kg/sq. m) **OR** 3.7 lb/sq. ft. (18.1 kg/sq. m) **OR** 4.1 lb/sq. ft. (20.0 kg/sq. m) **OR** 5.0 lb/sq. ft. (24.4 kg/sq. m), **as directed**.
c. Resin: Polyester **OR** Vinylester, **as directed**.
1) Flame-Spread Index: 25 or less when tested according to ASTM E 84.
2) U.S.D.A. Acceptance: Accepted for food-processing applications.
d. Color: Beige **OR** Gray **OR** Green **OR** Orange **OR** Yellow **OR** Manufacturer's standard, **as directed**.
e. Traffic Surface: Plain, meniscus **OR** Applied abrasive finish **OR** As indicated, **as directed**.

2. Pultruded Glass-Fiber-Reinforced Gratings: Bar gratings assembled from components made by simultaneously pulling glass fibers and extruding thermosetting plastic resin through a heated die under pressure to produce a product without voids and with a high glass-fiber content.
   a. Configuration: I4010; 1-inch (25-mm) I-bars spaced 1 inch (25 mm) o.c. (40 percent open) **OR** I6010; 1-inch (25-mm) I-bars spaced 1-1/2 inches (38 mm) o.c. (60 percent open) **OR** I4015; 1-1/2-inch (38-mm) I-bars spaced 1 inch (25 mm) o.c. (40 percent open) **OR** I6015; 1-1/2-inch (38-mm) I-bars spaced 1-1/2 inches (38 mm) o.c. (60 percent open) **OR** T3320; 2-inch (51-mm) T-bars spaced 1-1/2 inches (38 mm) o.c. (33 percent open) **OR** T5020; 2-inch (51-mm) T-bars spaced 2 inches (51 mm) o.c. (50 percent open) **OR** As required to comply with structural performance requirements, **as directed**.
   b. Weight: 2.35 lb/sq. ft. (11.5 kg/sq. m) **OR** 2.83 lb/sq. ft. (13.8 kg/sq. m) **OR** 3.10 lb/sq. ft. (15.1 kg/sq. m) **OR** 3.41 lb/sq. ft. (16.6 kg/sq. m) **OR** 4.10 lb/sq. ft. (20.0 kg/sq. m) **OR** 4.13 lb/sq. ft. (20.2 kg/sq. m), **as directed**.
   c. Resin Type: Polyester **OR** Vinylester, **as directed**.
      1) Flame-Spread Index: 25 or less when tested according to ASTM E 84.
      2) U.S.D.A. Acceptance: Accepted for food processing applications.
   d. Color: Beige **OR** Gray **OR** Green **OR** Orange **OR** Yellow **OR** Manufacturer's standard, **as directed**.
   e. Traffic Surface: Plain, grooved **OR** Applied abrasive finish **OR** As indicated, **as directed**.
3. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.

K. Grating Frames And Supports
1. Frames and Supports for Metal Gratings: Fabricate from metal shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.
   a. Unless otherwise indicated, fabricate from same basic metal as gratings.
   b. Equip units indicated to be cast into concrete or built into masonry with integrally welded anchors. Unless otherwise indicated, space anchors 24 inches (600 mm) o.c. and provide minimum anchor units in the form of steel straps 1-1/4 inches (32 mm) wide by 1/4 inch (6 mm) thick by 8 inches (200 mm) long.
2. Frames and Supports for Glass-Fiber-Reinforced Plastic Gratings: Fabricate from glass-fiber-reinforced plastic shapes of sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.
   a. Unless otherwise indicated, use shapes made from same resin as gratings.
   b. Equip units indicated to be cast into concrete or built into masonry with integral anchors.
3. Galvanize steel frames and supports in the following locations:
   a. Exterior.
   b. Interior, where indicated.

L. Aluminum Finishes
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. 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.

M. Steel Finishes
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Finish gratings, frames, and supports 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.

4. Shop prime gratings, frames and supports not indicated to be galvanized 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.
5. Preparation for Shop Priming: Prepare 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. 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 7/NACE No. 4, "Brush-off Blast Cleaning."
6. 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.

1.3 EXECUTION

A. Installation, General
   1. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings 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 gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
   3. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.
   4. Fit exposed connections accurately together to form hairline joints.
      a. 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 the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
   5. Attach toeplates to gratings by welding at locations indicated.
   6. 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.
   7. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

B. Installing Metal Bar Gratings
   1. General: Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.
   2. Attach removable units to supporting members with type and size of clips and fasteners indicated or, if not indicated, as recommended by grating manufacturer for type of installation conditions shown.
   3. Attach nonremovable units to supporting members by welding where both materials are same; otherwise, fasten by bolting as indicated above.

C. Installing Expanded-Metal Gratings
   1. General: Comply with manufacturer's written instructions for installing gratings.
   2. Place units with straight edge of bond up and with long direction of diamond-shaped openings parallel to direction of span.
   3. Attach removable units to supporting members by bolting at 6-inch (150-mm) intervals.
   4. Attach nonremovable units to supporting members by welding unless otherwise indicated. Space welds at 6-inch (150-mm) intervals.
   5. Attach aluminum units to steel supporting members by bolting at 6-inch (150-mm) intervals.
   6. Butt edges parallel to long direction of diamond-shaped openings and weld at every second bond point. Place individual grating sections so diamonds of one piece are aligned with those of adjacent sections.

D. Installing Metal Plank Gratings
   1. General: Comply with manufacturer's written instructions for installing gratings. Use manufacturer's standard anchor clips and hold-down devices for bolted connections.
   2. Attach removable units to supporting members by bolting at every point of contact.
   3. Attach nonremovable units to supporting members by welding unless otherwise indicated. Comply with manufacturer's written instructions for size and spacing of welds.
   4. Attach aluminum units to steel supporting members by bolting at side channels at every point of contact and by bolting intermediate planks at each end on alternate sides. Bolt adjacent planks together at midspan.

E. Installing Glass-Fiber-Reinforced Plastic Gratings
   1. Comply with manufacturer's written instructions for installing gratings. Use manufacturer's standard stainless-steel anchor clips and hold-down devices for bolted connections.

F. 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 requirements 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 05 53 13 00

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Task	Specification	Specification Description
05 53 13 00	01 22 16 00	No Specification Required
05 53 13 00	05 50 00 00	Metal Fabrications
05 54 00 00	05 50 00 00	Metal Fabrications
05 55 13 00	05 50 00 00	Metal Fabrications
05 55 13 00	05 51 13 00	Metal Stairs
05 55 13 00	05 51 13 00a	Fabricated Spiral Stairs
05 55 16 00	05 50 00 00	Metal Fabrications
05 55 16 00	05 51 13 00	Metal Stairs
05 55 16 00	05 51 13 00a	Fabricated Spiral Stairs
05 56 00 00	05 50 00 00	Metal Fabrications

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SECTION 05 58 16 00 - 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 "Hollow Metal 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 Final Completion.

END OF SECTION 05 58 16 00

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Task	Specification	Specification Description
05 58 16 00	05 15 16 00	Ornamental Metal
05 59 65 00	01 22 16 00	No Specification Required

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SECTION 05 73 00 00 - 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.
4. Product Design Data: For each type of product indicated in 1.2.

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. ICC International Building Code.
   c. ICC International Fire Code.
2. For use as a mechanical equipment ladder, comply with requirements of ICC International 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 22 OR Division 28.
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 27 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 05 73 00 00

SECTION 05 73 00 00a - ORNAMENTAL RAILINGS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for ornamental 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. Aluminum decorative railings with stainless-steel, wire-rope guard infill, **as directed**.
b. Copper-alloy decorative railings.
c. Stainless-steel decorative railings with stainless-steel, wire-rope guard infill, **as directed**.
d. Steel and iron decorative railings with stainless-steel, wire-rope guard infill, **as directed**.
e. Glass- and plastic-supported railings.
f. Post-supported railings with glass infill.
g. Illuminated decorative railings.

C. Definitions
1. Railings: Guards, handrails, and similar devices used for protection of occupants at open-sided floor areas, pedestrian guidance and support, visual separation, or wall protection.

D. 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. Aluminum: The lesser of minimum yield strength divided by 1.65 or minimum ultimate tensile strength divided by 1.95.
b. Copper Alloys: 60 percent of minimum yield strength.
c. Stainless Steel: 60 percent of minimum yield strength.
d. Steel: 72 percent of minimum yield strength.
e. Glass: 25 percent of mean modulus of rupture (50 percent probability of breakage), as listed in "Mechanical Properties" in AAMA's Aluminum Curtain Wall Series No. 12, "Structural Properties of Glass."
1) Requirement above is based on the 2006 International Building Code (IBC) for safety factor of 4.
3. Structural Performance: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
a. Loads below are based on the 2006 International Building Code (IBC).
1) Handrails and Top Rails of Guards:
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.
2) Infill of Guards:
a) Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
b) Infill load and other loads need not be assumed to act concurrently.
3) Glass-Supported Railings: Support each section of top rail by a minimum of three glass panels or by other means so top rail will remain in place if any one panel fails.

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.

E. Submittals
1. Product Data: For the following:
   a. Manufacturer's product lines of railings assembled from standard components.
   b. Grout, anchoring cement, and paint products.
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: Include plans, elevations, sections, details, and attachments to other work.
   a. For illuminated railings, include wiring diagrams and roughing-in details.
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. Each type of glass required.
   c. Fittings and brackets.
   d. Welded connections.
   e. Brazed connections.
   f. Assembled Samples of railing systems, made from full-size components, including top rail, post, handrail, and infill. Show method of finishing members at intersections. Samples need not be full height.
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. Mill Certificates: Signed by manufacturers of stainless-steel products certifying that products furnished comply with requirements.
8. Welding certificates.
9. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.

F. Quality Assurance
1. Source Limitations: Obtain each type of railing from single source from single manufacturer.
2. Product Options: Information on Drawings and in Specifications establishes requirements for system's 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 structural analysis, preconstruction testing, field testing, and in-service performance.
   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.
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."

4. Safety Glazing Labeling: Permanently mark glass with certification label of the SGCC **OR** the SGCC or another certification agency acceptable to authorities having jurisdiction **OR** manufacturer, **as directed**. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
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. Preinstallation Conference: Conduct conference at Project site.

G. Project Conditions
1. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication and indicate measurements on Shop Drawings.

H. 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 suit 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: Same metal and finish as supported rails unless otherwise indicated.
   a. Provide cast-metal brackets with flange tapped for concealed anchorage to threaded hanger bolt.
   b. Provide either formed- or cast-metal brackets with predrilled hole for exposed bolt anchorage.
   c. Provide formed-steel brackets with predrilled hole for bolted anchorage and with snap-on cover that matches rail finish and conceals bracket base and bolt head.
   d. Provide extruded-aluminum brackets with interlocking pieces that conceal anchorage. Locate set screws on bottom of bracket.

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.
2. Extruded Bars and Shapes, Including Extruded 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 5005-H32 **OR** Alloy 6061-T6, **as directed**.
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.

C. Copper Alloys
1. Copper and Copper Alloys, General: Provide alloys indicated and with temper to suit application and forming methods, but with strength and stiffness not less than Temper H01 (quarter hard) for plate, sheet, strip, and bars and Temper 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: Composition bronze castings complying with ASTM B 62, Alloy UNS No. C83600 (85-5-5-5 or No. 1 composition commercial red brass) or sand castings complying with ASTM B 584, Alloy UNS No. C86500 (No. 1 manganese bronze).
10. Castings, Brass: Sand castings complying with 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 Alloy 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.
7. Expanded Metal: ASTM F 1267, Type I (expanded) **OR** Type II (expanded and flattened), **as directed**, Class 3 (corrosion-resisting steel), made from stainless-steel sheet complying with 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**.
8. 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.

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 580/A 580M, Type 304 **OR** Type 316, **as directed**.

E. 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. 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. 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.
   OR
   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**.
8. 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).

F. Glass And Glazing Materials
1. Tempered Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated), Type 1 (transparent flat glass), Quality-Q3. Provide products that have been tested for surface and edge compression according to ASTM C 1048 and for impact strength according to 16 CFR 1201 for Category II materials.
   a. Glass Color: Clear **OR** Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.
   b. Thickness for Structural Glass Balusters: As required by structural loads, but not less than 12.0 **OR** 19.0, **as diected**, mm.
   c. Thickness for Glass Infill Panels: As required by structural loads, but not less than 6.0 **OR** 10.0, **as directed**, mm.
      OR
      Thickness: As indicated on Drawings.
2. Laminated Glass: ASTM C 1172, Condition A (uncoated), Type I (transparent flat glass), Quality-Q3 with two plies of glass and polyvinyl butyral interlayer not less than 0.060 inch (1.52 mm) thick.
   a. Kind: LA (laminated annealed) **OR** LHS (laminated heat strengthened) **OR** LT (laminated tempered) **OR** As indicated, **as directed**.
   b. Glass Color: Clear **OR** Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray, **as directed**.
   c. Interlayer Color: Clear **OR** Blue-green **OR** Bronze light **OR** Gray **OR** As selected from manufacturer's full range, **as directed**.
   d. Glass Plies for Structural Glass Balusters: Thickness required by structural loads, but not less than 6.0 **OR** 8.0, **as directed**, mm thick, each.
   e. Glass Plies for Glass Infill Panels: Thickness required by structural loads, but not less than 3.0 **OR** 4.0 **OR** 5.0, **as directed**, mm, each.
3. Ceramic-Coated 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 "Engineering Standards Manual" and with other requirements specified.

a. Glass Color: Clear **OR** Blue **OR** Blue-green **OR** Bronze **OR** Green **OR** Gray **OR** As selected from manufacturer's full range, **as directed**.

4. Plastic Structural Glazing: Uncoated, transparent, monolithic acrylic sheet complying with ASTM D 4802, Category A-1 or A-2 (cell cast or continuous cast), Finish 1 (smooth or polished), and as follows:
   a. Color: Colorless (clear) **OR** Blue **OR** Blue-green **OR** Bronze **OR** Gray **OR** Green **OR** Match glass, **as directed**.
   b. Thickness: 12.0 mm **OR** Match glass thickness, **as directed**.
5. Glazing Cement and Accessories for Structural Glazing: Glazing cement, setting blocks, shims, and related accessories as recommended or supplied by railing manufacturer for installing structural glazing in metal subrails.
   a. Glazing Cement: Nonshrinking organic cement designed for curing by passing an electric current through metal subrail holding glass panel, as standard with manufacturer.
6. Glazing Gaskets for Glass Infill Panels: Glazing gaskets and related accessories recommended or supplied by railing manufacturer for installing glass infill panels in post-supported railings.

G. Fasteners
1. Fastener Materials: Unless otherwise indicated, provide the following:
   a. Aluminum Components: Type 304 **OR** Type 316, **as directed**, stainless-steel fasteners.
   b. Copper-Alloy (Bronze) Components: Silicon bronze (Alloy 651 or Alloy 655) fasteners where concealed; muntz metal (Alloy 280) fasteners where exposed.
   c. Copper-Alloy (Brass) Components: Silicon bronze (Alloy 651 or Alloy 655) fasteners where concealed; brass (Alloy 260 or Alloy 360) fasteners where exposed.
   d. Stainless-Steel Components: Type 304 **OR** Type 316, **as directed**, stainless-steel fasteners.
   e. Uncoated Steel Components: 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.
   f. Galvanized-Steel Components: Plated-steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating.
   g. Dissimilar Metals: Type 304 **OR** Type 316, **as directed**, stainless-steel fasteners.
2. Fasteners for Anchoring 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. Provide concealed fasteners for interconnecting railing components and for attaching railings to other work unless otherwise indicated **OR** exposed fasteners are unavoidable **OR** exposed fasteners are the standard fastening method for railings indicated,**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 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).

H. Miscellaneous Materials
1. Wood Rails: Clear, straight-grained hardwood rails secured to recessed **OR** exposed, **as directed**, metal subrail.
   a. Species: Ash **OR** Cherry **OR** Red oak **OR** Walnut **OR** White oak, **as directed**.

b. Finish: Manufacturer's standard **OR** Transparent polyurethane **OR** Penetrating oil **OR** Acrylic impregnated, **as directed**.
c. Staining: None **OR** Match the Owner's sample **OR** As selected from manufacturer's full range, **as directed**.
d. Profile: Square, 1-3/4 by 1-3/4 inches (45 by 45 mm) with edges eased to 1/4-inch (6-mm) radius **OR** Rectangular, 1-3/4 by 5 inches (45 by 127 mm) with edges eased to 1/4-inch (6-mm) radius **OR** Round, 2-inch (50-mm) diameter **OR** As indicated, **as directed**.

OR

Wood Rails: Hardwood rails complying with Division 06 Section "Interior Architectural Woodwork"

2. Electrical Components: Provide internal, fluorescent light fixtures and electrical components, required as part of illuminated railings, that comply with NFPA 70 and that are listed and labeled by UL.
3. Plastic Handrail Caps: Thermoplastic rail covering, color as indicated or, if not indicated, as selected by the Owner from manufacturer's standard colors.
4. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
   a. For aluminum 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.
5. Brazing Rods: For copper-alloy railings, 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.
6. Lacquer for Copper Alloys: Clear acrylic lacquer specially developed for coating copper-alloy products.
7. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
8. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
9. 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**.
10. 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.
11. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
12. 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**.
13. 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**.
14. Epoxy Intermediate Coat: Complying with MPI#77 and compatible with primer and topcoat.
15. Polyurethane Topcoat: Complying with MPI#72 and compatible with undercoat.
16. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
17. 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.
18. 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.

I. 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. 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.
4. 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.
5. Form work true to line and level with accurate angles and surfaces.
6. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.
7. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
8. Connections: Fabricate railings with welded or nonwelded connections unless otherwise indicated.
9. 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 welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 welds: no evidence of a welded joint.
10. 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.
11. Brazed Connections: Connect copper-alloy railings by brazing. Cope components at connections to provide close fit, or use fittings designed for this purpose. Braze corners and seams continuously.
    a. Use materials and methods that match color of base metal, minimize distortion, and develop maximum strength and corrosion resistance.
    b. Remove flux immediately.
    c. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and brazed surface matches contours of adjoining surfaces.
12. Mechanical 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.
13. 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.
       OR
       By bending to smallest radius that will not result in distortion of railing member.
14. 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.
15. Close exposed ends of hollow railing members with prefabricated end fittings.

16. 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.
17. 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.
18. 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.
19. 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.
20. 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.
21. Expanded-Metal Infill Panels: Fabricate infill panels from stainless-steel **OR** steel, **as directed**, expanded metal unless otherwise indicated.
    a. Edge panels with U-shaped channels made from same metal as infill; 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**.
22. 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**.
23. 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.
    a. Make wire mesh and frames from aluminum **OR** stainless steel **OR** steel, **as directed**, unless otherwise indicated.
    b. Orient wire mesh with diamonds vertical **OR** wires perpendicular and parallel to top rail **OR** wires horizontal and vertical, **as directed**.
24. 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.

J. Glazing Panel Fabrication
    1. General: Fabricate to sizes and shapes required; provide for proper edge clearance and bite on glazing panels.
        a. Clean-cut or flat-grind edges at butt-glazed sealant joints to produce square edges with slight chamfers at junctions of edges and faces
        b. Grind smooth exposed edges, including those at open joints, to produce square edges with slight chamfers at junctions of edges and faces.
    2. Structural Glass Balusters: Factory-bond glass to aluminum base and top-rail channels in railing manufacturer's plant using glazing cement to comply with manufacturer's written specifications, unless field glazing is standard with manufacturer.
    3. Structural Balusters: Provide tempered **OR** laminated, heat-strengthened **OR** laminated, tempered, **as directed**, glass panels for both straight and curved sections, **as directed**.
       OR

Structural Balusters: Provide thermoformed, curved, plastic glazing panels for curved sections and tempered **OR** laminated, heat-strengthened **OR** laminated, tempered, **as directed**, glass panels for straight sections.
OR
Infill Panels: Provide tempered **OR** laminated, annealed **OR** laminated, heat-strengthened **OR** laminated, tempered, **as directed**, glass panels for both straight and curved sections, **as directed**.

K. Illuminated Railings
1. General: Comply with requirements in this Section for aluminum railings with welded connections.
2. Illuminated Units: Provide internal illumination using concealed, internally wired, fluorescent-strip fixture system to illuminate walking surfaces adjacent to railings without light leaks. Make provisions for servicing and for concealed connection to electric service. Coordinate electrical characteristics with those of the power supply provided.
   a. Fluorescent Tubes: Provide number of tubes indicated or required by railing length.
   b. Diffusers: UV-stabilized acrylic diffusers matching profile of railings.
   c. Ballasts: Energy-saving, high power factor, Class P, electromagnetic type; designed for use with high-output lamps, and with automatic-reset thermal protection. Ballasts comply with ANSI C82.1, bear Certified Ballast Manufacturer Certification labels, and are rated for 0 deg F (minus 17 deg C) **OR** minus 20 deg F (minus 29 deg C), **as directed**, starting temperature.

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. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.
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.
4. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

M. Aluminum Finishes
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Mechanical Finish: AA-M3x (Mechanical Finish: as specified); sand top rails, handrails, and intermediate rails in one direction only, parallel to length of railing, with 120- and 320-grit abrasive. After installation, polish railings with No. 0 steel wool immersed in paste wax, then rub to a luster with a soft dry cloth.
3. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
4. 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**.
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** As selected from manufacturer's full range, **as directed**.

6. 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**.
7. 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**.

N. Copper-Alloy Finishes
1. Finish designations for copper alloys comply with the system 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.

O. 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. Directional Satin Finish: No. 4.
4. Dull Satin Finish: No. 6.
5. Satin, Reflective, Directional Polish: No. 7.
6. Mirrorlike Reflective, Nondirectional Polish: No. 8.
7. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
8. Sputter-Coated Finish: Titanium nitride coating deposited by magnetic sputter-coating process over indicated mechanical finish.

P. Steel And Iron Finishes
1. Galvanized Railings:
   a. Hot-dip galvanize steel **OR** exterior steel, **as directed**, and iron railings, including hardware, after fabrication.
   b. Hot-dip galvanize indicated steel and iron railings, including hardware, after fabrication.
   c. Comply with ASTM A 123/A 123M for hot-dip galvanized railings.
   d. Comply with ASTM A 153/A 153M for hot-dip galvanized hardware.
   e. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
   f. Fill vent and drain holes that are 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. 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. 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 7/NACE No. 4, "Brush-off Blast 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**.

9. 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**.
10. 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**.

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 and copper alloys 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. Use wood blocks and padding to prevent damage to railing members and fittings. 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 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, 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 flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:
   a. For aluminum railings, attach posts as indicated using fittings designed and engineered for this purpose.
   b. For copper-alloy railings, attach posts as indicated using fittings designed and engineered for this purpose.
   c. For stainless-steel railings, weld flanges to posts and bolt to metal-supporting surfaces.
   d. For steel railings, weld flanges to posts 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 to concrete and masonry with sleeves concealed within **OR** flanges connected to **OR** brackets on underside of rails connected to, **as directed**, railing ends and anchored to wall construction with anchors and bolts.
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 handrails to walls 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 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, fasten brackets directly to steel framing or concealed steel reinforcements using self-tapping screws of size and type required to support structural loads.

OR

For steel-framed partitions, fasten brackets with toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

F. Installing Glass Panels
   1. Glass-Supported Railings: Install assembly to comply with railing manufacturer's written instructions.
      a. Attach base channel to building structure, then insert and connect factory-fabricated and -assembled glass panels if glass was bonded to base and top rail channels in factory.
      b. Attach base channel to building structure, then insert glass into base channel and bond with glazing cement unless glass was bonded to base and top rail channels in factory.
         1) Support glass panels in base channel at quarter points with channel-shaped setting blocks that also act as shims to maintain uniform space for glazing cement. Fill remaining space in base channel with glazing cement for uniform support of glass.
      c. Adjust spacing of glass panels so gaps between panels are equal before securing in position.
      d. Erect glass railings under direct supervision of manufacturer's authorized technical personnel.
   2. Post-Supported Glass Railings: Install assembly to comply with railing manufacturer's written instructions and with requirements in other Part 1.3 articles. Erect posts and other metal railing components, then set factory-cut glass panels. Do not cut, drill, or alter glass panels in field. Protect edges from damage.

G. Installing Plastic Handrail Caps
   1. Apply plastic handrail caps to top rails and handrails, where indicated, complying with manufacturer's written instructions for cutting, mounting, forming, welding, cleaning, applying end caps, and finishing.
   2. Minimize number of joints in plastic caps by installing in lengths as long as possible. Allow for shortening of plastic cap caused by welding and splicing process; butt ends together to produce hairline joint.
      a. Continuously weld, splice, miter, and end-cap joints using cap manufacturer's electric welding iron designed for this purpose. Remove welding flash while material is still soft.
      b. Weld only prongs on underside of plastic cap at splice, miter, and end-cap joints. After cutting plastic cap, dress ends with file to produce a hairline fit between abutting sections. After mounting cap, polish top surface with cap manufacturer's solvent designed for this purpose until joint becomes almost invisible.

H. Field Quality Control
   1. Testing Agency: Perform field tests and inspections and prepare test reports.
   2. Extent and Testing Methodology: Randomly select completed railing assemblies for testing that are representative of different railing designs and conditions in the completed Work. Railings will be tested according to ASTM E 894 and ASTM E 935 for compliance with performance requirements.
   3. Remove and replace railings where test results indicate that they do not comply with specified requirements unless they can be repaired in a manner satisfactory to the Owner and will 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.

I. Cleaning
   1. Clean aluminum and stainless steel by washing thoroughly with clean water and soap, rinsing with clean water, and wiping dry.
   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. Clean and polish glass and plastic glazing as recommended in writing by manufacturer. Wash both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Final Completion.
4. Clean wood rails and plastic handrail caps by wiping with a damp cloth and then wiping dry.
5. 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.

   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**.
6. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

J. 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 Final Completion.
   2. 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 05 73 00 00a

Task	Specification	Specification Description
05 73 00 00	05 15 16 00	Ornamental Metal
05 75 00 00	05 15 16 00	Ornamental Metal
05 75 00 00	05 73 00 00	Miscellaneous Ornamental Metals
05 75 00 00	05 58 16 00	Ornamental Formed Metal

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SECTION 06 05 23 00 - 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 06 05 23 00

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SECTION 06 05 23 00a - 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 06 05 23 00a

Task	Specification	Specification Description
06 05 23 00	06 10 00 00	Rough Carpentry
06 05 23 00	01 95 06 00	Miscellaneous Carpentry

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SECTION 06 10 00 00 - 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. "Nailing Schedule," and Tables in Section 2304, of ICC's International Building Code.
    d. Table 2306.1, "Fastening Schedule," in SBCCI's Standard Building Code.
    e. 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.
    f. 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 06 10 00 00

Task	Specification	Specification Description
06 11 13 00	06 10 00 00	Rough Carpentry
06 11 13 00	01 95 06 00	Miscellaneous Carpentry

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SECTION 06 11 16 00 - 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 necessary, 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 06 11 16 00

Task	Specification	Specification Description
06 11 16 00	01 22 16 00	No Specification Required
06 11 16 00	06 10 00 00	Rough Carpentry
06 11 16 00	01 95 06 00	Miscellaneous Carpentry

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SECTION 06 15 13 00 - 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. "Nailing Schedule," and Tables in Section 2304 of the ICC's International Building Code.
    d. Table 2306.1, "Fastening Schedule," in SBCCI's Standard Building Code.
    e. 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 06 15 13 00

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SECTION 06 15 13 00a - 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. Product Data for Credit EQ 4.1: For sealants and installation adhesives, including printed statement of VOC content.
b. 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.

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 "Staining And Transparent Finishing" 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 06 15 13 00a

Task	Specification	Specification Description
06 15 13 00	06 10 00 00	Rough Carpentry
06 15 13 00	01 95 06 00	Miscellaneous Carpentry
06 15 13 00	06 11 16 00	Rough Carpentry Renovation

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SECTION 06 16 23 00 - 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

IBC Standard 1404.2, 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. "Nailing Schedule," and Tables in Section 2304 of the ICC's International Building Code.
   d. Table 2306.1, "Fastening Schedule," in SBCCI's "Standard Building Code."

e. 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."
f. 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 06 16 23 00

Task	Specification	Specification Description
06 16 23 00	06 10 00 00	Rough Carpentry
06 16 23 00	01 95 06 00	Miscellaneous Carpentry
06 16 33 00	06 10 00 00	Rough Carpentry
06 16 33 00	01 95 06 00	Miscellaneous Carpentry
06 16 33 00	06 16 23 00	Sheathing
06 16 43 00	06 10 00 00	Rough Carpentry
06 16 43 00	01 95 06 00	Miscellaneous Carpentry
06 16 43 00	06 16 23 00	Sheathing
06 16 43 00	06 11 16 00	Rough Carpentry Renovation

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SECTION 06 17 13 00 - STRUCTURAL GLUED-LAMINATED TIMBER

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for structural glued-laminated timber. 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 structural glued-laminated timber.

C. Definitions
1. Structural Glued-Laminated (Glulam) Timber: An engineered, stress-rated timber product assembled from selected and prepared wood laminations bonded together with adhesives and with the grain of the laminations approximately parallel longitudinally.

D. Performance Requirements
1. Delegated Design: Design structural glued-laminated timber and connectors, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Structural Performance: Structural glued-laminated timber and connectors shall withstand the effects of structural loads shown on Drawings without exceeding allowable design working stresses listed in AITC 117 or determined according to ASTM D 3737 and acceptable to authorities having jurisdiction.
3. Seismic Performance: Structural glued-laminated timber and connectors shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

E. 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 structural glued-laminated timber 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 4.4: For laminating adhesive used for structural glued-laminated timber, indicating that product contains no urea formaldehyde.
3. Delegated-Design Submittal: For structural glued-laminated timber and timber connectors indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
4. Certificates of Conformance: Issued by a qualified testing and inspecting agency indicating that structural glued-laminated timber complies with requirements in AITC A190.1.

F. Quality Assurance
1. Manufacturer Qualifications: Provide factory-glued structural units produced by an AITC- or APA-licensed firm that is certified for chain of custody by an FSC-accredited certification body.
   a. Factory mark each piece of structural glued-laminated timber with AITC Quality Mark or APA-EWS trademark. Place mark on surfaces that will not be exposed in the completed Work.
2. Quality Standard: Comply with AITC A190.1.

3. Forest Certification: Provide structural glued-laminated timber 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. General: Comply with provisions in AITC 111.
2. Individually wrap members using plastic-coated paper covering with water-resistant seams.

1.2 PRODUCTS

A. Structural Glued-Laminated Timber
1. General: Provide structural glued-laminated timber that complies with AITC 117 or research/evaluation reports acceptable to authorities having jurisdiction.
a. Provide structural glued-laminated timber made from solid lumber laminations; do not use laminated veneer lumber.
b. Provide structural glued-laminated timber made with wet-use adhesive complying with ASTM D 2559.
1) Use adhesive that contains no urea-formaldehyde resins.
2. Species and Grades for Structural Glued-Laminated Timber:
a. Alaska cedar **OR** Douglas fir-larch **OR** Southern pine **OR** Any species, **as directed**, in grades needed to comply with "Performance Requirements" Article.
OR
Alaska cedar **OR** Douglas fir-larch **OR** Southern pine **OR** Any species, **as directed**, that complies with structural properties **OR** combination symbols **OR** beam stress classifications, **as directed**, indicated.
3. Species and Grades for Beams and Purlins:
a. Species and Beam Stress Classification: Ponderosa pine, 16F-1.3E **OR** Alaska cedar, 20F-1.5E **OR** Eastern spruce, 20F-1.5E **OR** Any species, 20F-1.5E **OR** Any species, 24F-1.7E **OR** Douglas fir-larch, 24F-1.8E **OR** Southern pine, 24F-1.8E **OR** Douglas fir-larch or southern pine, 24F-1.8E **OR** Southern pine, 30F-2.1E, **as directed**.
b. Lay-up: Balanced **OR** Either balanced or unbalanced, **as directed**.
4. Species and Grades for Columns and Truss Members:
a. Species and Combination Symbol: Alaska cedar, 70 **OR** Douglas fir-larch, 1 **OR** Douglas fir-larch, 3 **OR** Southern pine, 47 **OR** Southern pine, 50, **as directed**.
5. Appearance Grade: Premium **OR** Architectural **OR** Industrial **OR** Framing, **as directed**, complying with AITC 110.
6. Preservative Treatment after Fabrication: Where preservative-treated structural glued-laminated timber is indicated, pressure treat after fabrication according to AWPA C28.
a. Use oxine copper (copper-8-quinolinolate) in a light petroleum solvent.
OR
Use copper naphthenate in a light petroleum solvent.
OR
Use preservative solution without water repellents or substances that might interfere with application of indicated finishes.
OR
Do not incise structural glued-laminated timber.
7. Preservative Treatment before Fabrication: Where preservative-treated structural glued-laminated timber is indicated, pressure treat lumber before gluing according to AWPA C28.
a. Use oxine copper (copper-8-quinolinolate) in a light petroleum solvent.
OR
Use copper naphthenate in a light petroleum solvent.
OR
Use a waterborne preservative that is acceptable to authorities having jurisdiction and that contains no arsenic or chromium.

OR

Use preservative solution without water repellents or substances that might interfere with application of indicated finishes.

OR

Do not incise wood used for producing structural glued-laminated timber.

OR

After dressing and fabricating members, apply a field-treatment preservative to comply with AWPA M4 to surfaces cut to a depth of more than 1/16 inch (1.5 mm).

1) Use inorganic boron (SBX) treatment for members not in contact with the ground and continuously protected from liquid water.

OR

Use copper naphthenate treatment for members in contact with the ground or not continuously protected from liquid water.

8. 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.
9. Penetrating Sealer: Manufacturer's standard, transparent, penetrating wood sealer that is compatible with indicated finish.

B. 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 (5-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 arch base shoes from steel **OR** stainless steel, **as directed**, with 1-inch (25-mm) base plates and 3/8-inch (9.5-mm) side plates.
4. 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.
5. Fabricate hinge connectors from steel **OR** stainless steel, **as directed**, with 0.179-inch (4.6-mm) side plates and 3/4-inch (19-mm) **OR** 1-inch (25-mm), **as directed**, top and bottom plates.
6. 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.
7. Fabricate tie rods from round steel bars with upset threads connected with forged-steel turnbuckles complying with ASTM A 668/A 668M.
8. Provide bolts, 3/4 inch (19 mm) unless otherwise indicated, complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); nuts complying with ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.
9. Provide shear plates, 2-5/8 inches (66.7 mm) **OR** 4 inches (102 mm), **as directed**, in diameter, complying with ASTM D 5933.
10. Finish steel assemblies and fasteners with rust-inhibitive primer, 2-mil (0.05-mm) dry film thickness.
11. Hot-dip galvanize steel assemblies and fasteners after fabrication to comply with ASTM A 123/A 123M or ASTM A 153/A 153M.

C. Fabrication

1. Shop fabricate for connections to greatest extent possible, including cutting to length and drilling bolt holes.

a. Dress 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.

2. Camber: Fabricate horizontal and inclined members of less than 1:1 slope with either circular or parabolic camber equal to 1/500 of span.
3. End-Cut Sealing: Immediately after end cutting each member to final length and after preservative treatment, apply a saturation coat of end sealer to ends and other cross-cut surfaces, keeping surfaces flood coated for not less than 10 minutes.
4. Seal Coat: After fabricating, sanding, and end-coat sealing, apply a heavy saturation coat of penetrating sealer on surfaces of each unit, except for preservative-treated wood where treatment included a water repellent.

D. Factory Finishing
1. Wiped Stain Finish: Manufacturer's standard, dry-appearance, penetrating acrylic stain and sealer; oven dried and resistant to mildew and fungus.
   a. Color: As selected by the Owner from manufacturer's full range.
2. Clear Finish: Manufacturer's standard, two-coat, clear conversion varnish finish; oven dried and resistant to mildew and fungus.

1.3 EXECUTION

A. Installation
1. General: Erect structural glued-laminated timber true and plumb, and with uniform, close-fitting joints. Provide temporary bracing to maintain lines and levels until permanent supporting members are in place.
   a. Lift with padded slings and protect corners with wood blocking.
   b. Install structural glued-laminated timber to comply with Shop Drawings.
   c. Install timber connectors as indicated.
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); and do not embed more than 4 inches (102 mm) unless otherwise indicated.
3. Fit structural glued-laminated timber by cutting and restoring exposed surfaces to match specified surfacing and finishing.
   a. Predrill for fasteners using timber connectors as templates.
   b. Dress 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.
   c. Coat cross cuts with end sealer.
   d. 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.
         OR
         Use copper naphthenate treatment for members in contact with the ground or not continuously protected from liquid water.
4. Cutting: Avoid cutting after fabrication. Where field fitting is unavoidable, comply with requirements for shop fabrication.
   a. 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.
         OR
         Use copper naphthenate treatment for members in contact with the ground or not continuously protected from liquid water.

B. Adjusting

1. Repair damaged surfaces and finishes after completing erection. Replace damaged structural glued-laminated timber if repairs are not approved by the Owner.

C. Protection
   1. Do not remove wrappings on individually wrapped members until they no longer serve a useful purpose including protection from weather, sunlight, soiling, and damage from work of other trades.
      a. Coordinate wrapping removal with finishing work specified in Division 07. Retain wrapping where it can serve as a painting shield.

END OF SECTION 06 17 13 00

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Task	Specification	Specification Description
06 17 13 00	06 05 23 00	Timber Bridge Components
06 17 13 00	06 10 00 00	Rough Carpentry
06 17 23 00	06 10 00 00	Rough Carpentry
06 17 23 00	01 95 06 00	Miscellaneous Carpentry
06 17 23 00	06 11 16 00	Rough Carpentry Renovation

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SECTION 06 17 33 00 - 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 Rough 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 Rough 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 06 17 33 00

Task	Specification	Specification Description
06 17 43 00	06 05 23 00	Timber Bridge Components
06 17 43 00	06 10 00 00	Rough Carpentry
06 17 43 00	06 17 13 00	Structural Glued-Laminated Timber
06 17 53 00	06 17 33 00	Metal-Plate-Connected Wood Trusses
06 18 13 00	06 15 13 00a	Wood Decking
06 18 13 00	06 17 13 00	Structural Glued-Laminated Timber
06 18 16 00	06 05 23 00	Timber Bridge Components
06 18 16 00	06 10 00 00	Rough Carpentry
06 18 16 00	06 17 13 00	Structural Glued-Laminated Timber
06 22 13 00	01 95 06 00	Miscellaneous Carpentry
06 22 13 00	01 95 06 00a	Exterior Finish Carpentry
06 22 13 00	01 95 06 00b	Interior Finish Carpentry

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SECTION 06 25 16 00 - 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 06 25 16 00

SECTION 06 41 13 00 - WOOD-VENEER-FACED ARCHITECTURAL CABINETS

SECTION 06 4113 - WOOD-VENEER-FACED ARCHITECTURAL CABINETS

PART 1 - GENERAL

1 SUMMARY

A. Section Includes:

1. Wood furring, blocking, shims, and hanging strips for installing architectural wood cabinets unless concealed within other construction before cabinet installation.
2. Shop finishing of architectural wood cabinets.

2 ACTION SUBMITTALS

A. Product Data: For each type of product, including panel products cabinet hardware and accessories and finishing materials and processes.

B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.

C. Samples:
1. Lumber for transparent finish, for each species and cut, finished on one side and one edge.
2. Veneer leaves representative of and selected from flitches to be used for transparent-finished cabinets.
3. Lumber and panel products with shop-applied opaque finish, for each finish system and color, with exposed surface finished.
4. Exposed cabinet hardware and accessories, one unit for each type and finish.

3 INFORMATIONAL SUBMITTALS

A. Woodwork Quality Standard Compliance Certificates: WI Certified Compliance Program certificates.

4 QUALITY ASSURANCE

A. Fabricator Qualifications: Licensee of WI's Certified Compliance Program.

B. Installer Qualifications: Licensee of WI's Certified Compliance Program.

PART 2 - PRODUCTS

1 ARCHITECTURAL WOOD CABINETS, GENERAL

A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of architectural wood cabinets indicated for construction, finishes, installation, and other requirements.
1. Provide labels and certificates from WI certification program indicating that woodwork, including installation, complies with requirements of grades specified.

2 WOOD CABINETS FOR TRANSPARENT FINISH

A. Grade: Custom.

B. Type of Construction: Frameless.

C. Cabinet and Door and Drawer Front Interface Style: Flush overlay.

1. Door Name: "Bronco" by Decorative Specialties. Solid maple frame with 1/4" plywood center panel.
2. Drawer Front: Solid maple slab with same edge detail as door.
3. Provide rubber stops at ends and backs of doors.
4. The reveal dimension shall be consistent across the cabinet elevation. The doors and drawer faces shall allign.

D. Wood for Exposed Surfaces: As indicated.
1. Species: Maple.
2. Cut: Plain sliced/plain sawn.
3. Grain Direction: Vertically for drawer fronts, doors, and fixed panels As indicated.
4. Matching of Veneer Leaves: match.
5. Veneer Matching within Panel Face: Running match.

E. Semiexposed Surfaces: Provide surface materials indicated below:
1. Surfaces Other Than Drawer Bodies: Same species and cut indicated for exposed surfaces.
2. Drawer Subfronts, Backs, and Sides: Solid-hardwood lumber, same species indicated for exposed surfaces.
3. Drawer Bottoms: Hardwood plywood.
4. Provide rubber stops at ends and backs of doors.

F. Dust Panels: 1/4-inch plywood or tempered hardboard above compartments and drawers unless located directly under tops.

G. No particle board or MDF is to be used.

3 WOOD MATERIALS

A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of woodwork and quality grade specified unless otherwise indicated.
1. Wood Moisture Content: 5 to 10 percent.

B. Composite Wood and Agrifiber Products: Provide materials that comply with requirements of referenced quality standard for each type of woodwork and quality grade specified unless otherwise indicated.

1. Composite Wood and Agrifiber Products: Products shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
2. Softwood Plywood: DOC PS 1, medium-density overlay.
3. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1, made with adhesive containing no urea formaldehyde.

4. Thermoset Decorative Panels: Particleboard or medium-density fiberboard finished with thermally fused, melamine-impregnated decorative paper and complying with requirements of NEMA LD 3, Grade VGL, for test methods 3.3, 3.4, 3.6, 3.8, and 3.10.

4 CABINET HARDWARE AND ACCESSORIES

A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets .

B. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 135 degrees of opening, self-closing.

C. Back-Mounted Pulls: BHMA A156.9, B02011.

D. Wire Pulls: Back mounted, solid metal, 4 inches long, 5/16 inch in diameter.

E. Catches: Magnetic catches, BHMA A156.9, B03141.

F. Adjustable Shelf Standards and Supports: BHMA A156.9, B04071; with shelf rests, B04081.

G. Shelf Rests: BHMA A156.9, B04013; metal, two-pin type with shelf hold-down clip.

H. Drawer Slides: BHMA A156.9.

1. Grade 1HD-100 and Grade 1HD-200: Side mounted; full-extension type; zinc-plated-steel ball-bearing slides.
2. For drawers more than 3 inches high but not more than 6 inches high and not more than 24 inches wide, provide Grade 1HD-100.
3. For drawers more than 6 inches high or more than 24 inches wide, provide Grade 1HD-200.

I. Door and Drawer Silencers: BHMA A156.16, L03011.

J. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.

1. Satin Chromium Plated: BHMA 626 for brass or bronze base; BHMA 652 for steel base.
2. Satin Stainless Steel: BHMA 630.

5 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.

B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

C. Adhesives: Do not use adhesives that contain urea formaldehyde.

D. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

6 FABRICATION

A. 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.

B. Shop-cut openings to maximum extent possible to receive hardware, appliances, 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.

7 SHOP FINISHING

A. General: Finish architectural wood cabinets at fabrication shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.

B. Finish Materials: Use finish materials that meet the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural wood cabinets, as applicable to each unit of work.
   1. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of cabinets.

PART 3 - EXECUTION

1 PREPARATION

A. Before installation, condition cabinets to average prevailing humidity conditions in installation areas.

2 INSTALLATION

A. Grade: Install cabinets to comply with same grade as item to be installed.

B. Install cabinets level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches.

C. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

D. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork.

E. 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.

1. Install cabinets with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
2. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches o.c. with No. 10 wafer-head screws sized for not less than 1-1/2-inch penetration into wood framing, blocking, or hanging strips.

F. Touch up finishing work specified in this Section after installation of woodwork. Fill nail holes with matching filler where exposed.

END OF SECTION 06 41 13 00

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Task	Specification	Specification Description
06 41 13 00	01 95 06 00c	Interior Architectural Woodwork
06 41 13 00	01 95 06 00d	Casework
06 41 93 00	08 71 23 00	Door Hardware
06 42 13 00	06 25 16 00	Paneling
06 42 16 00	06 25 16 00	Paneling

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SECTION 06 42 19 00 - 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 06 42 19 00

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Task	Specification	Specification Description
06 42 19 00	06 25 16 00	Paneling
06 43 16 00	01 95 06 00c	Interior Architectural Woodwork
06 44 39 00	01 95 06 00c	Interior Architectural Woodwork
06 46 13 00	01 95 06 00	Miscellaneous Carpentry
06 46 13 00	01 95 06 00a	Exterior Finish Carpentry
06 46 13 00	01 95 06 00b	Interior Finish Carpentry
06 46 19 00	01 22 16 00	No Specification Required
06 46 19 00	01 95 06 00	Miscellaneous Carpentry
06 46 19 00	01 95 06 00a	Exterior Finish Carpentry
06 46 19 00	01 95 06 00b	Interior Finish Carpentry
06 46 19 00	01 95 06 00c	Interior Architectural Woodwork
06 46 23 00	01 95 06 00c	Interior Architectural Woodwork
06 46 26 00	01 95 06 00c	Interior Architectural Woodwork

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SECTION 06 46 29 00 - 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 06 46 29 00

Task	Specification	Specification Description
06 46 29 00	01 95 06 00c	Interior Architectural Woodwork
06 46 36 00	01 95 06 00c	Interior Architectural Woodwork

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SECTION 06 48 13 00 - WOOD DOORS

1.1 DESCRIPTION OF WORK

A. This specification covers the furnishing and installation of materials for wood doors. 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. Definitions
1. Supply-and-Delivery-Only Contract: Includes supply and delivery to site FOB destination. Freight prepaid. Unless otherwise specified or scheduled, unloading and handling at site is by the Owner.
2. Supply-and-Install Contract: Includes supply, delivery to site FOB destination, freight prepaid, unloading and handling at site, and installation.

B. System Description
1. Door Assemblies: Include doors, frames, and hardware.
a. Provide with fire rating as indicated or specified.
2. Security Entry Door System (Assembly) Performance Requirements:
a. Forced Entry: ASTM F 476, Grade 40.

C. Submittals
1. Shop Drawings:
a. Indicate location, size, elevation, details of construction, marks used to identify doors, location and extent of hardware blocking, fire rating, factory preparation requirements for each door type. Drawings shall include catalog cuts or descriptive data for weatherstripping and thresholds to be used.
2. Quality Assurance/Control Submittals:
a. Test Reports: Results of testing by accredited independent laboratory demonstrating compliance of door systems with specified performance requirements.
1) Indicate that tests were performed in accordance with standard referenced.
b. Certificates: Manufacturer's written certification that door systems meet or exceed specified requirements.
c. Manufacturer’s installation instructions.
3. Closeout Submittals:
a. Operation and maintenance data.
b. Special warranty.

D. Quality Assurance
1. Regulatory Requirements: Comply with following:
a. Fire-Rated Label: Determined using ASTM E 152, and bear label of UL or other recognized fire-rating program acceptable to authorities having jurisdiction,
1) If any door or frame scheduled to be fire-rated cannot qualify for appropriate labeling because of Its design, hardware, or any other reason, advise the Owner prior to submission of bids.
b. Accessibility: (Required for accessible units only, including main building entrances.)
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).

2. Mock-ups: Install one mock-up of each type of door system, including doors, frames, hardware, thresholds, and accessories.
   a. Location: As directed.
   b. Approved Mock-up: Standard for rest of work, and may remain part of completed project.

E. Delivery, Storage, And Handling
1. Packing, Shipping, Handling, and Unloading: Pack materials at manufacturing plant to prevent damage during shipping.
   a. Delivery: Do not deliver doors to building until it is entirely enclosed, drywall and concrete work is completed, and humidity in building has reached average relative humidity of locality.
   b. Storage: Stack doors flat and off floor in manner to prevent warping or twisting, and to provide ventilation. Do not drag doors across one another.
   c. Protection: Protect doors during transit, storage, and handling to prevent damage, soiling, and deterioration, and from extremes in temperature and humidity. Comply with “On-site Care" recommendations of NWWDA Care and Finishing of Wood Doors, and with manufacturer's recommendations.
2. Acceptance at Site: Inspect door systems upon delivery. Replace damaged or defective materials before installation.

F. Project Conditions
1. Field Measurements: Field measure openings for door systems before start of fabrication.

G. Scheduling And Sequencing
1. Scheduling and Completion: Comply with requirements of Detailed Scope of Work.

H. Warranty
1. Special Warranty:
   a. Swinging Doors and Standard Closet Doors Warranty: Provide one-year written warranty covering materials and installation for wood doors.
      1) Include coverage of hardware.
      2) Cover warping (bow, cup, or twist), photographing of construction below face veneers, tolerance limitations of NWWDA I.S. 1-A.
      3) Cover delamination.
      4) Glazing not included.
      5) Defects resulting from vandalism not included.
   b. Heavy-Duty Closet Doors Warranty: Provide manufacturer's five-year written warranty covering materials and installation for bifold closet doors.
   c. For Supply-and-Delivery-Only Contract:
      1) Contractor: Agrees to supply and deliver to the Owner, free of charge, any required replacement parts that can be readily installed by the Owner without special tools.
      2) Contractor: Agrees to supply and deliver to the Owner, free of charge, complete replacement door, when defective part or parts cannot be installed without use of special tools.
   d. For Supply-and-Install Contract: Contractor: Agrees to supply and install. free of charge, any required replacement parts or complete replacement door.

1.3 PRODUCTS

A. Door Frames
1. Wood Frames: Kiln dried Ponderosa Pine, toxic-treated, and primed.
   a. Applied stops are permitted, unless otherwise indicated.

2. Steel Frames:
   a. Steel: ASTM A 366 cold rolled steel.
   b. Steel Frames and/or Adapter Frames: Minimum of 18 gage (1.07 mm) galvanized bonderized steel, pre-drilled and reinforced for hinges as required.
      1) Shape of Frame: Generally L-shaped.
   c. Heavy-Duty Door Frames: 16 gage (1.35 mm) minimum thickness.
      1) When required, provide B-Label, 1-1 /2 hour fire rating.
   d. Security Door Frames: Comply with SDI 100, minimum of 14 gage (1.70 mm) galvanized bonderized steel, pre-drilled and reinforced for hinges as required.
      1) When required, provide B-Label, 1-1 /2 hour fire rating.
      2) Comply with Performance Requirements in this Section.
   e. Preparation for Hardware: Machine and reinforce frames for attachment of hardware, including mortising, drilling, and tapping for hinges and mortised hardware.
   f. Frame Anchors: Provide jamb anchors as suitable for wall conditions and floor anchors, minimum 18 gage.
      1) Provide welded type frames with temporary spreader bars.

B. Interior Wood Swinging Doors
1. Standard Products: Doors shall be of type, size, and design indicated, and shall be standard products of manufacturers regularly engaged in manufacture of wood doors.
   a. Marking: Each door shall bear stamp, brand. or other identifying mark indicating quality and construction of door. Identifying mark or separate certification shall include identification of standard on which construction of door is based, and identity of manufacturing plant.
2. Interior Wood Doors: NWWDA I.S. 1-A.
   a. Thickness: 44.4 mm (1-3/4 inch) unless otherwise indicated or scheduled.
   b. Adhesives: NWWDA I.S. 1-A, Type II.
   c. Prefitting: Provide doors prefitted or unfitted at option of Contractor.
   d. Faces. stiles. and rails bonded to cores.
3. Core Construction:
   a. Solid Core Door NWWDA Construction Type: One of following (as specified):
      1) PC-5 or PC-7 (5- or 7-ply) with particleboard core, bonded.
         a) Stiles: Full core thickness and minimum 34 mm (1-3/8 inch) face width.
      2) SLC-5 or SLC-7 (5- or 7-ply) provide with glued wood-block core, bonded.
         a) Stiles: Full core thickness and minimum 19 mm (3/4 inch) face width.
      3) Stiles and Rails: Top and bottom rails for particleboard and wood-block core doors shall have minimum 29 mm (1-1/8 inch) face width by full core thickness.
   b. Hollow-Core Doors: NWWDA IHC (Institutional Hollow Core) or SHC (Standard Hollow Core), as specified.
      1) Provide with heavy-duty wood stiles, rails, lock blocks and other reinforcement inside core as required to allow for secure screw attachment of hardware.
      2) Hinge Stile: Minimum 25 mm (1 inch) minimum thick.
   c. Stile Edge Bands: Mill option specie.
      1) No visible finger-joints acceptable in stile edge bands.
      2) When used, locate finger-joints under hardware.
   d. Fire-Rated Door NWWDA Construction Type: As required for fire rating indicated or scheduled.
      1) Mineral Core Doors: Provide with heavy duty wood stiles, rails, lock blocks, and other reinforcement inside core as required to allow for secure screw attachment of hardware including closers and exit devices.
         a) Reinforcement Blocking: In compliance with manufacturer's labeling requirements.
      2) Provide factory prefitting and premachining as required for fire-rated labels.
      3) Means of Egress Fire Doors: Provide doors with maximum 232 degrees C (450 degree F) temperature rise rating in 30 minutes of fire exposure.
   e. Wood Stiles, Rails, Lock Blocks, and Other Reinforcement: Wood:
      1) Rail Blocks: Not less than 125 mm (5 inches) wide by full core thickness.

2) Split Resistance: NWWDA TM-5, average of ten test samples shall be not less than 225 load kilograms (500 load pounds).
3) Direct Screw Withdrawal: NWWDA TM-10, average of ten test samples shall be not less than 315 load kilograms (700 load pounds) when tested for direct screw withdrawal using steel, fully threaded wood screw.
4) Cycle/Swing: NWWDA TM-7. 200,000 cycles with no loose hinge screws or other visible signs of failure.

f. Under Cutting: Preserve full bottom rail.

4. Face Panels:
   a. Painted Finish: NWWDA I.S. 1-A, minimum 3 mm (1/8 inch) thick hardboard.
   b. Plastic Laminate Finish: NEMA LD 3, high pressure decorative laminate, Grade GP50, 1.3 mm (0.050 inch) thick.
      1) Faces: Adhesively apply over minimum 3 mm (1/8 inch) thick hardboard.
      2) Edges: Adhesively apply plastic laminate matching face panels.
      3) Color and Pattern: As selected.

C. Hardware
1. General: Comply with ANSI/BHMA A156.1 and applicable accessibility regulatory requirements and perform functions for which It was intended.
2. Butts and Hinges: ANSI/BHMA A156.1, as scheduled.
   a. Install non-rising pins (NRP) on out-swing residential unit entry doors.
   b. Self Closing: ANSI/BHMA A156.17.
   c. Security Door: Comply with Performance Requirements in this Section.
3. Fire-Rated Door Hardware: Comply with NFPA 80.
   a. Exit Doors: Comply with NFPA 101 (Life Safety Code) for exit doors, as well as other requirements specified.
   b. Labeling and Listing: Listed in UL Building Materials Directory.
      1) In Lieu of UL Labeling and Listing: Test reports from nationally recognized testing agency showing that hardware has been tested in accordance with UL test methods and conforms to NFPA requirements.
   c. Install minimum latch throw as specified on label of individual door.
   d. Provide hardware listed by UL, except where heavier materials, larger sizes, or higher grades are specified.
   e. Closers: ANSI/BHMA A156.4.
4. Lock Sets and Passage Sets: As scheduled. Comply with following standards:
   a. Bored and Preassembled Locks and Latches: ANSI/BHMA A156.2, Grade 2.
   b. Dead Bolt: ANSI/BHMA A156.5.
   c. Mortise Locks and Latches: ANSI/BHMA A156.13, Grade 1 or Security Grade, single or multiple throw.
   d. Interconnected Deadlock and Passage Set: ANSI/BHMA A156.12, Grade 2.
   e. Cylindrical Lock: Grade 2 cylindrical deadbolt lock/passage set combination.
   f. Security Door Locksets: ANSI/BHMA A156.13 Security Grade or UL 437 Key locks.
      1) Comply with Performance Requirements in this Section.
   g. Keys: Provide two keys for each lock provided. Provide master keying and keying alike on any locks as directed at no additional charge.
   h. Locks: Provide with interchangeable cores.
5. Door Viewers: ANSI/BHMA A156.16.

D. Factory Fitting And Machining
1. Doors: Prefit, bevel, mortise, and machine doors at factory in accordance with NWWDA I.S. 1-A.
   a. Comply with hardware schedules and door frame Shop Drawings with hardware templates to ensure proper fit of doors and hardware.
      1) Take accurate field measurements of hardware mortises in metal frames to verify dimensions and alignment before proceeding with machining in factory.
   b. Machine doors for hardware requiring cutting of doors.
   c. Fit doors to frame bevel lock edge of doors (1/8 inch) for each (2 inches) of door thickness.

d. Finish all surfaces, including both faces, top and bottom and edges of doors smooth to touch.

2. Edge Sealing: Seal wood end grain exposed at edges and cutouts of doors against moisture penetration prior to shipment.
   a. Sealer: Two coats of spar varnish or other sealer recommended by door manufacturer.
3. Tolerances: Comply with NWWDA tolerance requirements for prefitting.

E. Door Assemblies
1. Prehung Swinging Doors: Prehung door with matching wood frame complete with hinges, lockset or passage set, and other hardware, as indicated or specified.
2. Fire-Rated Doors and Frames: NFPA 80 and bear identifying label of UL or nationally recognized testing agency qualified to perform certification programs indicating that units conform to requirements for class indicated.
   a. Labels: Metal with raised or incised markings.
   b. Hardware: As required to maintain fire rating and receive label.
3. Security Entry Frames and Doors:
   a. Comply with Performance Requirements in this Section.
   b. Fire Rating: When required, provide B-Label, 1-1/2 hour fire rating.

F. Closet Doors
1. Heavy-Duty Bifold Closet Doors: Particleboard bifold doors, prime painted, factory premachined, complete with manufacturer's standard hardware to provide complete operating bifold doors.
   a. Panels: 721 kg/ cubic m (45 PCF) industrial-grade particle board, 19.1 mm (3/4 inch) thick.
      1) Long Edges: Plasticized.
      2) Room Side: Filled and prime painted.
      3) Closet Side: Prime painted.
      4) Exposed Surfaces Finish: Painted or plastic laminate as indicated or scheduled.
   b. Track: No. 6063-T6 extruded aluminum, 20.5 mm (13/16 inch) by 32 mm (1-1/4 inch).
      1) Track Guides: Delrin.
   c. Hardware: Factory-applied to doors and track.
      1) Pivot and Mounting Hardware: 14 gage cold-rolled steel, carbonized for strength and durability.
      2) Top Pivot and Guide Pins: 75 mm (3 inch) removable compensating pins.
      3) Toggle Pivot: Ensure doors remain in place.
      4) Spring Enclosure: Provide positive closing with little effort and keep doors closed.
      5) Bottom Pivot: Carry weight of door, floor-mounted, and designed for vertical and horizontal adjustment.
      6) Panel Brackets: Wrap-around feature to eliminate unnecessary stress on screws.
      7) Panels: Hinged together with continuous piano hinges inserted into routed grooves and secured with tempered pins.
      8) Pulls: As selected from manufacturer's standards.
   d. Doors: Comply with accessibility requirements (as specified).
2. Standard Bifold Closet Doors: Provide complete manufacturer’s standard hardware, including tracks, hinges, guides, and pulls to provide complete operating bifold doors.
   a. Hollow-Core Doors: NWWDA I.S. 1-A and NWWDA IHC (Institutional Hollow Core).
      1) Provide with heavy-duty wood stiles, rails, lock blocks and other reinforcement inside core as required to allow for secure screw attachment of hardware.
   b. Doors: 34.9 mm (1-3/8 inch) thick unless otherwise indicated.
   c. Surface-Mounted Pulls: As selected from manufacturer standards.
3. Standard Sliding Closet Doors: Provide complete manufacturer’s standard hardware, including tracks, guides, and pulls to provide complete operating sliding doors.
   a. Hollow-Core Doors: NWWDA I.S. 1-A and NWWDA lHC (Institutional Hollow Core).
      1) Provide with heavy-duty wood stiles, rails, lock blocks and other reinforcement inside core as required to allow for secure screw attachment of hardware.
   b. Doors: 34.9 mm (1-3/8 inch) thick unless otherwise indicated.
   c. Recessed Pulls: As selected from manufacturer standards.
4. Standard Closet Door Face Panels:

a. Painted Finish: NWWDA I.S. 1-A, minimum 3 mm (1/8 inch) thick hardboard.
b. Plastic Laminate Finish: NEMA LD 3, high-pressure decorative laminate, Grade GP50, 1.3 mm (0.050 inch) thick.
    1) Faces: Adhesively apply over minimum 3 mm (1/8 inch) thick hardboard.
    2) Edges: Adhesively apply plastic laminate matching face panels.
    3) Color and Pattem: As selected.

G. Finishes
1. Painted Wood Finish: One of following as indicated or scheduled:
    a. Factory Finish: NWWDA System No. 10-Conversion Varnish.
        1) Color: As selected.
    b. Field Finish: Factory primed for field paint under Division 9 Section “Painting.”
2. Painted Steel Finish: Clean and free from serious surface blemishes.
    a. Exposed Surfaces: ASTM A 591 electrolytic zinc-coated steel, Class A.
    b. Primer: ANSI A224.1, factory-applied primer.
    c. Finish Coat: One of following as specified or scheduled:
        1) Factory Finish: Electrostatically factory applied baked-on enamel finish.
            a) Color: As selected from manufacturer's list of colors.
        2) Field Finish: Factory-primed for field paint under Division 9 Section “Painting.”

1.4 EXECUTION

A. Examination
1. Site Verification of Conditions:
    a. Existing Conditions: Examine openings before beginning installation.
    b. Field Measurements: Verify field measurements are as indicated on Shop Drawings.
    c. Before installation of doors, verify that frames are proper size, location, type, and swing characteristics for door, and are installed with plumb jambs and level heads as required for proper installation of doors.
    d. Reject doors with defects.
    e. Do not proceed with installation until conditions are satisfactory.

B. Preparation
1. Protection: Protect adjacent elements from damage and disfiguration in accordance with Detailed Scope of Work.
    a. Contractor: Responsible for damage to buildings and any other facilities or property caused by construction operations.
    b. Repair or replace damaged elements in accordance with Detailed Scope of Work.
2. Existing Doors: Remove existing doors and debris from site in accordance with Detailed Scope of Work.
3. Preparation: Prepare existing openings in accordance with ASTM E 737, manufacturer's recommendations, and approved Shop Drawings.
4. Wood Door Preparation:
    a. Conditioning: Condition wood doors to average humidity in installation area prior to hanging.
    b. Prefitting: Prefit wood doors to frames and machine for hardware to whatever extent not previously worked at factory as required for proper fit and uniform clearance at each edge.
    c. Sealing: Before installation of hardware on wood doors, brush apply sealer to all job site cut or planed surfaces.

C. Door Frame Installation
1. Door Frames: Install in accordance with ASTM E 737, manufacturer's recommendations, and approved Shop Drawings.

a. Set frames accurately in accordance with details, straight and free of twist with head level, jambs plumb, and without distortion. Rigidly anchor to walls and partitions and securely brace until surrounding work is completed.

2. Wood Frames: Set plumb and square, and rigidly anchor In place using finish type nails. Provide double wedge blocking near top, bottom, and midpoint of each jamb.

3. Steel Frames: Comply with SDI 105:
   a. Fire-Rated Openings: Place frames and provide clearances in accordance with NFPA 80 and GA 253.
   b. Field Welds: Make welds full length of joints. Remove splatter, and grind exposed welds to match adjacent surfaces. Provide the Owner with ample notice to review welds before finish operations begin.
   c. Wherever possible, leave spreader bars in place until frames are securely anchored.

D. Wood Door Installation
1. General: Install doors in accordance with NWWDA I.S. 1-A, ASTM E 737, manufacturer's recommendations, and approved Shop Drawings.
   a. Install doors and frames securely, straight, plumb, and level without distortion.
2. Wood Doors: Install wood doors in accordance with manufacturers recommendations.
   a. Prefit Doors: Fit to frames for uniform clearance at each edge.
   b. 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.
   c. Hanging: After sizing doors, fit and machine for hardware as scheduled.
      1) Hang doors to be free of binding, with hardware functioning properly.
   d. Clearances for Nonfire-Rated Doors:
      1) Jamb: 3 mm (1/8 inch), 3 mm (1/8 inch) bevel in 50 mm (2 inches).
      2) Head: 3 mm (1/8 inch).
      3) Bottom at Decorative Floor Finish or Covering: 13 mm (1/2 inch).
      4) Bottom at Threshold: 6 mm (1/4 inch) between bottom of door and top of threshold.
   e. Clearances for Fire Rated Doors: Comply with NFPA 80 and local code.
      1) Bevel fire-rated doors 3 mm in 50 mm (1/8 inch in 2 inches) at lock edge; trim stiles and rails only to extent permitted by labeling agency.
   f. Seal cut surfaces after fitting and machining as specified above.
3. Fire-Rated Doors:
   a. Installation, Hardware, and Operational Characteristics: Comply with NFPA 80, NFPA 101, and manufacturer's recommendations.
   b. Factory-Applied Labels: Remain intact where installed. Do not trim labeled hinge stile edge and top edge of door.
      1) Do not paint over labels.
   c. Clearances for Fire-Rated Doors: Comply with NFPA 80 and local code.
      1) Lockstile Edge and Bottom Edge: May be trimmed only to extent recommended by door manufacturer.
      2) Bevel fire-rated doors 3 mm in 50 mm (1/8 inch in 2 inches) at lock edge; trim stiles and rails only to extent permitted by labeling agency.
   d. Seal cut surfaces after fitting and machining as specified above.

E. Hardware Installation
1. General: Install hardware in accordance with SDI 109, DHI recommended locations, and manufacturers recommendations.
2. Fastening: Furnish items of hardware with attachment screws, bolts. nuts. etc., as required to attach hardware to type of material involved and with finish to match adjacent hardware.
   a. Make attachments to metal by template machine screws.
   b. Through-bolt hardware such as door closers, forearm shoes of closers, holding devices, and panic hardware mounted on doors or panels.
   c. Attach hardware to masonry or concrete with expansion bolts or similar drilled anchors to develop full strength of attached device. Set expansion anchors in solid masonry, not mortar joints.

3. Accessories:
    a. Smoke Seals and Sound-stripping: Run full height of both jambs and full width of head.
    b. Thresholds: Run full width of opening. Install thresholds with continuous threshold anchors cast into slab and set in sealant.

F. Door Assemblies Installation
1. Prehung Wood Doors in Frames with Hardware: Install in accordance with manufacturer's recommendations.
2. Bifold Closet Doors with Hardware: Install in accordance with manufacturers recommendations.
3. Sliding Closet Doors with Hardware: Install in accordance with manufacturer's recommendations.

G. Adjusting And Cleaning
1. Adjusting: At completion of job, check, adjust. and lubricate hardware as required, and leave doors and hardware in proper operating condition.
    a. Operation: Rehang or replace doors which do not swing or operate freely.
2. Cleaning: Comply with requirements of Detailed Scope of Work.
    a. Clean doors after installation to remove foreign matter and surface blemishes.
    b. Scratched or Abraded Painted Surfaces: Touch-up with primer and enamel paint compatible with factory finish.

H. Protection
1. Installed Work: Protect doors from damage after installation. as recommended by door manufacturer. to ensure that doors will be without damage or deterioration at project completion.
2. Replacement: Refinish or replace doors damaged during installation.
    a. Causes for Rejection of Wood Doors: Include warp, chips, scratches, or gouges of veneer. and finish defects.

END OF SECTION 06 48 13 00

Task	Specification	Specification Description
06 48 16 00	06 48 13 00	Wood Doors

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SECTION 06 51 13 00 - 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. Submittals
1. Product Data and Certificates: For each product indicated.
   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. Show details full size.
   b. Show locations and sizes of furring and blocking, including concealed blocking specified in other Sections.
   c. Apply WI Certified Compliance Program label to first page of Shop Drawings.
3. Samples for initial selection for high-pressure decorative laminates.
4. Samples for verification for plastic laminates, 8 by 10 inches (200 by 250 mm) **OR** 12 by 12 inches (300 by 300 mm), **as directed,** for each type, color, pattern, and surface finish, with one sample applied to core material and specified edge material applied to one edge.
5. Qualification Data: For Installer **OR** Fabricator, **as directed**.
6. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates **OR** WI Certified Compliance Program certificates, **as directed**.
7. Evaluation Reports: For fire-retardant-treated materials from ICC-ES.

D. 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.

E. 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 06 51 13 00

SECTION 06 51 13 00a - 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. Submittals
1. Product Data and Certificates: For each product indicated.
   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. Show details full size.
   b. Show locations and sizes of furring and blocking, including concealed blocking specified in other Sections.
   c. Apply WI Certified Compliance Program label to first page of Shop Drawings.
3. Samples for initial selection for high-pressure decorative laminates.
4. Samples for verification for plastic laminates, 8 by 10 inches (200 by 250 mm) **OR** 12 by 12 inches (300 by 300 mm), **as directed,** for each type, color, pattern, and surface finish, with one sample applied to core material and specified edge material applied to one edge.
5. Qualification Data: For Installer **OR** Fabricator, **as directed**.
6. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates **OR** WI Certified Compliance Program certificates, **as directed**.
7. Evaluation Reports: For fire-retardant-treated materials from ICC-ES.

D. 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.

E. 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.

F. 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 06 51 13 00a

SECTION 06 51 13 00b - 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. Submittals
1. Product Data and Certificates: For each product indicated.
   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. Show details full size.
   b. Show locations and sizes of furring and blocking, including concealed blocking specified in other Sections.
   c. Apply WI Certified Compliance Program label to first page of Shop Drawings.
3. Samples for initial selection for high-pressure decorative laminates.
4. Samples for verification for plastic laminates, 8 by 10 inches (200 by 250 mm) **OR** 12 by 12 inches (300 by 300 mm), **as directed,** for each type, color, pattern, and surface finish, with one sample applied to core material and specified edge material applied to one edge.
5. Qualification Data: For Installer **OR** Fabricator, **as directed**.
6. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates **OR** WI Certified Compliance Program certificates, **as directed**.
7. Evaluation Reports: For fire-retardant-treated materials from ICC-ES.

D. 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.

E. 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 06 51 13 00b

Task	Specification	Specification Description
06 65 00 00	01 95 06 00	Miscellaneous Carpentry

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SECTION 06 74 13 00 - 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 06 74 13 00

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Task	Specification	Specification Description
06 74 13 00	05 53 13 00	Gratings

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SECTION 06 82 00 00 - 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 06 82 00 00

SECTION 07 05 13 00 - 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 Decking".

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 **OR** 20 **OR** 25 **OR** 30, **as directed**, years from date of Final 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.
   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 Final 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 07 05 13 00

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SECTION 07 05 13 00a - 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 Decking".

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 Final 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 Decking", 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 Final 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 07 05 13 00a

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SECTION 07 05 13 00b - 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 Decking".

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 **OR** 20 **OR** 25 **OR** 30, **as directed**, years from date of Final 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 Rough 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 Decking".
   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 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.
   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 Final 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.

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SECTION 07 05 13 00c - 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 Decking".

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 **OR** 20 **OR** 25 **OR** 30, **as directed,** years from date of Final 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 Rough 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 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.
   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 Final 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 07 05 13 00c

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SECTION 07 05 13 00d - PREPARATION FOR RE-ROOFING

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for preparation for re-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. Roof tear-off.
b. Partial roof tear-off.
c. Temporary roofing membrane.
d. Roof re-cover preparation.
e. Removal of base flashings.

C. Materials Ownership
1. Except for items or materials indicated to be reused, reinstalled, or otherwise indicated to remain the Owner's property, demolished materials shall become Contractor's property and shall be removed from Project site.

D. Definitions
1. Roofing Terminology: Refer to 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.
2. Existing Membrane Roofing System: Built-up asphalt, Built-up coal-tar, EPDM, CSPE, PVC, TPO, APP-modified bituminous, or SBS-modified bituminous roofing membrane, roof insulation, surfacing, and components and accessories between deck and roofing membrane.
3. Roof Re-Cover Preparation: Existing roofing membrane that is to remain and be prepared for reuse.
4. Roof Tear-Off: Removal of existing membrane roofing system from deck.
5. Partial Roof Tear-Off: Removal of a portion of existing membrane roofing system from deck or removal of selected components and accessories from existing membrane roofing system.
6. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and reinstalled.
7. Existing to Remain: Existing items of construction that are not indicated to be removed.

E. Submittals
1. Product Data: For each type of product indicated.
2. Temporary Roofing: Include Product Data and description of temporary roofing system. If temporary roof will remain in place, submit surface preparation requirements needed to receive permanent roof, and submit a letter from roofing membrane manufacturer stating acceptance of the temporary membrane and that its inclusion will not adversely affect the roofing system's resistance to fire and wind or its FM Global rating, **as directed**.
3. Coal tar roofs can't be mixed with asphalt roofs. Test materials in accordance with the American Society for Testing and Materials (ASTM).
4. Fastener pull-out test report.
5. Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including exterior and interior finish surfaces that might be misconstrued as having been damaged by reroofing operations. Submit before Work begins.
6. Landfill Records: Indicate receipt and acceptance of hazardous wastes, such as asbestos-containing material, by a landfill facility licensed to accept hazardous wastes.

7. Qualification Data: For Installer including certificate that Installer is licensed to perform asbestos abatement and is approved by warrantor of existing roofing system.

F. Quality Assurance
1. Installer Qualifications: Installer of new membrane roofing system, licensed to perform asbestos abatement in the State or jurisdiction where Project is located, **as directed**, and approved by warrantor of existing roofing system to work on existing roofing, **as directed**.
2. Regulatory Requirements: Comply with governing EPA notification regulations before beginning membrane roofing removal. Comply with hauling and disposal regulations of authorities having jurisdiction.
3. Reroofing Conference: Conduct conference at Project site.

G. Project Conditions
1. the Owner will occupy portions of building immediately below reroofing area. Conduct reroofing so the Owner's operations will not be disrupted. Provide the Owner with not less than 72 hours' notice of activities that may affect the Owner's operations.
   a. Coordinate work activities daily with the Owner so the Owner can place protective dust or water leakage covers over sensitive equipment or furnishings, shut down HVAC and fire-alarm or -detection equipment if needed, and evacuate occupants from below the work area.
   b. Before working over structurally impaired areas of deck, notify the Owner to evacuate occupants from below the affected area. Verify that occupants below the work area have been evacuated before proceeding with work over the impaired deck area.
2. Protect building to be reroofed, adjacent buildings, walkways, site improvements, exterior plantings, and landscaping from damage or soiling from reroofing operations.
3. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.
4. Conditions existing at time of inspection for bidding will be maintained by the Owner as far as practical.
   a. A roof moisture survey of existing membrane roofing system is available for Contractor's reference.
   b. The results of an analysis of test cores from existing membrane roofing system are available for Contractor's reference.
   c. Construction Drawings and Project Manual for existing roofing system are provided for Contractor's reference. Contractor is responsible for conclusions derived from existing documents.
5. Limit construction loads on roof, as directed by the Owner. Rooftop equipment wheel loads and for uniformly distributed loads.
6. Weather Limitations: Proceed with reroofing preparation only when existing and forecasted weather conditions permit Work to proceed without water entering existing roofing system or building.
7. Hazardous Materials: It is not expected that hazardous materials such as asbestos-containing materials will be encountered in the Work.
   a. Hazardous materials will be removed by the Owner before start of the Work. Existing roof will be left no less watertight than before removal.
   b. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify the Owner. Hazardous materials will be removed by the Owner under a separate contract.

   OR

   Hazardous Materials: Present in building to be reroofed. 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 according to procedures specified elsewhere in the Contract Documents.

c. Coordinate with hazardous material remediation subcontractor to prevent water from entering existing roofing system or building.

H. Warranty
1. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during reroofing, by methods and with materials so as not to void existing roofing system warranty. Notify warrantor before proceeding.
a. Notify warrantor of existing roofing system on completion of reroofing, and obtain documentation verifying that existing roofing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

1.2 PRODUCTS

A. Infill Materials
1. Use infill materials matching existing membrane roofing system materials unless otherwise indicated.
a. Infill materials are specified in a Division 07.

B. Temporary Roofing Materials
1. Design and selection of materials for temporary roofing are responsibilities of Contractor.
2. Sheathing Paper: Red-rosin type, minimum 3 lb/100 sq. ft. (0.16 kg/sq. m).
3. Base Sheet: ASTM D 4601, Type II, nonperforated, asphalt-impregnated and -coated, glass-fiber sheet.
4. Glass-Fiber Felts: ASTM D 2178, Type IV, asphalt-impregnated, glass-fiber felt.
5. Asphalt Primer: ASTM D 41.
6. Roofing Asphalt: ASTM D 312, Type III or IV.

C. Recover Boards
1. Recover Board: ASTM C 208, Type II, Grade 1 **OR** 2, **as directed**, cellulosic-fiber insulation board; 1/2 inch (13 mm) thick.
OR
Recover Board: Fan-folded, unfaced, extruded-polystyrene board insulation; 3/16-inch (5-mm) **OR** 1/4-inch (6-mm) **OR** 3/8-inch (10-mm), **as directed**, nominal thickness.
OR
Recover 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
Recover 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
Recover Board: ASTM C 728, perlite board; 1/2 inch (13 mm) **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick.
2. Fasteners: Factory-coated steel fasteners, No. 12 or 14, and metal or plastic plates listed in FM Approval's "Approval Guide," designed for fastening recover boards to deck.

D. Auxiliary Reroofing Materials
1. General: Auxiliary reroofing preparation materials recommended by roofing system manufacturer for intended use and compatible with components of existing and new membrane roofing system.
2. Base Sheet Fasteners: Capped head, factory-coated steel fasteners, listed in FM Approval's "Approval Guide."
3. Metal Flashing Sheet: Metal flashing sheet is specified in Division 07 Section "Sheet Metal Flashing And Trim".

1.3 EXECUTION

A. Preparation
1. Protect existing membrane roofing system that is indicated not to be reroofed.
   a. Loosely lay 1-inch- (25-mm-) minimum thick, molded expanded polystyrene (MEPS) insulation over the roofing membrane in areas indicated. Loosely lay 15/32-inch (12-mm) plywood or OSB panels over MEPS. Extend MEPS past edges of plywood or OSB panels a minimum of 1 inch (25 mm).
   b. Limit traffic and material storage to areas of existing roofing membrane that have been protected.
   c. Maintain temporary protection and leave in place until replacement roofing has been completed. Remove temporary protection on completion of reroofing.
2. Coordinate with the Owner to shut down air-intake equipment in the vicinity of the Work. Cover air-intake louvers before proceeding with reroofing work that could affect indoor air quality or activate smoke detectors in the ductwork.
3. During removal operations, have sufficient and suitable materials on-site to facilitate rapid installation of temporary protection in the event of unexpected rain.
4. Maintain roof drains in functioning condition to ensure roof drainage at end of each workday. Prevent debris from entering or blocking roof drains and conductors. Use roof-drain plugs specifically designed for this purpose. Remove roof-drain plugs at end of each workday, when no work is taking place, or when rain is forecast.
   a. If roof drains are temporarily blocked or unserviceable due to roofing system removal or partial installation of new membrane roofing system, provide alternative drainage method to remove water and eliminate ponding. Do not permit water to enter into or under existing membrane roofing system components that are to remain.
5. Verify that rooftop utilities and service piping have been shut off before beginning the Work.

B. Roof Tear-Off
1. General: Notify the Owner each day of extent of roof tear-off proposed for that day and obtain authorization to proceed.
2. Remove aggregate ballast from roofing membrane. Store aggregate ballast for reuse, **as directed**.
3. Remove loose aggregate from aggregate-surfaced built-up bituminous roofing using a power broom.
4. Remove pavers and accessories from roofing membrane. Store and protect pavers and accessories for reuse, **as directed**. Discard cracked pavers, **as directed**.
5. Remove protection mat and extruded-polystyrene insulation from protected roofing membrane.
   a. Discard extruded-polystyrene insulation that is wet and exceeds 8 lb/cu. ft. (128 kg/cu. m).
   b. Store extruded-polystyrene insulation for reuse and protect from physical damage.
6. Roof Tear-Off: Remove existing roofing membrane and other membrane roofing system components down to the deck.
   a. Remove cover boards **OR** roof insulation **OR** substrate boards, **as directed**.
   b. Bitumen and felts that are firmly bonded to concrete decks are permitted to remain if felts are dry. Remove unadhered bitumen and felts and wet felts.
   c. Remove excess asphalt from steel deck. A maximum of 15 lb/100 sq. ft. (0.72 kg/sq. m) of asphalt is permitted to remain on steel decks.
   d. Remove fasteners from deck or cut fasteners off slightly above deck surface, **as directed**.
7. Partial Roof Tear-Off: Where indicated, remove existing roofing membrane and other membrane roofing system components down to the deck.
   a. Remove cover boards **OR** roof insulation **OR** substrate boards, **as directed**.
   b. Bitumen and felts that are firmly bonded to concrete decks are permitted to remain if felts are dry. Remove unadhered bitumen and felts and wet felts.
   c. Remove excess asphalt from steel deck. A maximum of 15 lb/100 sq. ft. (0.72 kg/sq. m) of asphalt is permitted to remain on steel decks.
   d. Remove fasteners from deck or cut fasteners off slightly above deck surface, **as directed**.

OR

Partial Roof Tear-Off: Remove existing roofing membrane and immediately check for presence of moisture by visually observing cover boards **OR** roof insulation **OR** substrate boards, **as directed**, that will remain.

a. Coordinate with the Owner's inspector to schedule times for tests and inspections immediately after membrane removal.
b. With an electrical capacitance moisture-detection meter, spot check cover boards **OR** roof insulation **OR** substrate boards, **as directed**, that will remain.
c. Remove wet or damp boards and roof insulation. Removal will be paid for by adjusting the Contract Sum according to unit prices included in the Contract Documents, **as directed**.
d. Bitumen and felts that are firmly bonded to concrete decks are permitted to remain if felts are dry. Remove unadhered bitumen and felts and wet felts.
e. Remove excess asphalt from steel deck. A maximum of 15 lb/100 sq. ft. (0.72 kg/sq. m) of asphalt is permitted to remain on steel decks.
f. Remove fasteners from deck or cut fasteners off slightly above deck surface, **as directed**.

C. Deck Preparation

1. Inspect deck after tear-off **OR** partial tear-off, **as directed**, of membrane roofing system.
2. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263 or 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 moisture condenses under the plastic sheet or if asphalt test sample foams or can be easily and cleanly stripped after cooling.
3. If broken or loose fasteners that secure deck panels to one another or to structure are observed or if deck appears or feels inadequately attached, immediately notify the Owner. Do not proceed with installation until directed by the Owner.
4. If deck surface is not suitable for receiving new roofing or if structural integrity of deck is suspect, immediately notify the Owner. Do not proceed with installation until directed by the Owner.
5. Provide additional deck securement as indicated on Drawings.
6. Replace deck as indicated on Drawings. Replacement deck is specified in Division 31 OR Division 03 OR Division 21 Section(s) "Fire-suppression Standpipes".

D. Infill Materials Installation

1. Immediately after removal of selected portions of existing membrane roofing system, and inspection and repair, if needed, of deck, fill in the tear-off areas to match existing membrane roofing system construction.
   a. Installation of infill materials is specified in Division 07.
   b. Install new roofing membrane patch over roof infill area. If new roofing membrane is installed the same day tear-off is made, roofing membrane patch is not required.

E. Temporary Roofing Membrane

1. Install approved temporary roofing membrane over area to be reroofed.

   OR

   Install temporary roofing membrane over area to be reroofed. Install two glass-fiber felts **OR** Mechanically fasten base sheet and install a glass-fiber felt, **as directed**, lapping each sheet 19 inches (483 mm) over preceding sheet. Embed glass-fiber felt in a solid mopping of hot roofing asphalt applied within equiviscous temperature range. Glaze-coat completed surface with hot roofing asphalt.
2. Remove temporary roofing membrane before installing new roofing membrane.

   OR

   Prepare the temporary roof to receive new roofing membrane according to approved temporary roofing membrane proposal **OR** by patching and repairing temporary roofing membrane, **as directed**. Restore temporary roofing membrane to watertight condition. Obtain approval for temporary roof substrate from roofing membrane manufacturer and the Owner before installing new roof.

F. Roof Re-Cover Preparation

1. Remove blisters, ridges, buckles, mechanically attached roofing membrane fastener buttons projecting above the membrane, **as directed**, and other substrate irregularities from existing roofing membrane that inhibit new recover boards from conforming to substrate.
   a. Remove loose aggregate from aggregate-surfaced built-up bituminous roofing with a power broom.
   b. Scarify the surface of sprayed polyurethane foam as necessary to achieve a sufficiently uniform plane to receive new recover boards.
   c. Broom clean existing substrate.
   d. Coordinate with the Owner's inspector to schedule times for tests and inspections before proceeding with installation of recover boards.
   e. Verify that existing substrate is dry before proceeding with installation of recover boards. Spot check substrates with an electrical capacitance moisture-detection meter.
   f. Remove materials that are wet or damp. Removal will be paid for by adjusting the Contract Sum according to unit prices included in the Contract Documents.
2. Remove blisters, ridges, buckles, mechanically attached roofing membrane fastener buttons projecting above the membrane, **as directed**, and other substrate irregularities from existing roofing membrane that inhibit new recover boards **OR** roofing membrane, **as directed**, from conforming to substrate.
   a. Remove loose aggregate from aggregate-surfaced built-up bituminous roofing with a power broom.
   b. Scarify the surface of sprayed polyurethane foam as necessary to achieve a sufficiently uniform plane to receive new recover boards **OR** roofing membrane, **as directed**.
   c. Broom clean existing substrate.
   d. Coordinate with the Owner's inspector to schedule times for tests and inspections.
   e. Verify that existing substrate is dry before proceeding with installation. Spot check substrates with an electrical capacitance moisture-detection meter.
   f. Remove materials that are wet and damp. Removal will be paid for by adjusting the Contract Sum according to unit prices included in the Contract Documents.
3. Remove blisters and areas of membrane not fully adhered.

   OR

   Remove mechanically attached roofing membrane fastener buttons projecting above the membrane and other, **as directed**, substrate irregularities that inhibit new recover boards from conforming to substrate.
   a. Remove loose aggregate from aggregate-surfaced built-up bituminous roofing with a power broom.
   b. Clean substrate of contaminants such as dirt, debris, oil, and grease that can affect adhesion of coated foamed roofing.
   c. Power vacuum the existing roof surface. If recommended by foam manufacturer, prime dried surface at recommended rate with recommended primer.
   d. Scarify the surface of coated polyurethane roofing as necessary to achieve a suitable substrate for new roofing.
   e. Provide additional uplift securement for existing roofing system with new screws and plates applied to each roof zone at the following densities:
      1) Field of roof, one fastener for each.
      2) Corners of roof, one fastener for each.
      3) Perimeters of roof, one fastener for each. Width of perimeter zone of roof as directed by the Owner.
   f. Verify that surface is dry by pressing litmus paper to surface areas most likely to retain moisture, such as shaded areas and low spots. If paper changes color, surface is too wet to apply foam.
   g. Build up isolated low spots on existing roofing membrane with sprayed foam specified in Division 07 Section "Coated Foamed Roofing" to prevent ponding.

G. Existing Base Flashings

1. Remove existing base flashings around parapets, curbs, walls, and penetrations.
   a. Clean substrates of contaminants such as asphalt, sheet materials, dirt, and debris.
2. Do not damage metal counterflashings that are to remain. Replace metal counterflashings damaged during removal with counterflashings of same metal, weight or thickness, and finish **OR** specified in Division 07 Section "Sheet Metal Flashing And Trim" **OR** specified in Division 07 Section "Roof Specialties", **as directed**.
3. Inspect parapet sheathing for deterioration and damage. If parapet sheathing has deteriorated, immediately notify the Owner.
4. Remove existing parapet sheathing and replace with new pressure-preservative **OR** exterior fire-retardant, **as directed**,-treated plywood sheathing, 19/32 inch (15 mm) thick. If parapet framing has deteriorated, immediately notify the Owner.
   a. Plywood parapet sheathing is specified in Division 06 Section(s) "Rough Carpentry" OR "Miscellaneous Rough Carpentry", **as directed**.

H. Fastener Pull-Out Testing
1. Perform **OR** Retain independent testing and inspecting agency to conduct, **as directed**, fastener pull-out tests according to SPRI FX-1, and submit test report to the Owner **OR** roofing membrane manufacturer, **as directed**, before installing new membrane roofing system.
   a. Obtain the Owner's **OR** roofing membrane manufacturer's, **as directed**, approval to proceed with specified fastening pattern. the Owner **OR** Roofing membrane manufacturer, **as directed**, may furnish revised fastening pattern commensurate with pull-out test results.

I. Recover Board Installation
1. Install recover boards over roof insulation **OR** roofing membrane, **as directed**, with long joints in continuous straight lines and end joints staggered between rows. Loosely butt recover boards together and fasten to deck, **as directed**.
   a. Tape joints of recover boards if required by roofing membrane manufacturer.
   b. Fasten recover boards to resist wind-uplift pressure at corners, perimeter, and field of roof specified in Division 07 Section "Built-up Asphalt Roofing".
   c. Install additional fasteners near board corners and edges as necessary to conform boards to substrate and to adjacent boards.

J. Disposal
1. Collect demolished materials and place in containers. Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.
   a. Storage or sale of demolished items or materials on-site is not permitted.
2. Transport and legally dispose of demolished materials off the Owner's property.

END OF SECTION 07 05 13 00d

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Task	Specification	Specification Description
07 05 13 00	07 53 16 00	EPDM Membrane Roofing

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SECTION 07 11 13 00 - BITUMINOUS DAMPPROOFING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. 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.

1.2 SUMMARY

A. Section Includes:

1. Hot-applied asphalt dampproofing.
2. Cold-applied, cut-back-asphalt dampproofing.
3. Cold-applied, emulsified-asphalt dampproofing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.2: For dampproofing, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For dampproofing, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

1.4 FIELD CONDITIONS

A. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit dampproofing to be performed according to manufacturers' written instructions.

B. Ventilation: Provide adequate ventilation during application of dampproofing in enclosed spaces. Maintain ventilation until dampproofing has cured.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Source Limitations: Obtain primary dampproofing materials and primers from single source from single manufacturer. Provide protection course, molded-sheet drainage panels and auxiliary materials recommended in writing by manufacturer of primary materials.

B. VOC Content: Products shall comply with VOC content limits of authorities having jurisdiction unless otherwise required.

2.2 HOT-APPLIED ASPHALT DAMPPROOFING

A. Hot-Applied Asphalt: ASTM D 449, Type II **OR** Type III, **as directed**.

B. VOC Content: 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Low-Emitting Materials: Dampproofing shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 COLD-APPLIED, CUT-BACK-ASPHALT DAMPPROOFING

A. Trowel Coats: ASTM D 4586, Type I, Class 1, fibered.

B. Brush and Spray Coats: ASTM D 4479, Type I, fibered or nonfibered.

C. VOC Content: 250 **OR** 300, **as directed,** g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Low-Emitting Materials: Dampproofing shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

A. Trowel Coats: ASTM D 1227, Type II, Class 1.

B. Fibered Brush and Spray Coats: ASTM D 1227, Type II, Class 1.

C. Brush and Spray Coats: ASTM D 1227, Type III, Class 1.

D. VOC Content: Zero **OR** 30 g/L or less, **as directed**.

E. Low-Emitting Materials: Dampproofing shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.5 AUXILIARY MATERIALS

A. General: Furnish auxiliary materials recommended in writing by dampproofing manufacturer for intended use and compatible with bituminous dampproofing.

B. Cut-Back-Asphalt Primer: ASTM D 41.

C. Emulsified-Asphalt Primer: ASTM D 1227, Type III, Class 1, except diluted with water as recommended in writing by manufacturer.

1. Primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Asphalt-Coated Glass Fabric: ASTM D 1668, Type I.

E. Patching Compound: Epoxy or latex-modified repair mortar **OR** Asbestos-free fibered mastic**, as directed,** of type recommended in writing by dampproofing manufacturer.

F. Protection Course: ASTM D 6506, 1/8-inch- (3-mm-) thick, semirigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners.

G. Protection Course: Fan folded, with a core of extruded-polystyrene board insulation faced on one side or both sides with plastic film, nominal thickness 1/4 inch (6 mm), with a 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.

H. Protection Course: Extruded-polystyrene board insulation, unfaced, ASTM C 578, Type X, 1/2 inch (13 mm) thick.

I. Protection Course: Smooth-surfaced roll roofing complying with ASTM D 6380, Class S, Type III.

2.6 MOLDED-SHEET DRAINAGE PANELS

A. Molded-Sheet Drainage Panel: Comply with Section 334600 "Subdrainage."

B. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel: Composite subsurface drainage panel consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 (0.21-mm) sieve laminated to one side of the core; and with a vertical flow rate of 9 to 15 gpm per ft. (112 to 188 L/min. per m).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions with Applicator present, for compliance with requirements for surface smoothness, surface moisture, and other conditions affecting performance of bituminous dampproofing work.

1. Test for surface moisture according to ASTM D 4263.

B. Proceed with application only after substrate construction and penetrating work have been completed and unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. 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.

B. Clean substrates of projections and substances detrimental to the dampproofing work; fill voids, seal joints, and remove bond breakers if any, as recommended in writing by prime material manufacturer.

C. Apply patching compound to patch and fill tie holes, honeycombs, reveals, and other imperfections; cover with asphalt-coated glass fabric.

3.3 APPLICATION, GENERAL

A. Comply with manufacturer's written instructions for dampproofing application, cure time between coats, and drying time before backfilling unless more stringent requirements are indicated.

1. Apply dampproofing to provide continuous plane of protection.
2. Apply additional coats if recommended in writing by manufacturer or to achieve a smooth surface and uninterrupted coverage.

B. Where dampproofing footings and foundation walls, 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.

1. Extend dampproofing 12 inches (300 mm) onto intersecting walls and footings, but do not extend onto surfaces exposed to view when Project is completed.
2. 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.

C. Where dampproofing exterior face of inner wythe of exterior masonry cavity walls, lap dampproofing at least 1/4 inch (6 mm) onto flashing, masonry reinforcement, veneer ties, and other items that penetrate inner wythe.

1. Extend dampproofing over outer face of structural members and concrete slabs that interrupt inner wythe.
2. Lap dampproofing at least 1/4 inch (6 mm) onto shelf angles supporting veneer.

D. Where dampproofing interior face of above-grade, exterior concrete and masonry single-wythe masonry walls, continue dampproofing through intersecting walls by keeping vertical mortar joints at intersection temporarily open or by dampproofing wall before constructing intersecting walls.

3.4 HOT-APPLIED ASPHALT DAMPPROOFING

A. Do not apply hot asphalt when substrate condition causes foaming.

B. Kettle Temperature: Comply with dampproofing-material manufacturer's written instructions, and keep at least 25 deg F (14 deg C) below the flash point.

C. Prime masonry and other porous substrates.

D. Apply a uniform coat of hot asphalt by mopping or spraying at not less than 20 lb or 2.5 gal./100 sq. ft. (1 kg or 1 L/sq. m).

1. Apply a second coat to below-grade foundation walls and where first application has failed to produce a smooth surface and uninterrupted coverage. Apply second coat at the rate specified for first coat.

3.5 COLD-APPLIED, CUT-BACK-ASPHALT DAMPPROOFING

A. Concrete Foundations and Parged Masonry Foundation Walls: Apply two 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 one trowel coat at not less than 4 gal./100 sq. ft. (1.6 L/sq. m).

B. Unparged Masonry Foundation Walls: Apply primer and two 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 one trowel coat at not less than 4 gal./100 sq. ft. (1.6 L/sq. m).

C. Unexposed Face of Concrete Retaining Walls: Apply one brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).

D. Unexposed Face of Masonry Retaining Walls: Apply primer and one brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).

E. Concrete Backup for Brick Veneer Assemblies, Stone Veneer Assemblies and Dimension Stone Cladding: Apply one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

F. Masonry Backup for Brick Veneer Assemblies, Stone Veneer Assemblies and Dimension Stone Cladding: Apply primer and one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

G. Exterior Face of Inner Wythe of Cavity Walls: Apply primer and one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

3.6 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

A. Concrete Foundations and Parged Masonry Foundation Walls: Apply two 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 one fibered brush or spray coat at not less than 3 gal./100 sq. ft. (1.2 L/sq. m) or one trowel coat at not less than 4 gal./100 sq. ft. (1.6 L/sq. m).

B. Unparged Masonry Foundation Walls: Apply primer and two 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 one fibered brush or spray coat at not less than 3 gal./100 sq. ft. (1.2 L/sq. m) or primer and one trowel coat at not less than 5 gal./100 sq. ft. (2 L/sq. m).

C. Unexposed Face of Concrete Retaining Walls: Apply one brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).

D. Unexposed Face of Masonry Retaining Walls: Apply primer and one brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).

E. Concrete Backup for Brick Veneer Assemblies, Stone Veneer Assemblies and Dimension Stone Cladding: Apply one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

F. Masonry Backup for Brick Veneer Assemblies, Stone Veneer Assemblies and Dimension Stone Cladding: Apply primer and one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

G. Exterior Face of Inner Wythe of Cavity Walls: Apply primer and one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

H. Interior Face of Exterior Concrete Walls: Where above grade and indicated to be furred and finished, apply one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

I. Interior Face of Single-Wythe Exterior Masonry Walls: Where above grade and indicated to be furred and finished, apply primer and one brush or spray coat at not less than 1 gal./100 sq. ft. (0.4 L/sq. m).

3.7 INSTALLATION OF PROTECTION COURSE

A. Where indicated, install protection course over completed-and-cured dampproofing. Comply with dampproofing-material and protection-course manufacturers' written instructions for attaching protection course.

1. Support protection course over cured coating with spot application of adhesive type recommended in writing by protection-board manufacturer.
2. Install protection course on same day **OR** within 24 hours, **as directed,** of installation of dampproofing (while coating is tacky) to ensure adhesion.

3.8 INSTALLATION OF MOLDED-SHEET DRAINAGE PANELS

A. Place and secure molded-sheet drainage panels, with geotextile facing away from wall substrate, according to manufacturer's written instructions. Use adhesives or other methods that do not penetrate dampproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.

1. Install protection course before installing drainage panels.

3.9 CLEANING

A. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION 07 11 13 00

SECTION 07 11 13 00a - 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 Final 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 33 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 32 Section "Unit Paving".
   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 32 Section "Unit Paving".
   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 32 Section(s) "Unit Paving" 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 07 11 13 00a

SECTION 07 13 13 00 - 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 07 13 13 00

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Task	Specification	Specification Description
07 13 13 00	07 11 13 00	Bituminous Dampproofing

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SECTION 07 13 53 00 - 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 Final 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 33 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 32 Section "Unit Paving".
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 32 Section "Unit Paving".
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 32 Section(s) "Unit Paving" 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 07 13 53 00

Task	Specification	Specification Description
07 13 53 00	03 01 30 71a	Self-Adhering Sheet Waterproofing

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SECTION 07 14 13 00 - 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 Final 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 32 Section "Unit Paving".
      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 32 Section "Unit Paving".
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 32 Section(s) "Unit Paving" 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 07 14 13 00

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SECTION 07 16 13 00 - 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 07 16 13 00

SECTION 07 16 16 00 - 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 07 16 16 00

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SECTION 07 16 19 00 - 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 07 16 19 00

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SECTION 07 17 13 00 - 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 Final 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 33 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 07 17 13 00

SECTION 07 19 13 00 - 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 Final 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 07 19 13 00

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Task	Specification	Specification Description
07 19 16 00	07 19 13 00	Water Repellents

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SECTION 07 21 13 13 - 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".
   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.

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SECTION 07 21 13 13a - MODIFIED BITUMOUS PROTECTED MEMBRANE ROOFING

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for modified bituminous 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. Summary
1. Section includes APP-modified and SBS-modified bituminous protected membrane roofing.

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 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.
   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 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.
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. 10 lb (4.5 kg) of aggregate ballast in gradation and color indicated.
   d. Roof paver, full sized, in each color and texture required.
5. Qualification Data: For qualified Installer and manufacturer.
6. 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.
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.
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 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, roof pavers, and other components of membrane roofing system.
   b. Warranty Period: 10 **OR** 15, **as directed**, years from date of Final 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.

B. 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.

OR

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, **as directed**.

C. Base-Sheet Materials

1. 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.

D. 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.

E. 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 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

   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. 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.
3. Granule-Surfaced Flashing Sheet (for use with APP-modified roofing membranes): 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**.

4. Granule-Surfaced Flashing Sheet (for use with SBS-modified roofing membranes): 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**.
5. 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**.
6. Glass-Fiber Fabric: Woven glass-fiber cloth, treated with asphalt, complying with ASTM D 1668, Type I.

F. Auxiliary Roofing Membrane Materials
   1. General: Auxiliary materials recommended by roofing 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) Multipurpose Construction Adhesives: 70 g/L.
         3) Fiberglass Adhesives: 80 g/L.
         4) Contact Adhesives: 80 g/L.
         5) Other Adhesives: 250 g/L.
         6) Nonmembrane Roof Sealants: 300 g/L.
         7) Sealant Primers for Nonporous Substrates: 250 g/L.
         8) 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 manufacturer for application, **as directed**.

      OR

      Roofing Asphalt: ASTM D 6152, SEBS modified.
   4. 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 roofing membrane and base flashings.
   5. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required by roofing 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. Insulation Cant Strips: ASTM C 728, perlite insulation board.

      OR

      Insulation Cant Strips: ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board.
   9. Metal Flashing Sheet: As specified in Division 7 Section "Sheet Metal Flashing and Trim."

10. 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.
11. Separator Sheet: Polyethylene sheet, 4 mils (0.1 mm) thick, minimum.
12. Miscellaneous Accessories: Provide those recommended by roofing system manufacturer.

G. 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.
OR
Roof Coating: ASTM D 1227, Type III, Class 1, mineral-colloid-emulsified **OR** Class 2, chemically emulsified, **as directed**, asphalt emulsion, nonfibered.
OR
Roof Coating: ASTM D 2824, Type I, nonfibered **OR** Type 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.
a. Color: White **OR** Gray **OR** Buff, **as directed**.

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 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.
3. 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, 4.5 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**.

I. Insulation Accessories
1. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing.
2. 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.
3. Metal Securement System: Perimeter securement flashing and strapping fabricated from stainless steel, a minimum of 0.031 inch (0.8 mm) thick. Provide fasteners as recommended by mortar-faced insulation manufacturer.

J. 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: ASTM D 448, Size 5, ranging in size from 1/2 to 1 inch (13 to 25 mm).
b. Size: ASTM D 448, Size 4, ranging in size from 3/4 to 1-1/2 inches (19 to 38 mm).
c. Size: ASTM D 448, Size 2, ranging in size from 1-1/2 to 2-1/2 inches (38 to 63 mm).
2. 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. Size and weight shall be as directed.
a. Compressive Strength: 2500 psi (17 MPa) **OR** 5000 psi (34 MPa), **as directed**, minimum.
b. Colors and Textures: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **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. Weight: Weight shall be as directed.
   c. Compressive Strength: 7500 psi (52 MPa) **OR** 6500 psi (45 MPa), **as directed**, minimum; ASTM C 140.
   d. Colors and Textures: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
   e. Paver Supports: Integral corner pedestals.
      OR
      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) **OR** 1/8 to 3/16 inch (3 to 5 mm), **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.
      c. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
      d. 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.
      e. 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 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.

C. 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** S, **as directed**,-4-C-T **OR** M **OR** L, **as directed**,-P, 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 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. Membrane: A (APP) **OR** S (SBS), **as directed**.
   b. Deck Type: C (concrete or nonnailable).
   c. Adhering Method: T (torched) **OR** M (mopped) **OR** L (cold-applied adhesive), **as directed**.
   d. Base Sheet: One.
   e. Number of Glass-Fiber Base-Ply Sheets: One.
   f. Number of Modified Asphalt Sheets: Two.
   g. Surfacing Type: P (protected).
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 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 installing roofing system so 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. Provide tie-offs at end of each day's work to cover exposed roofing membrane sheets 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 from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.

D. Base-Sheet Installation
   1. Install lapped base sheet course, extending sheet over and terminating beyond cants. Attach base sheet as follows:
      a. 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**.

E. 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 glass-fiber base-ply sheets over and terminate beyond cants. 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.

F. Modified Bituminous Membrane Installation

1. Install modified bituminous roofing membrane sheet and cap sheet according to roofing manufacturer's written instructions, starting at low point of roofing system. Extend roofing membrane sheets over and terminate beyond cants.
   a. 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.

G. 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 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 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.
      OR
      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.
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) 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.

H. Coating Installation
1. Apply coatings to base flashings according to manufacturer's written instructions, by spray, roller, or other suitable application method.

I. Insulation Installation
1. Loosely lay separator sheet over cooled roofing membrane, with minimum 2-inch (50-mm) side laps and 4-inch (150-mm) end laps.

2. 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.
3. 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.
4. 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.

J. 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, **as directed**. Apply ballast as insulation is installed, leaving roofing membrane insulated and ballasted at end of workday.
   a. Ballast (Dow's "Standard Design"): 15 lb/sq. ft. (75 kg/sq. m) **OR** 20 lb/sq. ft. (100 kg/sq. m), **as directed**, 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.
      1) If partially replacing aggregate ballast with roof pavers, install one row of roof pavers in lieu of aggregate ballast at roof perimeter, corners, and penetrations.
   b. Ballast (for Dow's "Design #1"): 15 lb/sq. ft. (75 kg/sq. m) **OR** 20 lb/sq. ft. (100 kg/sq. m), **as directed**, 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.
   c. Ballast (for Dow's "Design #1") (if combining aggregate ballast with roof pavers): 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.
   d. Ballast (for Dow's "Design #2") (for aggregate ballast with roof pavers at corners): 15 lb/sq. ft. (75 kg/sq. m) **OR** 20 lb/sq. ft. (100 kg/sq. m), **as directed**, 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.
   e. Ballast (for Dow's "Design #2") (if combining aggregate ballast with roof pavers at roof perimeters, corners, and penetrations): 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. Mechanically fasten securement strapping to center of first perimeter and perimeter corner row of roof pavers.
   f. Ballast (for Dow's "Design #3"): 15 lb/sq. ft. (75 kg/sq. m) **OR** 20 lb/sq. ft. (100 kg/sq. m), **as directed**, 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.
2. Walkway Pavers: Install walkways formed from one row **OR** two rows, **as directed**, of roof pavers, loosely laid and butted.

K. Roof-Paver Installation
1. Interlocking Roof Pavers: Install interlocking roof pavers over roofed area according to manufacturer's written instructions.
2. For Dow's Technote 508 "Standard Design" and "Design #1", install roof pavers over roofed area according to insulation manufacturer's written instructions.
3. For Dow's Technote 508 "Standard Design" and "Design #2", 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. For Dow's Technote 508 "Standard Design" and "Design #3", 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.

L. 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.

M. Field Quality Control
1. Testing Agency: Perform tests and inspections and to prepare 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 compliance of replaced or additional work 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 Final 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 07 21 13 13a

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Task	Specification	Specification Description
07 21 13 13	07 51 13 00	Built-Up Asphalt Roofing
07 21 13 13	07 05 13 00	Built-Up Coal-Tar Roofing
07 21 13 13	07 53 16 00	EPDM Membrane Roofing
07 21 13 13	07 05 13 00a	CSPE Membrane Roofing
07 21 13 13	07 05 13 00b	APP-Modified Bituminous Membrane Roofing
07 21 13 13	07 05 13 00c	SBS-Modified Bituminous Membrane Roofing
07 21 13 16	07 21 13 13	Building Insulation
07 21 13 16	07 51 13 00	Built-Up Asphalt Roofing
07 21 13 16	07 05 13 00	Built-Up Coal-Tar Roofing
07 21 13 16	07 53 16 00	EPDM Membrane Roofing
07 21 13 16	07 05 13 00a	CSPE Membrane Roofing
07 21 13 16	07 05 13 00b	APP-Modified Bituminous Membrane Roofing
07 21 13 16	07 05 13 00c	SBS-Modified Bituminous Membrane Roofing
07 21 13 19	07 21 13 13	Building Insulation
07 21 13 19	07 51 13 00	Built-Up Asphalt Roofing
07 21 13 19	07 05 13 00	Built-Up Coal-Tar Roofing
07 21 13 19	07 53 16 00	EPDM Membrane Roofing
07 21 13 19	07 05 13 00a	CSPE Membrane Roofing
07 21 13 19	07 05 13 00b	APP-Modified Bituminous Membrane Roofing
07 21 13 19	07 05 13 00c	SBS-Modified Bituminous Membrane Roofing
07 21 16 00	07 21 13 13	Building Insulation
07 21 23 00	07 21 13 13	Building Insulation
07 21 26 00	07 21 13 13	Building Insulation

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SECTION 07 22 16 00 - 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 Final 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 the 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 it will, at its 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 the 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 the 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 the 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 the 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 the 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. the 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 the Owner from other remedies and resources lawfully available to the 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 the Owner or a subcontract with the 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 07 22 16 00

Task	Specification	Specification Description
07 22 16 00	07 51 13 00	Built-Up Asphalt Roofing
07 22 16 00	07 05 13 00	Built-Up Coal-Tar Roofing
07 22 16 00	07 53 16 00	EPDM Membrane Roofing
07 22 16 00	07 05 13 00a	CSPE Membrane Roofing
07 22 16 00	07 05 13 00b	APP-Modified Bituminous Membrane Roofing
07 22 16 00	07 05 13 00c	SBS-Modified Bituminous Membrane Roofing

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SECTION 07 24 13 00 - 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 IBC Standard.
    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** IBC Standard, **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** IBC Standard, **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 07 24 13 00

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SECTION 07 24 13 00a - 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 IBC Standard.
   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** IBC Standard, **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** IBC Standard, **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 07 24 13 00a

Task	Specification	Specification Description
07 26 13 00	06 10 00 00	Rough Carpentry

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SECTION 07 31 13 00 - 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 Final 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 Final Completion.

c. Algae-Discoloration Warranty Period: Asphalt shingles will not discolor five **OR** 10, **as directed**, years from date of Final Completion.
d. Workmanship Warranty Period: 10 **OR** 12, **as directed**, years from date of Final 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.

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SECTION 07 31 16 00 - 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 Final 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 Final 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 Final 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.

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SECTION 07 31 26 00 - 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 Final 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 Rough 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.

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SECTION 07 31 29 13 - 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 Final 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.

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**.

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 07 31 29 13

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Task	Specification	Specification Description
07 31 29 16	07 31 29 13	Wood Shingles And Shakes
07 31 29 17	01 22 16 00	No Specification Required

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SECTION 07 31 33 00 - 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^{TM}, 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 the 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 the 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 the 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 the 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 07 31 33 00

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Task	Specification	Specification Description
07 31 33 00	01 22 16 00	No Specification Required

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SECTION 07 32 13 00 - 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 Final 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 Rough 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 07 32 13 00

SECTION 07 32 16 00 - CONCRETE ROOF TILES

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for concrete 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. Concrete 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 concrete roof tiles, documentation indicating compliance with Solar Reflectance Index requirement.
3. Samples: For each type of concrete 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 concrete 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 concrete roof tiles that fail in materials within specified warranty period.
a. Materials-Only Warranty Period: 50 years from date of Final Completion.

1.2 PRODUCTS

A. Concrete Roof Tiles
1. Concrete Roof Tiles: ASTM C 1492, molded- or extruded-concrete roof tile units of shape and configuration indicated, with integral color, and free of surface imperfections. Provide with fastening holes prepunched at factory.
   a. Weight: Normal **OR** Medium **OR** Light, **as directed**.
   b. High-Profile Shape: Type I, Spanish or "S".
   c. Medium-Profile Shape: Type II, French interlocking.
   d. Low-Profile Shape: Type III, flat shingle **OR** Type III, flat interlocking, **as directed**.
   e. Side Configuration: Interlocking **OR** Noninterlocking, **as directed**.
   f. Solar Reflectance Index: Provide concrete roof tiles 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.
   g. Colors, Blends, and Patterns: As selected from manufacturer's full range.
   h. Finish and Texture: Matte, smooth **OR** Matte, striated **OR** Glazed, smooth, **as directed**.
   i. Color: Brown **OR** White **OR** Red **OR** Pale red **OR** Green **OR** Gray **OR** Buff, **as directed**.
   j. High **OR** Medium, **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, and terminal, **as directed**, units, in color matching concrete roof tiles.
   k. Low-Profile-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 concrete 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 concrete roof tile manufacturer.
   OR
   Mortar: ASTM C 270, Type M, natural color **OR** with ASTM C 979, pigmented mortar matching the color of concrete 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 concrete roof tiles.
8. Ridge Closure: Manufacturer's standard EPDM ridge closure, formed to shape of concrete roof tiles.
9. 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 Rough Carpentry", **as directed**.
10. 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. Hook Nails: One-piece wind lock and concrete 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.
7. 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 concrete roof tiles.
8. 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 concrete 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, 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 concrete 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. 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 concrete 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 concrete 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 concrete 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 concrete 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. Concrete Roof Tile Installation
1. General: Install concrete 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 concrete roof tiles throughout roof.
   b. Extend tiles 2 inches (50 mm) over eave fasciae.
   c. Nail Fastening: Drive nails to clear the concrete 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 concrete roof tiles according to manufacturer's written instructions.
   e. Foam-Adhesive **OR** Mortar, **as directed**, Setting: Install concrete roof tiles according to TRI/FRSA's "Concrete and Clay Roof Tile Installation Manual."
   f. Install storm clips to capture edges of longitudinal sides of concrete roof tiles and securely fasten to roof deck.
   g. Install concrete roof tile locks to support and lock overlying tile butts to underlying tiles.

h. Cut and fit concrete roof tiles neatly around roof vents, pipes, ventilators, and other projections through roof. Fill voids with mortar.
i. Install concrete roof tiles with color blend approved by the Owner.

2. Flat Shingle Concrete Roof Tile Installation:
   a. Maintain 2-inch (50-mm) head lap between succeeding courses of concrete roof tiles.
   b. Offset joints by half the concrete roof tile width in succeeding courses.
   c. Extend concrete 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 concrete 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 concrete roof tiles, and strike mortar flush with face of hip cover tiles.

3. Flat Interlocking Concrete Roof Tile Installation:
   a. Provide minimum 3-inch (75-mm) lap between succeeding courses of concrete roof tiles.
   b. Offset joints by half the concrete 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 concrete 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 meets concrete roof tiles, and strike mortar flush with face of hip cover tiles.

4. Low-Profile, Interlocking Concrete Roof Tile Installation:
   a. Provide minimum 3-inch (75-mm) lap between succeeding courses of concrete 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 Concrete 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 concrete 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 concrete 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 concrete 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 concrete roof tiles.
2. Remove excess concrete roof tiles and debris from Project site.

END OF SECTION 07 32 16 00

Task	Specification	Specification Description
07 34 00 00	07 31 13 00	Asphalt Shingles
07 34 00 00	07 31 16 00	Metal Shingles
07 34 00 00	07 31 26 00	Slate Shingles
07 34 00 00	07 31 29 13	Wood Shingles And Shakes
07 34 00 00	07 32 13 00	Clay Roof Tiles

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SECTION 07 41 13 00 - 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 Final 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 Final 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 Final 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 Final 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 "Thermal 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 07 41 13 00

SECTION 07 41 13 00a - 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 Final 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 Final 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) "Maintenance Of Decorative Metal" OR Division 06 Section(s) "Miscellaneous Rough 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 07 41 13 00a

Task	Specification	Specification Description
07 41 33 00	07 41 13 00	Metal Roof Panels

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SECTION 07 46 16 00 - 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 Final 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 Final Completion for fluoropolymer finish.
      2) 10 years from date of Final 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 "Thermal 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 07 46 16 00

SECTION 07 46 16 00a - 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 Final 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 Final Completion for fluoropolymer finish.
      2) 10 years from date of Final 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 07 46 16 00a

SECTION 07 46 16 00b - 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 Final 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 07 46 16 00b

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Task	Specification	Specification Description
07 46 16 00	07 41 13 00	Metal Roof Panels
07 46 19 00	07 41 13 00	Metal Roof Panels
07 46 19 00	07 46 16 00	Metal Wall Panels
07 46 19 00	07 46 16 00a	Metal Plate Wall Panels
07 46 19 00	07 46 16 00b	Siding
07 46 23 00	06 10 00 00	Rough Carpentry
07 46 23 00	01 95 06 00	Miscellaneous Carpentry
07 46 23 00	06 16 23 00	Sheathing
07 46 29 00	06 10 00 00	Rough Carpentry
07 46 29 00	01 95 06 00	Miscellaneous Carpentry
07 46 29 00	06 16 23 00	Sheathing
07 46 33 00	07 46 16 00b	Siding
07 46 46 00	01 22 16 00	No Specification Required
07 46 46 00	06 46 29 00	Exterior Architectural Woodwork
07 46 46 00	01 95 06 00c	Interior Architectural Woodwork
07 46 46 00	07 46 16 00b	Siding

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SECTION 07 46 63 00 - 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 Final 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 Final Completion for fluoropolymer finish.
      2) 10 years from date of Final 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 07 46 63 00

Task	Specification	Specification Description
07 46 63 00	07 46 16 00	Metal Wall Panels

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SECTION 07 51 13 00 - 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 **OR** 20 **OR** 25 **OR** 30, **as directed**, years from date of Final 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 Final 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 Decking".
   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 the 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 Final 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 07 51 13 00

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Task	Specification	Specification Description
07 51 13 00	01 95 06 00	Miscellaneous Carpentry
07 51 13 00	07 05 13 00	Built-Up Coal-Tar Roofing
07 51 13 00	07 53 16 00	EPDM Membrane Roofing
07 51 13 00	07 05 13 00b	APP-Modified Bituminous Membrane Roofing
07 51 13 00	07 05 13 00c	SBS-Modified Bituminous Membrane Roofing
07 51 13 00	07 05 13 00d	Preparation for Re-Roofing
07 52 13 00	07 05 13 00b	APP-Modified Bituminous Membrane Roofing
07 52 13 00	07 05 13 00d	Preparation for Re-Roofing
07 52 16 00	07 05 13 00c	SBS-Modified Bituminous Membrane Roofing
07 52 16 00	07 05 13 00d	Preparation for Re-Roofing

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SECTION 07 53 16 00 - 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 Decking".

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: 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 Final 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 Decking", 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 the 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 Final 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 07 53 16 00

Task	Specification	Specification Description
07 53 16 00	07 51 13 00	Built-Up Asphalt Roofing
07 53 16 00	07 05 13 00	Built-Up Coal-Tar Roofing
07 53 16 00	07 05 13 00a	CSPE Membrane Roofing
07 53 16 00	07 05 13 00d	Preparation for Re-Roofing
07 53 23 00	07 51 13 00	Built-Up Asphalt Roofing
07 53 23 00	07 05 13 00	Built-Up Coal-Tar Roofing
07 53 23 00	07 53 16 00	EPDM Membrane Roofing
07 53 23 00	07 05 13 00d	Preparation for Re-Roofing
07 53 29 00	07 51 13 00	Built-Up Asphalt Roofing
07 53 29 00	07 05 13 00	Built-Up Coal-Tar Roofing
07 53 29 00	07 53 16 00	EPDM Membrane Roofing
07 53 29 00	07 05 13 00d	Preparation for Re-Roofing

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SECTION 07 54 19 00 - 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 Decking".

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 Final 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 Decking", 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 the 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 Final 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 07 54 19 00

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Task	Specification	Specification Description
07 54 19 00	07 05 13 00d	Preparation for Re-Roofing

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SECTION 07 54 23 00 - 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 Decking".

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 Final 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 Decking", 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 the 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 Final 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 07 54 23 00

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Task	Specification	Specification Description
07 54 23 00	07 05 13 00d	Preparation for Re-Roofing
07 56 00 00	07 51 13 00	Built-Up Asphalt Roofing
07 56 00 00	07 05 13 00	Built-Up Coal-Tar Roofing
07 56 00 00	07 53 16 00	EPDM Membrane Roofing
07 56 00 00	07 54 19 00	Polyvinyl-Chloride (PVC) Roofing
07 56 00 00	07 57 00 00	Coated Foamed Roofing
07 56 00 00	07 05 13 00d	Preparation for Re-Roofing

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SECTION 07 57 00 00 - 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 Final 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 "Preparation For Re-roofing".
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 "Preparation For Re-roofing". 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 "Preparation For Re-roofing" 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 07 57 00 00

Task	Specification	Specification Description
07 57 13 00	07 57 00 00	Coated Foamed Roofing
07 58 00 00	07 51 13 00	Built-Up Asphalt Roofing

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SECTION 07 62 00 00 - 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 Final 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" 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", **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 07 62 00 00

Task	Specification	Specification Description
07 63 00 00	07 62 00 00	Sheet Metal Flashing And Trim
07 63 00 00	01 95 99 99i	Common Work Results for Fire Suppression
07 63 00 00	01 95 99 99j	Common Work Results for Plumbing
07 63 00 00	01 95 99 99k	Common Work Results for HVAC
07 65 16 00	07 51 13 00	Built-Up Asphalt Roofing
07 65 16 00	07 05 13 00	Built-Up Coal-Tar Roofing
07 65 16 00	07 53 16 00	EPDM Membrane Roofing
07 65 16 00	07 57 00 00	Coated Foamed Roofing
07 71 13 00	07 62 00 00	Sheet Metal Flashing And Trim

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SECTION 07 71 23 00 - 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 Final 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" 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 07 71 23 00

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Task	Specification	Specification Description
07 71 23 00	01 22 16 00	No Specification Required
07 71 23 00	05 73 00 00	Miscellaneous Ornamental Metals
07 71 23 00	07 62 00 00	Sheet Metal Flashing And Trim
07 71 26 00	07 62 00 00	Sheet Metal Flashing And Trim

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SECTION 07 72 13 00 - PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for packaged, outdoor, central-station air-handling units. 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 packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:
   a. Direct-expansion cooling.
   b. Heat-pump refrigeration components.
   c. Hot-gas reheat.
   d. Electric-heating coils.
   e. Gas furnace.
   f. Economizer outdoor- and return-air damper section.
   g. Integral, space temperature controls.
   h. Roof curbs.

C. Definitions
1. DDC: Direct-digital controls.
2. ECM: Electrically commutated motor.
3. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
4. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
5. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.
6. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
7. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
8. VVT: Variable-air volume and temperature.

D. Performance Requirements
1. Delegated Design: Design RTU supports to comply with wind and seismic, **as directed**, performance requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Wind-Restraint Performance:
   a. Basic Wind Speed: <**Insert value**>.
   b. Building Classification Category: I **OR** II **OR** III **OR** IV, **as directed**.
   c. Minimum 10 lb/sq. ft (48.8 kg/sq. m) multiplied by the maximum area of the mechanical component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.
3. Seismic Performance: RTUs 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: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
2. LEED Submittals:
   a. Product Data for Credit EA 4: Documentation required by Credit EA 4 indicating that equipment and refrigerants comply.
   b. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
3. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   a. Wiring Diagrams: Power, signal, and control wiring.
4. Delegated-Design Submittal: For RTU supports 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. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints, **as directed**, and for designing vibration isolation bases.
   b. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
   c. Wind- and Seismic-Restraint Details, **as directed**: Detail fabrication and attachment of wind and seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.
5. Manufacturer Wind Loading Qualification Certification: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
   a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
   b. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force 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.
6. Manufacturer Seismic Qualification Certification: Submit certification that RTUs, accessories, and components will withstand seismic forces defined in "Performance Requirements" Article and in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
   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.
7. Field quality-control test reports.
8. Operation and maintenance data.
9. Warranty: Special warranty specified in this Section.

F. Quality Assurance
1. ARI Compliance:
   a. Comply with ARI 210/240 and ARI 340/360 for testing and rating energy efficiencies for RTUs.
   b. Comply with ARI 270 for testing and rating sound performance for RTUs.
2. ASHRAE Compliance:
   a. Comply with ASHRAE 15 for refrigeration system safety.
   b. Comply with ASHRAE 33 for methods of testing cooling and heating coils.

c. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

3. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
4. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.
5. UL Compliance: Comply with UL 1995.
6. 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.

G. Warranty

1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.
   a. Warranty Period for Compressors: Manufacturer's standard, but not less than five **OR** 10, **as directed**, years from date of Final Completion.
   b. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than five **OR** 10 **OR** 15 **OR** 20, **as directed**, years from date of Final Completion.
   c. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than three years from date of Final Completion.
   d. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Final Completion.

1.2 PRODUCTS

A. Casing

1. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
2. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
   a. Exterior Casing Thickness: 0.052 inch (1.3 mm) **OR** 0.0626 inch (1.6 mm) **OR** 0.079 inch (2.0 mm), **as directed**, thick.
3. Inner Casing Fabrication Requirements:
   a. Inside Casing: Galvanized steel, 0.034 inch (0.86 mm) **OR** 0.028 inch (0.7 mm), **as directed**, thick, perforated 40 percent free area, **as directed**.
4. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
   a. Materials: ASTM C 1071, Type I.
   b. Thickness: 1/2 inch (13 mm) **OR** 1 inch (25 mm), **as directed**.
   c. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
   d. Liner Adhesive: Comply with ASTM C 916, Type I.
5. Condensate Drain Pans: Formed sections of galvanized-steel **OR** stainless-steel, **as directed**, sheet, a minimum of 2 inches (50 mm) deep, and complying with ASHRAE 62.1, **as directed**.
   a. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
   b. Drain Connections: Threaded nipple both sides of drain pan, **as directed**.
   c. Pan-Top Surface Coating: Corrosion-resistant compound for galvanized-steel drain pans.
6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

B. Fans

1. Direct-Driven Supply-Air Fans: Double width, forward curved **OR** backward inclined, **as directed**, centrifugal; with permanently lubricated, multispeed **OR** ECM, **as directed**, motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

OR

Belt-Driven Supply-Air Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the casing. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

2. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.
3. Relief-Air Fan: Propeller **OR** Forward curved **OR** Backward inclined, **as directed**, shaft mounted on permanently lubricated motor.
4. Seismic Fabrication Requirements: Fabricate fan section, internal mounting frame and attachment to fans, fan housings, motors, casings, accessories, and other fan section components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment" when fan-mounted frame and RTU-mounted frame are anchored to building structure.
5. Fan Motor: Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".

C. Coils

1. Supply-Air Refrigerant Coil:
   a. Aluminum-plate **OR** Copper-plate, **as directed**, fin and seamless internally grooved, **as directed**, copper tube in steel casing with equalizing-type vertical distributor.
   b. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
   c. Coil Split: Interlaced.
   d. Baked phenolic **OR** Cathodic epoxy, **as directed**, coating.
   e. Condensate Drain Pan: Galvanized steel with corrosion-resistant coating **OR** Stainless steel, **as directed**, formed with pitch and drain connections complying with ASHRAE 62.1, **as directed**.
2. Outdoor-Air Refrigerant Coil:
   a. Aluminum-plate **OR** Copper-plate, **as directed**, fin and seamless internally grooved, **as directed**, copper tube in steel casing with equalizing-type vertical distributor.
   b. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
   c. Baked phenolic **OR** Cathodic epoxy, **as directed**, coating.
3. Hot-Gas Reheat Refrigerant Coil:
   a. Aluminum-plate **OR** Copper-plate, **as directed**, fin and seamless internally grooved, **as directed**, copper tube in steel casing with equalizing-type vertical distributor.
   b. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
   c. Baked phenolic **OR** Cathodic epoxy, **as directed**, coating.
4. Electric-Resistance Heating:
   a. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.
   b. Overtemperature Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box.
   c. Overcurrent Protection: Manual-reset thermal cutouts, factory wired in each heater stage.
   d. Control Panel: Unit mounted with disconnecting means and overcurrent protection. Include the following controls:
      1) Magnetic **OR** Mercury, **as directed**, contactors.
      2) Step Controller: Pilot lights and override toggle switch for each step.
      3) SCR Controller: Pilot lights operate on load ratio, a minimum of five steps.
      4) Time-delay relay.
      5) Airflow proving switch.

D. Refrigerant Circuit Components
   1. Number of Refrigerant Circuits: One **OR** Two, **as directed**.
   2. Compressor: Hermetic, reciprocating **OR** Semihermetic, reciprocating **OR** Hermetic, scroll, **as directed**, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater, **as directed**.
   3. Refrigeration Specialties:
      a. Refrigerant: R-407C **OR** R-410A, **as directed**.
      b. Expansion valve with replaceable thermostatic element.
      c. Refrigerant filter/dryer.
      d. Manual-reset high-pressure safety switch.
      e. Automatic-reset low-pressure safety switch.
      f. Minimum off-time relay.
      g. Automatic-reset compressor motor thermal overload.
      h. Brass service valves installed in compressor suction and liquid lines.
      i. Low-ambient kit high-pressure sensor.
      j. Hot-gas reheat solenoid valve with a replaceable magnetic coil.
      k. Hot-gas bypass solenoid valve with a replaceable magnetic coil.
      l. Four-way reversing valve with a replaceable magnetic coil, thermostatic expansion valves with bypass check valves, and a suction line accumulator.

E. Air Filtration
   1. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
      a. Glass Fiber: Minimum 80 percent arrestance, and MERV 5.
      b. Pleated: Minimum 90 percent arrestance, and MERV 7.

F. Gas Furnace
   1. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54.
      a. CSA Approval: Designed and certified by and bearing label of CSA.
   2. Burners: Stainless steel.
      a. Fuel: Natural **OR** Propane, **as directed**, gas.
      b. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.
      c. High-Altitude Model **OR** Kit, **as directed**: For Project elevations more than 2000 feet (610 m) above sea level.
   3. Heat-Exchanger and Drain Pan: Stainless steel.
   4. Venting: Gravity vented with vertical extension, **as directed**.
      OR
      Power Vent: Integral, motorized centrifugal fan interlocked with gas valve with vertical extension, **as directed**.
   5. Safety Controls:
      a. Gas Control Valve: Single stage **OR** Two stage **OR** Modulating, **as directed**.
      b. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

G. Dampers
   1. Outdoor-Air Damper: Linked damper blades, for 0 to 25 percent outdoor air, with manual **OR** motorized, **as directed**, damper filter.
   2. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.
      a. Damper Motor: Modulating with adjustable minimum position.
      b. Relief-Air Damper: Gravity actuated or motorized, as required by ASHRAE/IESNA 90.1, with bird screen and hood.

H. Electrical Power Connection

1. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit, **as directed**, and control-circuit transformer with built-in overcurrent protection.

I. Controls
   1. Control equipment and sequence of operation are specified in Division 23 Section "Instrumentation And Control For Hvac".
   2. Basic Unit Controls:
      a. Control-voltage transformer.
      b. Wall-mounted thermostat or sensor with the following features:
         1) Heat-cool-off switch.
         2) Fan on-auto switch.
         3) Fan-speed switch.
         4) Manual **OR** Automatic, **as directed**, changeover.
         5) Adjustable deadband.
         6) Concealed **OR** Exposed, **as directed**, set point.
         7) Concealed **OR** Exposed, **as directed**, indication.
         8) Degree F **OR** Degree C, **as directed**, indication.
         9) Unoccupied-period-override push button.
         10) Data entry and access port to input temperature and humidity, **as directed**, set points, occupied and unoccupied periods, and output room temperature and humidity, **as directed**, supply-air temperature, operating mode, and status.
      c. Wall-mounted humidistat or sensor with the following features:
         1) Concealed **OR** Exposed, **as directed**, set point.
         2) Concealed **OR** Exposed, **as directed**, indication.
      d. Remote Wall **OR** Unit, **as directed**,-Mounted Annunciator Panel for Each Unit:
         1) Lights to indicate power on, cooling, heating, fan running, filter dirty, and unit alarm or failure.
         2) DDC controller or programmable timer and interface with HVAC instrumentation and control system.
         3) Digital display of outdoor-air temperature, supply-air temperature, return-air temperature, economizer damper position, indoor-air quality, and control parameters.
   3. Electronic **OR** DDC, **as directed**, Controller:
      a. Controller shall have volatile-memory backup.
      b. Safety Control Operation:
         1) Smoke Detectors: Stop fan and close outdoor-air damper if smoke is detected. Provide additional contacts for alarm interface to fire alarm control panel.
         2) Firestats: Stop fan and close outdoor-air damper if air greater than 130 deg F (54 deg C) enters unit. Provide additional contacts for alarm interface to fire alarm control panel.
         3) Fire Alarm Control Panel Interface: Provide control interface to coordinate with operating sequence described in Division 28 Section(s) "Digital, Addressable Fire-alarm System" OR "Zoned (dc Loop) Fire-alarm System", **as directed.**
         4) Low-Discharge Temperature: Stop fan and close outdoor-air damper if supply air temperature is less than 40 deg F (4 deg C).
         5) Defrost Control for Condenser Coil: Pressure differential switch to initiate defrost sequence.
      c. Scheduled Operation: Occupied and unoccupied periods on seven-day **OR** 365-day, **as directed**, clock with a minimum of two **OR** four, **as directed**, programmable periods per day.
      d. Unoccupied Period:
         1) Heating Setback: 10 deg F (5.6 deg C).
         2) Cooling Setback: System off.
         3) Override Operation: Two hours.
      e. Supply Fan Operation:

1) Occupied Periods: Run fan continuously.
2) Unoccupied Periods: Cycle fan to maintain setback temperature.

f. Refrigerant Circuit Operation:
1) Occupied Periods: Cycle or stage compressors, and operate hot-gas bypass, **as directed**, to match compressor output to cooling load to maintain room **OR** discharge, **as directed**, temperature and humidity, **as directed**. Cycle condenser fans to maintain maximum hot-gas pressure. Operate low-ambient control kit to maintain minimum hot-gas pressure.
2) Unoccupied Periods: Compressors off **OR** Cycle compressors and condenser fans for heating to maintain setback temperature, **as directed**.
3) Switch reversing valve for heating or cooling mode on air-to-air heat pump.

g. Hot-Gas Reheat-Coil Operation:
1) Occupied Periods: Humidistat opens hot-gas valve to provide hot-gas reheat, and cycles compressor.
2) Unoccupied Periods: Reheat not required.

h. Gas Furnace Operation:
1) Occupied Periods: Cycle **OR** Stage **OR** Modulate, **as directed**, burner to maintain room **OR** discharge, **as directed**, temperature.
2) Unoccupied Periods: Cycle burner to maintain setback temperature.

i. Electric-Heating-Coil Operation:
1) Occupied Periods: Cycle **OR** Stage **OR** Modulate, **as directed**, coil to maintain room **OR** discharge, **as directed**, temperature.
2) Unoccupied Periods: Energize coil to maintain setback temperature.
3) Operate supplemental electric heating coil with compressor for heating with outdoor temperature below 25 deg F (minus 4 deg C).

j. Fixed Minimum Outdoor-Air Damper Operation:
1) Occupied Periods: Open to 25 percent.
2) Unoccupied Periods: Close the outdoor-air damper.

k. Economizer Outdoor-Air Damper Operation:
1) Occupied Periods: Open to 10 **OR** 25, **as directed**, percent fixed minimum intake, and maximum 100 percent of the fan capacity to comply with ASHRAE Cycle II. Controller shall permit air-side economizer operation when outdoor air is less than 60 deg F (15 deg C). Use outdoor-air temperature **OR** mixed-air and outdoor-air temperature **OR** outdoor-air enthalpy **OR** mixed-air temperature and select between outdoor-air and return-air enthalpy, **as directed**, to adjust mixing dampers. Start relief-air fan with end switch on outdoor-air damper, **as directed**. During economizer cycle operation, lock out cooling.
2) Unoccupied Periods: Close outdoor-air damper and open return-air damper.
3) Outdoor-Airflow Monitor: Accuracy maximum plus or minus 5 percent within 15 and 100 percent of total outdoor air. Monitor microprocessor shall adjust for temperature, and output shall range from 2- to 10-V dc **OR** 4 to 20 mA, **as directed**.

l. Carbon Dioxide Sensor Operation:
1) Occupied Periods: Reset minimum outdoor-air ratio down to minimum 10 percent to maintain maximum 1000-ppm concentration.
2) Unoccupied Periods: Close outdoor-air damper and open return-air damper.

m. VVT Relays:
1) Provide heating- and cooling-mode changeover relays compatible with VVT terminal control system required in Division 23 Section(s) "Air Terminal Units" AND "Instrumentation And Control For Hvac".

4. Interface Requirements for HVAC Instrumentation and Control System:
a. Interface relay for scheduled operation.
b. Interface relay to provide indication of fault at the central workstation and diagnostic code storage.
c. Provide BACnet **OR** LonWorks, **as directed**, compatible interface for central HVAC control workstation for the following:
1) Adjusting set points.

2) Monitoring supply fan start, stop, and operation.
3) Inquiring data to include outdoor-air damper position, **as directed**, supply- and room-air temperature and humidity, **as directed**.
4) Monitoring occupied and unoccupied operations.
5) Monitoring constant and variable motor loads.
6) Monitoring variable-frequency drive operation.
7) Monitoring cooling load.
8) Monitoring economizer cycles.
9) Monitoring air-distribution static pressure and ventilation air volume.

J. Accessories
1. Electric heater with integral thermostat maintains minimum 50 deg F (10 deg C) temperature in gas burner compartment.
2. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open, **as directed**.
3. Low-ambient kit using staged **OR** damper on **OR** variable-speed, **as directed**, condenser fans for operation down to 35 deg F (1.7 deg C).
4. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
5. Coil guards of painted, galvanized-steel wire.
6. Hail guards of galvanized steel, painted to match casing.
7. Concentric diffuser with white louvers and polished aluminum return grilles, insulated diffuser box with mounting flanges, and interior transition.

K. Roof Curbs
1. Roof curbs with vibration isolators and wind or seismic restraints are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
OR
Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
a. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
1) Materials: ASTM C 1071, Type I or II.
2) Thickness: 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**.
b. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
1) Liner Adhesive: Comply with ASTM C 916, Type I.
2) Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
3) Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
4) Liner Adhesive: Comply with ASTM C 916, Type I.
2. Curb Height: 14 inches (355 mm) **OR** 24 inches (610 mm) **OR** 36 inches (910 mm), **as directed**.
3. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment" for wind-load requirements.

1.3 EXECUTION

A. Installation

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 than supported equipment and minimum 6 inches (150 mm) above finished ground elevation.
   b. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   c. Install anchor bolts to elevations required for proper attachment to supported equipment.
   d. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   e. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-place Concrete".
2. Equipment Mounting: Install RTUs on concrete base using elastomeric pads **OR** elastomeric mounts **OR** restrained spring isolators, **as directed**. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-place Concrete".
   a. Minimum Deflection: 1/4 inch (6 mm) **OR** 1 inch (25 mm), **as directed**.

   OR

   Roof Curb: Install on roof structure or concrete base, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts" **OR** ARI Guideline B, **as directed**. Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 07 Section "Roof Accessories". Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.
3. Unit Support: Install unit level on structural curbs **OR** pilings, **as directed**. Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.
4. Install wind and seismic restraints according to manufacturer's written instructions. Wind and seismically restrained vibration isolation roof-curb rails are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".

B. Connections
1. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.
2. Install piping adjacent to RTUs to allow service and maintenance.
   a. Gas Piping: Comply with applicable requirements in Division 23 Section(s) "Facility Natural-gas Piping" OR "Facility Liquefied-petroleum Gas Piping", **as directed**. Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.
3. Duct installation requirements are specified in other Division 21. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
   a. Install ducts to termination at top of roof curb.
   b. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
   c. Connect supply ducts to RTUs with flexible duct connectors specified in Division 23 Section "Air Duct Accessories".
   d. Install return-air duct continuously through roof structure.
   e. Install normal-weight, 3000-psi (20.7-MPa), compressive strength (28-day) concrete mix inside roof curb, 4 inches (100 mm) thick. Concrete, formwork, and reinforcement are specified in Division 31.

C. Field Quality Control
1. Perform tests and inspections and prepare test reports.
2. Tests and Inspections:
   a. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
   b. Inspect for and remove shipping bolts, blocks, and tie-down straps.

c. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3. Remove and replace malfunctioning units and retest as specified above.

D. Startup Service
1. Engage a factory-authorized service representative to perform startup service.
2. Complete installation and startup checks according to manufacturer's written instructions and do the following:
a. Inspect for visible damage to unit casing.
b. Inspect for visible damage to furnace combustion chamber.
c. Inspect for visible damage to compressor, coils, and fans.
d. Inspect internal insulation.
e. Verify that labels are clearly visible.
f. Verify that clearances have been provided for servicing.
g. Verify that controls are connected and operable.
h. Verify that filters are installed.
i. Clean condenser coil and inspect for construction debris.
j. Clean furnace flue and inspect for construction debris.
k. Connect and purge gas line.
l. Remove packing from vibration isolators.
m. Inspect operation of barometric relief dampers.
n. Verify lubrication on fan and motor bearings.
o. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
p. Adjust fan belts to proper alignment and tension.
q. Start unit according to manufacturer's written instructions.
1) Start refrigeration system.
2) Do not operate below recommended low-ambient temperature.
3) Complete startup sheets and attach copy with Contractor's startup report.
r. Inspect and record performance of interlocks and protective devices; verify sequences.
s. Operate unit for an initial period as recommended or required by manufacturer.
t. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency.
1) Measure gas pressure on manifold.
2) Inspect operation of power vents.
3) Measure combustion-air temperature at inlet to combustion chamber.
4) Measure flue-gas temperature at furnace discharge.
5) Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
6) Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
u. Calibrate thermostats.
v. Adjust and inspect high-temperature limits.
w. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
x. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F (8 deg C) above return-air temperature:
1) Coil leaving-air, dry- and wet-bulb temperatures.
2) Coil entering-air, dry- and wet-bulb temperatures.
3) Outdoor-air, dry-bulb temperature.
4) Outdoor-air-coil, discharge-air, dry-bulb temperature.
y. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
z. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.

1) Supply-air volume.
2) Return-air volume.
3) Relief-air volume.
4) Outdoor-air intake volume.

aa. Simulate maximum cooling demand and inspect the following:
1) Compressor refrigerant suction and hot-gas pressures.
2) Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.

bb. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
1) High-temperature limit on gas-fired heat exchanger.
2) Low-temperature safety operation.
3) Filter high-pressure differential alarm.
4) Economizer to minimum outdoor-air changeover.
5) Relief-air fan operation.
6) Smoke and firestat alarms.

cc. After startup and performance testing and prior to Final Completion, replace existing filters with new filters.

E. Cleaning And Adjusting
1. Occupancy Adjustments: When requested within 12 months of date of Final Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site during other-than-normal occupancy hours for this purpose.
2. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

F. Demonstration

G. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs.

END OF SECTION 07 72 13 00

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SECTION 07 72 13 00a - INTAKE AND RELIEF VENTILATORS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for intake and relief ventilators. 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. Louvered-penthouse ventilators.
b. Roof hoods.
c. Goosenecks.

C. Performance Requirements
1. Delegated Design: Design ventilators, including comprehensive engineering analysis by a qualified professional engineer, using structural and seismic performance requirements and design criteria indicated.
2. Structural Performance: Ventilators shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of ventilator components, noise or metal fatigue caused by ventilator blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.
a. Wind Loads: Determine loads based on pressures as indicated on Drawings.
OR
Wind Loads: Determine loads based on a uniform pressure of 20 lbf/sq. ft. (960 Pa) **OR** 30 lbf/sq. ft. (1440 Pa), **as directed**, acting inward or outward.
OR
Wind Loads: Determine loads based on pressures indicated below:
1) Corner Zone: Within <**Insert distance**> of building corners, uniform pressure of <**Insert design wind pressure**>, acting inward, and <**Insert design wind pressure**>, acting outward.
2) Other Than Corner Zone: Uniform pressure of <**Insert design wind pressure**>, acting inward, and <**Insert design wind pressure**>, acting outward.
3. Seismic Performance: Ventilators, including attachments to other construction, 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 and the unit will be fully operational after the seismic event."
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. Water Entrainment: Limit water penetration through unit to comply with ASHRAE 62.1.

D. Submittals
1. Product Data: For each type of product indicated. For louvered-penthouse ventilators specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.
2. LEED Submittal:

a. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62., Section 5 - "Systems and Equipment."

3. Shop Drawings: For gravity ventilators. Include plans, elevations, sections, details, ventilator attachments to curbs, and curb attachments to roof structure.
   a. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.
4. Samples: For each exposed product and for each color and texture specified.
5. Delegated-Design Submittal: For shop-fabricated ventilators 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 shop-fabricated ventilators.
6. Coordination Drawings: Roof framing plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   a. Structural members to which roof curbs and ventilators will be attached.
   b. Sizes and locations of roof openings.
7. Seismic Qualification Certificates: For ventilators, accessories, and components, from manufacturer.
   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.
8. Welding certificates.

E. Quality Assurance
1. Welding Qualifications: 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."

F. Coordination
1. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.2 PRODUCTS

A. Materials
1. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T5 or T-52.
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. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 (Z275) zinc coating, mill phosphatized.
4. Stainless-Steel Sheet: ASTM A 666, Type 304, with No. 4 **OR** 6, **as directed**, finish.
5. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel unless otherwise indicated. Do not use metals that are incompatible with joined materials.
   a. Use types and sizes to suit unit installation conditions.
   b. Use Phillips flat **OR** hex-head or Phillips pan, **as directed**,-head screws for exposed fasteners unless otherwise indicated.
6. Post-Installed 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.
7. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

B. Fabrication, General
   1. Factory or shop fabricate gravity ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.
   2. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
   3. Fabricate units with closely fitted joints and exposed connections accurately located and secured.
   4. Fabricate supports, anchorages, and accessories required for complete assembly.
   5. Perform shop welding by AWS-certified procedures and personnel.

C. Louvered-Penthouse Ventilators
   1. Construction: All-welded assembly with 4-inch (100-mm) **OR** 6-inch (150-mm), **as directed**,- deep louvers, mitered corners, and aluminum **OR** galvanized-steel **OR** stainless-steel, **as directed**, sheet roof with mineral-fiber insulation and vapor barrier, **as directed**.
   2. Frame and Blade Material and Nominal Thickness: Extruded aluminum, of thickness required to comply with structural performance requirements, but not less than 0.080 inch (2.0 mm) for frames and 0.080 inch (2.0 mm) **OR** 0.060 inch (1.5 mm), **as directed**, for blades with condensate deflectors, **as directed**.
      a. AMCA Seal: Mark units with the AMCA Certified Ratings Seal.
      b. Exterior Corners: Prefabricated corner units with mitered and welded blades **OR** mitered blades with concealed close-fitting splices, **as directed**, and with fully recessed **OR** semirecessed, **as directed**, mullions at corners.
   3. Frame and Blade Material and Nominal Thickness: Galvanized-steel sheet, of thickness required to comply with structural performance requirements, but not less than 0.052 inch (1.3 mm) for frames and 0.040 inch (1.0 mm) **OR** 0.052 inch (1.3 mm) **OR** 0.064 inch (1.6 mm), **as directed**, for blades with condensate deflectors, **as directed**.
      a. AMCA Seal: Mark units with the AMCA Certified Ratings Seal.
      b. Exterior Corners: Prefabricated corner units with mitered and welded blades **OR** mitered blades with concealed close-fitting splices, **as directed**, and with fully recessed **OR** semirecessed, **as directed**, mullions at corners.
   4. Frame and Blade Material and Nominal Thickness: Stainless-steel sheet, of thickness required to comply with structural performance requirements, but not less than 0.050 inch (1.27 mm) **OR** 0.062 inch (1.57 mm), **as directed**, with grain running parallel **OR** perpendicular, **as directed**, to length of blades and frame members with condensate deflectors, **as directed**.
      a. AMCA Seal: Mark units with the AMCA Certified Ratings Seal.
      b. Exterior Corners: Prefabricated corner units with mitered and welded blades **OR** mitered blades with concealed close-fitting splices, **as directed**, and with fully recessed **OR** semirecessed, **as directed**, mullions at corners.
   5. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch- (40-mm-) thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch (40-mm) wood nailer. Size as required to fit roof opening and ventilator base.
      a. Configuration: Self-flashing without a cant strip, with **OR** Built-in cant and **OR** Built-in raised cant and, **as directed**, mounting flange.
      b. Overall Height: 8 inches (200 mm) **OR** 9-1/2 inches (240 mm) **OR** 12 inches (300 mm) **OR** 16 inches (400 mm) **OR** 18 inches (450 mm), **as directed**.
   6. Bird Screening: Galvanized-steel, 1/2-inch- (12.7-mm-) square mesh, 0.041-inch (1.04-mm) wire **OR** Aluminum, 1/2-inch- (12.7-mm-) square mesh, 0.063-inch (1.6-mm) wire **OR** Flattened, expanded aluminum, 3/4 by 0.050 inch (19 by 1.27 mm) thick **OR** Stainless-steel, 1/2-inch- (12.7-mm-) square mesh, 0.047-inch (1.19-mm) wire, **as directed**.
      OR
      Insect Screening: Aluminum, 18-by-16 (1.4-by-1.6-mm) mesh, 0.012-inch (0.30-mm) **OR** Stainless-steel, 18-by-18 (1.4-by-1.4-mm) mesh, 0.009-inch (0.23-mm), **as directed**, wire.
   7. Galvanized-Steel Sheet Finish:
      a. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair galvanizing according to

ASTM A 780. Apply a conversion coating suited to the organic coating to be applied over it.

b. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.

c. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil (0.025 mm) for topcoat and an overall minimum dry film thickness of 2 mils (0.05 mm).

1) Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

8. Accessories:

a. Dampers:

1) Location: Penthouse neck **OR** Inside louver face, **as directed**.

2) Control: Manual **OR** Motorized, **as directed**.

D. Roof Hoods

1. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figures 5-6 and 5-7.

2. Materials: Galvanized-steel sheet, minimum 0.064-inch- (1.62-mm-) thick base and 0.040-inch- (1.0-mm-) thick hood **OR** Aluminum sheet, minimum 0.063-inch- (1.6-mm-) thick base and 0.050-inch- (1.27-mm-) thick hood, **as directed**; suitably reinforced.

3. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch- (40-mm-) thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch (40-mm) wood nailer. Size as required to fit roof opening and ventilator base.

a. Configuration: Self-flashing without a cant strip, with **OR** Built-in cant and **OR** Built-in raised cant and, **as directed**, mounting flange.

b. Overall Height: 8 inches (200 mm) **OR** 9-1/2 inches (240 mm) **OR** 12 inches (300 mm) **OR** 16 inches (400 mm) **OR** 18 inches (450 mm), **as directed**.

4. Bird Screening: Galvanized-steel, 1/2-inch- (12.7-mm-) square mesh, 0.041-inch (1.04-mm) wire **OR** Aluminum, 1/2-inch- (12.7-mm-) square mesh, 0.063-inch (1.6-mm) wire **OR** Flattened, expanded aluminum, 3/4 by 0.050 inch (19 by 1.27 mm) thick **OR** Stainless-steel, 1/2-inch- (12.7-mm-) square mesh, 0.047-inch (1.19-mm) wire, **as directed**.

OR

Insect Screening: Aluminum, 18-by-16 (1.4-by-1.6-mm) mesh, 0.012-inch (0.30-mm) **OR** Stainless-steel, 18-by-18 (1.4-by-1.4-mm) mesh, 0.009-inch (0.23-mm), **as directed**, wire.

5. Galvanized-Steel Sheet Finish:

a. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair galvanizing according to ASTM A 780. Apply a conversion coating suited to the organic coating to be applied over it.

b. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.

c. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil (0.025 mm) for topcoat and an overall minimum dry film thickness of 2 mils (0.05 mm).

1) Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.

E. Goosenecks

1. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 5-5; with a minimum of 0.052-inch- (1.3-mm-) thick, galvanized-steel sheet.

2. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch- (40-mm-) thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch (40-mm) wood nailer. Size as required to fit roof opening and ventilator base.

a. Configuration: Self-flashing without a cant strip, with **OR** Built-in cant and **OR** Built-in raised cant and, **as directed**, mounting flange.
b. Overall Height: 8 inches (200 mm) **OR** 9-1/2 inches (240 mm) **OR** 12 inches (300 mm) **OR** 16 inches (400 mm) **OR** 18 inches (450 mm), **as directed**.

3. Bird Screening: Galvanized-steel, 1/2-inch- (12.7-mm-) square mesh, 0.041-inch (1.04-mm) wire **OR** Aluminum, 1/2-inch- (12.7-mm-) square mesh, 0.063-inch (1.6-mm) wire **OR** Flattened, expanded aluminum, 3/4 by 0.050 inch (19 by 1.27 mm) thick **OR** Stainless-steel, 1/2-inch- (12.7-mm-) square mesh, 0.047-inch (1.19-mm) wire, **as directed**.
OR
Insect Screening: Aluminum, 18-by-16 (1.4-by-1.6-mm) mesh, 0.012-inch (0.30-mm) **OR** Stainless-steel, 18-by-18 (1.4-by-1.4-mm) mesh, 0.009-inch (0.23-mm), **as directed**, wire.
4. Galvanized-Steel Sheet Finish:
a. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair galvanizing according to ASTM A 780. Apply a conversion coating suited to the organic coating to be applied over it.
b. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.
c. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil (0.025 mm) for topcoat and an overall minimum dry film thickness of 2 mils (0.05 mm).
1) 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. Install gravity ventilators level, plumb, and at indicated alignment with adjacent work.
2. Install goosenecks on curb base where throat size exceeds 9 by 9 inches (230 by 230 mm).
3. Install gravity ventilators with clearances for service and maintenance.
4. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
5. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Division 07 Section "Joint Sealants" for sealants applied during installation.
6. Label gravity ventilators according to requirements specified in Division 23 Section "Identification For Hvac Piping And Equipment".
7. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.
8. 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.

B. Connections
1. Duct installation and connection requirements are specified in other Division 21. Drawings indicate general arrangement of ducts and duct accessories.

C. Adjusting
1. Adjust damper linkages for proper damper operation.

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Task	Specification	Specification Description
07 72 13 00	01 95 26 00	Power Ventilators

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SECTION 07 72 23 00 - 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 Final 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 07 72 23 00

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Task	Specification	Specification Description
07 72 26 00	07 72 23 00	Roof Accessories
07 72 33 00	07 72 23 00	Roof Accessories
07 72 36 00	07 72 23 00	Roof Accessories
07 72 63 00	01 22 16 00	No Specification Required
07 73 00 00	07 51 13 00	Built-Up Asphalt Roofing
07 73 00 00	07 05 13 00	Built-Up Coal-Tar Roofing
07 73 00 00	07 53 16 00	EPDM Membrane Roofing
07 73 00 00	07 05 13 00a	CSPE Membrane Roofing
07 73 00 00	07 05 13 00b	APP-Modified Bituminous Membrane Roofing
07 73 00 00	07 05 13 00c	SBS-Modified Bituminous Membrane Roofing
07 73 00 00	07 22 16 00	Fluid-Applied Protected Membrane Roofing
07 76 16 00	01 22 16 00	No Specification Required

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SECTION 07 81 16 00 - 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 Final 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 Final 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 07 81 16 00

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Task	Specification	Specification Description
07 81 23 00	07 81 16 00	Sprayed Fire-Resistive Materials
07 81 33 00	07 81 16 00	Sprayed Fire-Resistive Materials

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SECTION 07 84 13 16 - 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 the 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: 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 Final 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 07 84 13 16

SECTION 07 84 13 16a - 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 IBC Standard **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 07 84 13 16a

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SECTION 07 84 13 16b - 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 07 84 13 16b

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Task	Specification	Specification Description
07 84 13 19	07 84 13 16	Through-Penetration Firestop Systems
07 84 13 19	07 84 13 16a	Fire-Resistive Joint Systems
07 84 13 19	07 84 13 16b	Firestopping
07 84 16 00	03 05 00 00	Cast-In-Place Concrete
07 84 43 00	07 84 13 16	Through-Penetration Firestop Systems
07 84 43 00	07 84 13 16a	Fire-Resistive Joint Systems
07 84 43 00	07 84 13 16b	Firestopping

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SECTION 07 84 56 13 - 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 Final Completion.

END OF SECTION 07 84 56 13

Task	Specification	Specification Description
07 84 56 13	07 81 16 00	Sprayed Fire-Resistive Materials

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SECTION 07 91 23 00 - 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 Final 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 Final 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 07 91 23 00

Task	Specification	Specification Description
07 91 26 00	07 91 23 00	Joint Sealants
07 92 13 00	07 91 23 00	Joint Sealants
07 92 19 00	07 91 23 00	Joint Sealants

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SECTION 07 95 13 13 - 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 07 95 13 13

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SECTION 07 95 13 16 - 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 Final 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 Final 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 07 Section "Expansion Control", 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 Final Completion.

END OF SECTION 07 95 13 16

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07 95 13 16	07 95 13 13	Architectural Joint Systems

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